COURSE OUTLINE BRIEFS

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

SARGODHA UNIVERSITY
Pathway to Progress

FACULTY OF SCIENCES

OVERVIEW

The Department of Computer Sciences and Information Technology was established at the Ibn-ul- Haytham Block in January 2003, where it started with the first batch of Bachelor of Computer Science (BSCS) and Master of Science (MCS) in March 2003. It encompasses Computer Science (CS), Information Technology (IT) and Software Engineering (SE).

The Department is committed to provide a high quality education for solving real world problems and leadership skills to its undergraduates and graduates in theoretical, practical and applied foundations of computer science.

To meet the ever-growing needs in field of CS and IT, the Department offers PhD, MSCS, MSIT, MSc (IT), BS (CS), BS (IT) and BS (SE) programs. The Department has highly qualified faculty including four PhD and 21 MS/MPhil qualified members.

The faculty is carrying out research along with students across a broad range of subjects within CS&IT including Machine Learning, Data Science, Fog Computing, IOT, Natural Language Processing, Software Engineering, Algorithms and Computing.

Academic Programs Offered

1. BS Computer Science
2. BS Information Technology
3. BS Software Engineering
4. MSc Information Technology
5. MS Compute Science
6. MS Information Technology
7. PhD Computer Science

Revised Curriculum of BS Computer Science for Main Campus, Sub Campuses, and Affiliated Colleges

Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall 2019)

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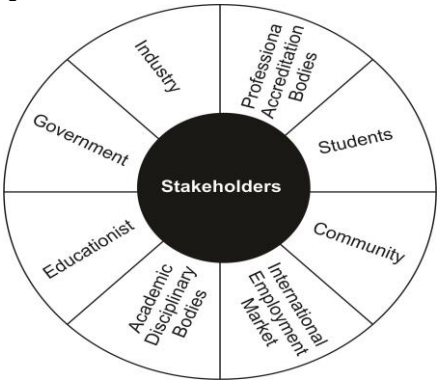
- BSCS program shall be offered under Term System observing University of Sargodha's Affiliation Rules & Regulation.
- There shall be two terms in a calendar academic year.
- The affiliated college(s)/institutions shall follow the prescribed curriculum and course matrix. Necessary modification/changes shall be communicated to the affiliated Colleges/Institutions, if any.
- For specialization elective courses, the affiliated institution(s)/college(s) shall follow "Regular Track". However, the administration of any affiliated institution must get prior permission from the competent authority to offer any specialization tracks from the approved curriculum. For this purpose, the institution's administration needs to show/demonstrate the availability of appropriate human resource along with necessary educational provisions before the start of the term in which specialization track shall be offered. The recommendations of the Convener BOS shall be solicited to allow the Institution to offer the requested specialization track already approved by the BOS.

Underlying Principles of Computer Science Degree Programs

Curriculum plays an important role within education as it outlines the planned and structured learning experiences that an academic program provides. For an effective academic program the curriculum must meet the needs of the stakeholders and face the emerging challenges. The Department of CS & IT (UOS) realizes the rapidly changing needs of today's knowledge intensive technology driven complex work places and the changing patterns of 21st century universities' education which have removed the identity of place, the identity of time, the identity of the scholarly community, and the identity of the student community. To meet these challenges, the Department has revised the existing curriculum. The revised curriculum is based on following underlying principles:



i. The curriculum should be a broad based and provides students with the flexibility to work across many disciplines & professions.
ii. The curriculum should prepare graduates to succeed in a rapidly changing field.
iii. The curriculum should provide guidance for the expected level of mastery of topics by graduates.
iv. Should provide realistic, adoptable recommendations that provide guidance and flexibility, allowing curricular designs that are innovative and track recent developments in the field.
v. The curriculum contents should be relevant and compatible with a variety of institutions.
vi. The size of the essential knowledge must be managed.
vii. The curriculum should identify the fundamental skills and knowledge that all graduates should possess.
viii. The curriculum should provide the greatest flexibility in organizing topics into courses and curricula.

The revised curriculum has developed using top-down curriculum development approach. It has adopted a balanced and multidisciplinary approach and presents a blend of study areas which spread across the boundaries of fundamental knowledge of traditional disciplines to advanced knowledge of the emerging disciplines. Body of knowledge (BOK) of CS program covers knowledge areas which are required for the program's accreditation from the Accreditation Council and knowledge area which are required for professional certification and professional development.

It is universally accepted that each profession needs both a specific skill set and an appropriate mindset. Developing an appropriate mindset of the prospective computing graduates requires a body of knowledge which enriches students' experiences, thoughts, beliefs, assumptions, and attitudes about the special characteristics of that specific domain. Therefore, the course contents and related practical experiences are designed to meet the professional requirements of the respective domain. For this the revised curriculum mainly focuses on following six (6) key areas:

i. Knowledge: Theoretical learning of concepts and principles regarding a particular subject(s).

ii. Skills: Capability of using learnt knowledge and applying it according to the context
iii. Competencies: The ability to do things satisfactory- not necessarily outstandingly or even well, but rather to a minimum level of acceptable performance.
iv. Expertise: Level of proficiency and innovative ways of applying learnt knowledge. (Competitive edge)
v. Dispositions: Habits of mind or tendencies to respond to certain situations in certain ways. The role of dispositions in computing education is very important. For example, having the disposition to be a programmer is much better that just having programming skills.
vi. Values: Moral, ethical and professional practices.

To strengthen the curriculum further, specialization tracks have also been integrated within the curriculum's BOK. These specialization tracks are designed according to what the industry is looking for in an employee and the learning interests of students. Furthermore, life skills including desired dispositions, soft skills, public speaking, critical thinking & reasoning, 21st Century literacies, personal attributes, entrepreneurship, attitude towards lifelong learning, professional practices and other social skills have not considered discrete items, rather threaded into the entire fabric of the curriculum.

Curriculum
for
BS Computer Science Program

BSCS Program's Rationale

Computer Science is the systematic study of the feasibility, structure, expression, and mechanization of the methodical processes (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information, whether such information is encoded in bits and bytes in a computer memory or transcribed in genes and protein structures in a human cell.

Computer Science spans a wide range, from its theoretical and algorithmic foundations to cutting-edge developments in robotics, computer vision, intelligent systems, bioinformatics, image processing, computational biology, computational lenses, and other exciting areas. Computer scientists develop new programming approaches for software development, devise new ways to use computers and develop effective ways to solve computing problems. While other disciplines produce graduates with more immediately relevant job-related skills, computer science offers a comprehensive foundation for research and innovation.

Recent developments in computer hardware, software and communication technologies have offered new exciting opportunities and challenges for creation of innovative learning environments for Computer Science and its curricula design. The challenge of getting all newly emerging technologies incorporated into the curriculum is becoming pivotal for the effectiveness of curricula. There is a need for curricula structures that are really able to meet the challenges of 21st century knowledge driven complex work places. The key rationale behind the BS Computer Science program is to prepare a curriculum that provide integration of all components and the foundations that allow accessing all of the new knowledge and technology to fulfill the vision of future.

Program's Aims & Objectives

BSCS Program is committed to create, expand, disseminate and teach the computer science body of knowledge through academics, applications and research which positively impact society locally, nationally, and internationally.

BSCS program aims to develop students' critical professional thinking and intuition. The program's curriculum provides a balanced mixture of learning experiences to make the graduates capable of sound professional decisions. As a result, the successful graduates will be able to assume responsible positions in business, government, and education at the research, development, and planning levels. The program also provides an excellent foundation for further formal learning and training. The program is also expected to provide environments to put into practice, the principles and techniques learnt during the course of implementation of the program's curriculum. Some of the key objectives of the program are listed below:

- The program should provide a broad understanding of the field through introducing concepts, theory, techniques, and through intensive education/training in focused areas of Computer Science.

- The program should encourage students to develop and use abstract models in addition to apply respective technology in practical situations.
- The program should promote students' special communication skills both orally and in writing. They must be able to produce well-organized reports/presentations/projects, which clearly delineate objectives, methods of solution, results, and conclusions for a complex task.
- The program should provide formal foundations for higher learning and education.
- The program should be dynamic and flexible enough to maintain its body of knowledge in line with the latest scientific and technological developments in the field.
- The program should provide professional orientation to prepare students for industry.

Program's Outcome

The program will produce Computer Scientists of great character, competence, vision and drive equipped with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in computer science domain or proceed to further or higher education or training.

Program's Structure

The structure of a BS Computer Science program meets the needs of students with formal computing experience and relevant skills. The students are expected to learn theoretical and practical understanding of the entire field of Computer Science. The program structure is dynamic and provides basis for various options including Breadth-Based, Depth-Based, and Integrated Breadth & Depth-Based specializations. Student may choose a particular option, which is the most appropriate to their planned future career. Followings are the program's details:

Specialization Tracks

Students can opt one of the following specialization tracks:

1. Regular Track
2. Computer Science
3. Web Engineering
4. Database Management Systems
5. Software Engineering
6. Computer Network

Degree Requirement

Minimum credit hours shall be 132 for BS Computer Science program including elective courses& a capstone project.

Duration

The program shall comprise Eight (8) Semesters/Terms spread over Four (4) calendar years with two Semesters/Terms a year as per rules of the University.

Eligibility Criteria

The minimum requirements for admission in a Bachelor degree program in Computer Science, is **at least 50% marks in Intermediate (HSSC) examination**

with Mathematics or equivalent qualification with Mathematics certified by IBCC.

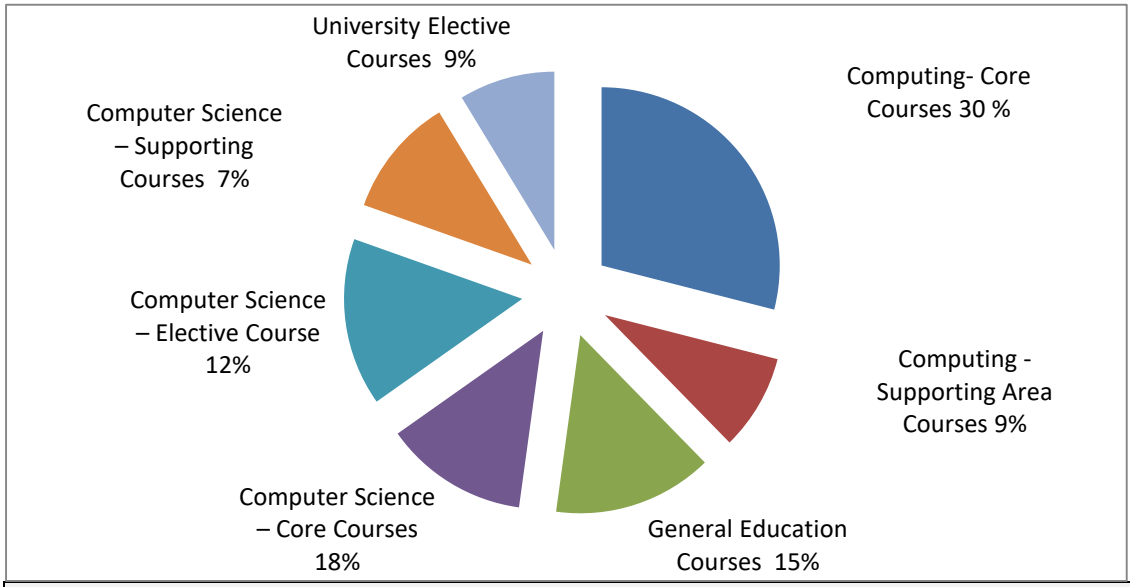
Assessment& Evaluation

University's semester and examination rules & regulations shall be followed for assessment & evaluation.

Distribution of Courses

Followings are the distribution of total credit hours:

Distribution of Courses		
Major Areas	**Credit Hours**	%
Computing- Core Courses	39	30%
Mathematics & Science Foundation	12	9%
General Education Courses	19	15%
Computer Science – Core Courses	24	18%
Computer Science – Elective Course	15	12%
Computer Science – Supporting Courses	09	7%
University Elective Courses	12	9%
Total	**130**	**100%**



Computing Core Courses – 39 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
1	CMPC-101	-	Programming Fundamentals	4 (3+1)
2	CMPC-102	CMPC-101	Object Oriented Programming	4 (3+1)
3	CMPC-104	-	Discrete Structures	3 (3+0)
4	CMPC-201	CMPC-102	Data Structure and Algorithms	4 (3+1)

5	CMPC-302	-	Information Security	3 (3+0)
6	CMPC-301	-	Operating Systems	4 (3+1)
7	CMPC-202	-	Database Systems	4 (3+1)
8	CMPC-204	-	Software Engineering	3 (3+0)
9	CMPC-205	-	Computer Networks	4 (3+1)
10	CMPC-401	-	Capstone Project	6 (0+6)

Mathematics & Science Foundation Courses - 12 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
11	MATH-101	-	Calculus and Analytical Geometry	3 (3+0)
12	MATH-102	-	Probability and Statistics	3 (3+0)
13	MATH-202	-	Linear Algebra	3 (3+0)
14	PHYS-101	-	Applied Physics	3 (3+0)

General Education Courses – 19 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
15	ENGL-101	-	Functional English (English-I)	3 (3+0)
16	ENGL-102	ENGL-101	Communication Skills (English-II)	3 (3+0)
17	ENGL-201	ENGL- 101	Technical and Report Writing (English-III)	3 (3+0)
18	ISLS-101	-	Islamic Studies	2 (2+0)
19	PKST-201	-	Pakistan Studies	2 (2+0)
20	ICTC-101	-	Introduction to Information & Communication Technologies	3(2+1)
21	CSSC-402	-	Professional Practices	3 (3+0)

Computer Science – Core Courses - 24 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
22	CSCC-102		Digital Logic and Design	4 (3+1)
23	CSCC-201	CSCC-102	Computer Organization and Assembly Language	4 (3+1)
24	CSCC-301		Theory of Automata	3 (3+0)
25	CSCC-202	CMPC-201	Design and Analysis of Algorithms	3 (3+0)
26	CSCC-302	CMPC-201	Artificial Intelligence	4 (3+1)
27	CSCC-304		Parallel & Distributed Computing	3 (3+0)
28	CSCC-306	CSCC-301	Compiler Construction	3 (3+0)

Computer Science Supporting Courses - 9 Credit Hours (Any three of the below)				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
29	MATH-301	MATH-101	Multivariable Calculus	3 (3+0)
30	CSSC-301	-	Differential Equations	3 (3+0)

31	CSSC-303	-	Numerical Computing	3 (3+0)
32	CSSC-307	CMPC-204	Object-Oriented Analysis and Design	3 (3+0)
33	CSSC-305	CSCC-102	Computer Architecture	3 (3+0)
34	CSSC-306		Internet Architecture and Protocols	3 (3+0)

GE/University Elective Courses - Credit Hours (Any four of the below)				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
35	BUSB-201	-	Principles of Management	3(3+0)
36	BUSB-204	-	Human Resource Management	3(3+0)
37	BUSB-202	-	Organizational Behavior	3(3+0)
38	ECON-402	-	Business Economics	3(3+0)
39	BUSB-401	-	Entrepreneurship	3(3+0)
40	BUSB-402		Financial Accounting	3(3+0)

Computer Science Elective Courses - 15 Credit Hours

Regular Track Elective Courses - 15 Credit Hours (Any 5 Courses) for Main Campus, Mianwali, Bhakkar Campus				
42	CSEC-301	-	Web systems Technologies	3(3+0)
43	CSEC-302	-	Multimedia Systems and Design	3(3+0)
44	CSEC-303	-	Big Data Analytics	3(3+0)
45	CSEC-304	-	Digital Image Processing	3(3+0)
46	CSEC-305	-	E-Commerce Applications Development	3(3+0)
47	CSEC-306	-	Enterprise Resource Planning Systems	3(3+0)
48	CSEC-312	-	Mobile Application Development	3(3+0)
49	CSEC-308	-	Enterprise Application Development	3(3+0)
50	CSEC-309	-	Cloud Computing	3(3+0)
51	CSEC-310	-	Systems Programming	3(3+0)
52	CSEC-311	-	Management Information Systems	3(3+0)
53	CSEC-401	-	Game Application Development	3(3+0)
54	CSEC-402	-	Computer Graphics	3(3+0)

55	CSEC-403	-	Semantic Web Techniques	3(3+0)
56	CSEC-404	-	Virtual Reality	3(3+0)
57	CSEC-405	-	Mobile Computing	3(3+0)
58	CSEC-406	-	Data Warehousing	3(3+0)
59	CSEC-407	-	Data Mining	3(3+0)
60	CSEC-408	-	Business Intelligence and Analytics	3(3+0)
61	CSEC-409	-	Database Administration & Management	3(3+0)
62	CSEC-410	-	Advance Database Management	3(3+0)
63	CSEC-411	-	Business Process Management	3(3+0)
64	CSEC-412	-	Knowledge Management	3(3+0)
65	CSEC-413	-	Graph Theory and Algorithms	3(3+0)

Course Coding Scheme

Course Level	
Level	**Course Type**
1	Foundation, Core Level 1 Courses
2	Foundation, Core Level 1 Courses
3	Core Level 2 + Specialization Level 1
4	Specialization Level 2
Discipline Code	
CMPC	Computing Core
CSCC	Computer Science Core
CSSC	Computer Science Supporting
CSEC	Computer Science Elective
PKST	Pakistan Studies
ISLS	Islamic Studies
MATH	Mathematics
ENGL	English
BUSB	Management
PHYS	Physics
ICTC	Information & Communication Technologies

Scheme of Studies for BS Computer Science Program for (Main, Mianwali , and Bhakkar Campuses)

(130 Credit Hours)

Semester - I

Code	Course Title	Credit Hours	Pre-requisite
ICTC-101	Introduction to ICT	2-1	
CMPC-101	Programming Fundamentals	3-1	
ENGL-101	Functional English	3-0	
MATH-101	Calculus & Analytical Geometry	3-0	
PHYS-101	Applied Physics	3-0	
ISLS-101	Islamic Studies	2-0	
	Total	16-2	

Semester - II

Code	Course Title	Credit Hours	Pre-requisite
CSCC-102	Digital Logic and Design	3-1	
CMPC-102	Object Oriented Programming	3-1	Programming Fundamentals
MATH-102	Probability & Statistics	3-0	
CMPC-104	Discrete Structure	3-0	
ENGL-102	Communication Skills	3-0	Functional English
	Total	15-2	

Semester - III

Code	Course Title	Credit Hours	Pre-requisite
CSCC-201	Comp Organization & Assembly Language	3-1	
CMPC-201	Data Structures & Algorithms	3-1	Object Oriented Programming
ENGL-201	Technical & Report Writing	3-0	Communication Skills
PKST-201	Pakistan Studies	2-0	
CMPC-205	Computer Networks	3-1	
xxxx-2xx	University Elective-1	3-0	
	Total	17-3	

Semester - IV

Code	Course Title	Credit Hours	Pre-requisite
CSCC-202	Design & Analysis of Algorithms	3-0	Data Structures & Algorithms
CMPC-202	Database Systems	3-1	
MATH-202	Linear Algebra	3-0	
CMPC-204	Software Engineering	3-0	
xxxx-2xx	University Elective-II	3-0	
	Total	15-1	

Semester - V

Code	Course Title	Credit Hours	Pre-requisite
CSCC-301	Theory of Automata	3-0	
CMPC-301	Operating Systems	3-1	Data Structures and Algorithms
CSEC-3xx	CS Elective-I	3-0	
CSSC-3xx	CS Supporting-I	3-0	
CSSC-3xx	CS Supporting-II	3-0	
CSSC-3xx	CS Supporting-III	3-0	
	Total	18-1	

Semester - VI

Code	Course Title	Credit Hours	Pre-requisite
CSCC-302	Artificial Intelligence	3-1	Discrete Structures
CSCC-306	Compiler Construction	3-0	Theory of Automata
CSCC-304	Parallel & Distributed Computing	3-0	
CMPC-302	Information Security	3-0	
CSEC-3xx	CS Elective-II	3-0	
	Total	15-1	

Semester - VII

Code	Course Title	Credit Hours	Pre-requisite
CMPC-401	Capstone	0-3	
CSEC-4xx	CS Elective-III	3-0	
xxxx-4xx	University Elective-III	3-0	
CSEC-4xx	CS Elective-IV	3-0	
	Total	9-3	

Semester - VIII

Code	Course Title	Credit Hours	Pre-requisite
CMPC-402	Capstone	0-3	
CSSC-402	Professional Practice	3-0	
CSEC-4xx	CS Elective-V	3-0	
xxxx-4xx	University Elective-IV	3-0	
	Total	9-3	

Scheme of Studies for BS Computer Science Program for (Affiliated Colleges and PPP- Sub Campuses)

(130 Credit Hours)

Semester - I

Code	Course Title	Credit Hours	Pre-requisite
ICTC-101	Introduction to ICT	2-1	

CMPC-101	Programming Fundamentals	3-1	
ENGL-101	Functional English	3-0	
MATH-101	Cal3culus & Analytical Geometry	3-0	
PHYS-101	Applied Physics	3-0	
ISLS-101	Islamic Studies	2-0	
	Total	16-2	

Semester - II

Code	Course Title	Credit Hours	Pre-requisite
CSCC-102	Digital Logic and Design	3-1	
CMPC-102	Object Oriented Programming	3-1	Programming Fundamentals
MATH-102	Probability & Statistics	3-0	
CMPC-104	Discrete Structure	3-0	
ENGL-102	Communication Skills	3-0	Functional English
	Total	15-2	

Semester - III

Code	Course Title	Credit Hours	Pre-requisite
CSCC-201	Comp Organization & Assembly Language	3-1	
CMPC-201	Data Structures & Algorithms	3-1	Object Oriented Programming
ENGL-201	Technical & Report Writing	3-0	Communication Skills
PKST-201	Pakistan Studies	2-0	
CMPC-205	Computer Networks	3-1	
BUSB-201	Principles of Management	3-0	
	Total	17-3	

Semester - IV

Code	Course Title	Credit Hours	Pre-requisite
CSCC-202	Design & Analysis of Algorithms	3-0	Data Structures & Algorithms
CMPC-202	Database Systems	3-1	
MATH-202	Linear Algebra	3-0	
CMPC-204	Software Engineering	3-0	
BUSB-204	Human Resource Management	3-0	
	Total	15-1	

Semester - V

Code	Course Title	Credit Hours	Pre-requisite
CSCC-301	Theory of Automata	3-0	
CMPC-301	Operating Systems	3-1	Data Structures and Algorithms

CSEC-301	Web systems Technologies	3-0
CSSC-301	Multimedia Systems and Design	3-0
MATH-301	Multivariable Calculus	3-0
CSSC-307	Object-Oriented Analysis and Design	3-0
	Total	18-1

Semester - VI

Code	Course Title	Credit Hours	Pre-requisite
CSCC-302	Artificial Intelligence	3-1	Discrete Structures
CSCC-306	Compiler Construction	3-0	Theory of Automata
CSCC-304	Parallel & Distributed Computing	3-0	
CMPC-302	Information Security	3-0	
CSEC-312	Mobile Application Development	3-0	
	Total	15-1	

Semester - VII

Code	Course Title	Credit Hours	Pre-requisite
CMPC-401	Capstone I	0-3	
CSEC-407	Data Mining	3-0	
BUSB-401	Entrepreneurship	3-0	
CSEC-409	Database Administration & Management	3-0	
	Total	9-3	

Semester - VIII

Code	Course Title	Credit Hours	Pre-requisite
CMPC-402	Capstone II	0-3	
CSSC-402	Professional Practice	3-0	
CSEC-406	Data Warehousing	3-0	
BUSB-402	Financial Accounting	3-0	
	Total	9-3	

Contents of Computing Core Courses

CMPC-101 Programming Fundamentals			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Problem solving skills	C	1
2. Coding skills	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective		

	domain

Course Content:

1. Introduction, Introduction to Computer Programming: Machine Languages, Assembly Languages and High-Level Languages. History of C, C Standard Library, Typical C Program Development Environment, Memory Concepts, white spaces, comments. [Ch. 1]
2. Principles of Structured and Modular Programming: Algorithms, Pseudo code, flowchart representation. Basic Data Types (variables, constants). [Ch. 2]
3. Unary (increment/decrement) and Binary (arithmetic, relational, arithmetic assignment) operators. Arithmetic (Expression) in C. C Programming Basics: Programming Practices, Summary. [Ch. 1, 2, 3]
4. Decision Statements: if statement, if-else statement, Multi if-else-if statement. Decision Statements: Nested if-else statements, Switch Statement. [Ch. 3]
5. Decision Statements: Conditional operator, Logical Operators, Programming Practices, and Summary. Program Control: Repetition Essentials, Counter-Controlled Repetition. for loop. [Ch. 3]
6. Loops: while loop, do while loop [Ch. 4]
7. Nested loop structures. Other Control Statements, break and continue Statements, Logical Operators, Confusing Equality (==) and Assignment (=) Operators. Programming Practices, Summary. [Ch. 4]
8. Arrays: Defining Arrays, Array Examples (finding max, min value from the array). Searching techniques (linear search, Binary search). Sorting Arrays: selection sort, bubble sort. Case Study: Computing Mean, Median and Mode Using Arrays. [Ch. 6]
9. Strings: String Library Functions Characters and Strings: Fundamentals of Strings and Characters. Strings: Character-Handling Library, Programming Practices, Summary. [Ch. 8]
10. Functions: Function declaration, definition, Passing Arguments to functions, Returning values from functions. Functions: Arguments pass by reference and pass by copy. [Ch. 8]
11. Functions: Passing arrays and strings to functions. Functions: Inline functions, Default arguments, Local and global variables, Summary. [Ch. 8]
12. Pointers: Pointers and their purpose. Pointer expressions. Pointers: Pointers and arrays, Pointers in functions. [Ch. 8]
13. Pointers: Static and dynamic memory allocation, Memory Management using Pointers. Problems with pointers, program practice, Summary.[Ch. 8]
14. Structures: Purpose, Defining structures, Initializing Structures, Accessing Structure Members. Example (complex number or Time). Structures: Passing Structures to functions, Structures using pointers,
15. File Processing: Data Hierarchy, Files and Streams, Creating a Sequential-Access File, Reading Data from a Sequential-Access File. File Processing: Random-Access Files, Creating a Random-Access File, Writing Data Randomly to a Random-Access File, Reading Data from a Random-Access File. [Ch.10]
2. Revise + Lab Exam discussion, Class discussion

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. C How to Program by Paul Deitel and Harvey Deitel, Prentice Hall; 7th Edition (March 4, 2012)
2. Programming in C by Stephen G. Kochan, Addison-Wesley Professional; 4 edition (September 25, 2013). ISBN-10: 0321776410

CMPC-102 Object Oriented Programming			
Credit Hours:	3+1	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand principles of object oriented paradigm.	C	2
2. Identify the objects & their relationships to build object oriented solution	C	3
3. Model a solution for a given problem using object oriented principles	C	3
4. Examine an object oriented solution.	C	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Classes, Objects and Strings: Defining a Class with a Member Function, Defining a Member Function with a Parameter, Data Members, set Member Functions and get Member Functions, Initializing Objects with Constructors, Placing a Class in a Separate File for Reusability, Separating Interface from Implementation, Validating Data with set Functions [Ch. 3]
2. Class Templates array and vector; Catching Exceptions: Introduction, Arrays, Declaring arrays, Examples Using arrays, Range-Based for Statement, Sorting and Searching arrays, Multidimensional arrays. [Ch. 7]
3. Classes - Throwing Exceptions: Class Scope and Accessing Class Members, Access Functions and Utility Functions, Constructors with Default Arguments, Destructors, When Constructors and Destructors Are Called, Default Memberwise Assignment, const Objects and const Member Functions, Composition: Objects as Members of Classes, friend Functions and friend Classes, Using the this Pointer, static Class Members. [Ch. 9] Operator Overloading; Class string: Introduction, Using the Overloaded Operators of Standard Library Class string, Fundamentals of Operator Overloading, Overloading Binary Operators, Overloading the Binary Stream Insertion and Stream Extraction Operators, Overloading Unary Operators, Overloading the Unary Prefix and Postfix ++ and – Operators, Dynamic Memory Management, Operators as Member vs. Non-Member Functions, Converting Between Types, explicit Constructors and Conversion Operators, Overloading the Function Call Operator ()[Ch. 10].
4. Inheritance: Introduction, Base Classes and Derived Classes, Relationship between Base

and Derived Classes, Constructors and Destructors in Derived Classes, public, protected and private Inheritance, Software Engineering with Inheritance. [Ch. 11]]

5. Polymorphism: Introduction, Relationships Among Objects in an Inheritance Hierarchy, Type Fields and switch Statements, Abstract Classes and Pure virtual Functions, Polymorphism, Virtual Functions and Dynamic Binding ―Under the Hood‖. [Ch. 12]
6. Stream Input/Output: Introduction, Streams, Stream Output, Stream Input, Unformatted I/O Using read, write and gcount, Introduction to Stream Manipulators, Stream Format States and Stream Manipulators, Stream Error States, Tying an Output Stream to an Input Prentice Hall File Processing: Introduction, Files and Streams, Creating a Sequential File, Reading Data from a Sequential File, Updating Sequential Files, Random-Access Files, Creating a Random-Access File, Writing Data Randomly to a Random-Access File, Reading from a Random-Access File Sequentially [Ch. 14]
7. Standard Library Containers and Iterators: Introduction to Containers, Introduction to Iterators, Introduction to Algorithms, Sequence Containers, Associative Containers, Container Adapters, Class bitset. [Ch. 15]
8. Exception Handling: Introduction, Rethrowing an Exception, Stack Unwinding, When to Use Exception Handling, Constructors, Destructors and Exception Handling, Exceptions and Inheritance, Processing new Failures, Class unique_ptr and Dynamic Memory Allocation, Standard Library Exception Hierarchy. [Ch. 17]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book & Reference Materials:

1. C++ How to Program, 10th Edition, Deitel & Deitel.
2. Object Oriented Programming in C++, 3rd Edition by Robert Lafore
3. Starting Out with C++ from Control Structures to Objects, 9th Edition, Tony Gaddis
4. Java: How to Program, 9th Edition by Paul Deitel
5. Beginning Java 2, 7th Edition by Ivor Horton
6. An Introduction to Object Oriented Programming with Java, 5th Edition by C. Thomas Wu

CMPC-104 Discrete Structures			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
The course provides a solid theoretical foundation of discrete structures as they apply to computer science problems and structures. The students will learn how to use mathematical notation and solve problems using mathematical tools.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Logic: Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Methods of Proof. [TB: Ch. 1]
2. Sets & Functions, Sequences and Summations. [TB: Ch. 2]
3. Algorithms: the Growth of Functions, Complexity of Algorithms, the Integers and Division, Matrices. [TB: Ch. 3]
4. Number Theory and Cryptography. [TB: Ch. 4]
5. Advanced Counting Techniques: Recurrence Relations, Solving Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion-Exclusion & its Application. [TB: Ch. 8]
6. Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings. [TB: Ch. 9]
7. Graph: Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. [TB: Ch. 10]
8. Trees: Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees. [TB: Ch. 11]

Teaching Methodology:

Lectures, Class Exercises

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

- K. H. Rosen, Discrete Mathematics and Its Applications, McGraw-Hill Science/Engineering/Math, 7th Ed. 2011. ISBN-10: 0073383090
- R. Johnsonbaugh, Discrete Mathematics, Pearson; 7th Ed., 2008. ISBN-10: 0131593188
- S. B. Maurer and A. Ralston, Discrete Algorithmic Mathematics, A K Peters/CRC Press; 3rd Ed., 2004. ISBN-10: 1568811667
- B. Kolman, R. Busby and S. C. Ross, Discrete Mathematical Structures, Pearson, 6th Ed. 2008. ISBN-10: 0132297515

CMPC-201 Data Structures and Algorithms			
Credit Hours:	3+1	**Prerequisites:**	Object Oriented Programming

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Acquire the basic knowledge of data structures & algorithms and understand the concepts of various data structures and use them in different applications.	C	1,2
2. Solve, analyze and evaluate the problems using different data structures and algorithms.	C	3
3. Demonstrate& apply independently the various forms of data structures and algorithms	P	3,4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Course, Basic Object Orientation concepts, Properties of Algorithm, Introduction to Algorithm's Performance Analysis and Measurement (Big Oh Notation)
2. ADT, Basic Operations, Reading, Writing, Insertion, Deletion, Merging, Binary

Search.
3. Introduction to Sorting types and Techniques, Logical and Algorithmic Implementation of Bubble, Selection Sort, Insertion, Quick Sort, Merge Sort.
4. The Stack ADT, Expressions, Postfix Notation, Infix to postfix, postfix evaluation, Applications of stack
5. Introduction to Recursion, Examples of Recursion, Writing Recursive Programs
6. The Queue ADT and Its Applications, Variation of Queue ADT i.e. Circular and Double Ended Queue
7. Priority Queues, Introduction to Pointers, Linear single Link
8. Linked Stacks and Queues, Linear Doubly Linked list
9. Circular Lists: Implementation of queues and stacks, Doubly Link List
10. Introduction to Trees, Tree Terminology, Logical construction and Representation of Trees, Introduction to Binary Tree ADT, Mathematical properties, Linked Implementation of Binary Trees (Insertion, Traversing, Searching and deletion in Binary Trees)
11. Binary Search Tree, Implementation and Applications of BSTs
12. Heaps and Heaps as Priority Queues, Introduction to Balanced and AVL Trees, Heap Sort.
13. Hashing, Overflow Handling, Open Addressing, Chaining
14. Introduction to graph and related terminology, Adjacency Matrix representation of graph and Adjacency list
15. Elementary Graph Operations, DFS, BFS, Spanning Trees
16. Shortest path algorithms: Dijkstra Algorithm, Minimum Cost Spanning Trees.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Data Structures and Algorithms in C++ by Michael T. Goodrich, Roberto Tamassia, and David Mount (2nd Edition) : ISBN-13: 978-0470383278
2. Data Structures and Algorithms in C++ 4th Edition by Adam Drozdek : ISBN-13: 978-1133608424
3. Data Structures and Algorithm Analysis in Java (3rd Edition) 3rd Edition by Mark A. Weiss : ISBN-13: 978-0132576277
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, “Introduction to Algorithms”, 2nd Ed, MIT Press, 2001, ISBN 0-07-013151-1
5. Data Structures and Abstractions with Java (5th Edition) (What's New in Computer Science) 5th Edition by Frank M. Carrano (Author), Timothy M. Henry (Author) : ISBN-13: 978-0134831695
6. Data Structures & Algorithm Analysis in C++ 4th Edition by Mark A. Weiss : ISBN-13: 978-0132847377

CMPC-301 Operating Systems			
Credit Hours:	3+1	**Prerequisites:**	Data Structures and Algorithms

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT**

		Level*
1. Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	C	2
2. Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions.	C	4,5
3. Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction: Over view of: Operating Systems, Operating-System Structure, Operating-System Operations, Process management, Memory Management, Storage Management, Protection and Security, Protection and Security, Distributed Systems, Special-Purpose Systems, Computing Environments. [TB: Ch1]
2. Operating-System Structures: Operating-System Services, Operating-System Structure, User Operating-System Interface, Virtual Machines, System Calls, Operating-System Generation, Types of System Calls, System Boot, System Programs. [TB:Ch2].
3. Processes: Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication, Communication in Client- Server Systems. Threads: Multithreading Models, Thread Libraries, Threading Issues. [TB: Ch. 3, 4]
4. CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling, Algorithm Evaluation. [TB: Ch. 5]
2. Process Synchronization: Background, Monitors, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classic Problems of Synchronization. [TB: Ch. 6]
3. Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock. [TB: Ch. 7]
4. Main Memory: Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Example: The Intel Pentium. [TB: Ch.8]
5. Virtual Memory: Allocating Kernel Memory, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing. [TB: Ch. 9]
6. File-System Implementation: File-System Structure, Log-Structured File Systems, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery. [TB: Ch. 11]
7. Security: The Security Problem, Computer-Security, Program Threats, Classifications, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks. [TB: Ch. 15]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book & Reference Materials:

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz [Text Book]
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

CSCC-102 Digital Logic and Design			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Introduces students with digital circuit of large complexity and how such circuits could be built in a methodological way, starting from Boolean logic and applying a set of rigorous techniques	C	1

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Number Systems, Operations, and Codes: Decimal Numbers, Binary Numbers, Decimalto-Binary Conversion, Binary Arithmetic, I's and 2's Complements of Binary, Numbers,
   Signed Numbers, Arithmetic Operations with Signed Numbers, Hexadecimal Numbers, Octal Numbers, Binary Coded Decimal (BCD), Digital Codes, Error Detection and Correction Codes. [Ch. 2]
2. Logic Gates: The Inverter, The AND Gate, The OR Gate, The NAND Gate, The NOR Gate, The Exclusive-OR and Exclusive-NOR Gates. [Ch. 3]
3. Boolean Algebra and logic Simplification: Boolean Operations and Expressions, Laws and Rules of Boolean Algebra, DeMorgan's Theorem, Boolean Analysis of Logic Circuits, Simplification Using Boolean Algebra, Standard Forms of Boolean Expressions, Boolean Expressions and Truth Tables, The Kamaugh Map, Karnaugh Map SOP Minimization, Karnaugh Map POS Minimization, Five-Variable Karnaugh Maps. [Ch. 4]
4. Combinational logic Analysis: Basic Combinational Logic Circuits, Implementing Combinational Logic, The Universal Property of NAND and NOR Gates, Combinational Logic Using NAND and NOR Gates. [Ch. 5]
5. Functions of Combinational logic: Basic Adders, Parallel Binary Adders, Ripple Carry versus Look-Ahead Carry Adders, Comparators, Decoders, Encoders. Code Conveners: Multiplexers (Data Selectors), Demultiplexers, Parity Generators/Checkers.[Ch. 6]
6. latches, Flip-Flops, and Timers: Latches, Edge-Triggered Flip-Flops, Flip-Flop Operating Characteristics, Flip-Flop Applications. [Ch. 7]
7. Counters: Asynchronous Counter Operation, Synchronous Counter Operation, Up/Down Synchronous Counters, Design of Synchronous Counters. [Ch. 8]
8. Shift Registers: Basic Shift Register Functions, Serial In/Serial Out Shift Registers, Serial In/Parallel Out Shift Registers, Parallel In/Serial Out Shift Registers, Parallel In/Parallel Out Shift Registers, Bidirectional Shift Registers, Shift Register Counters. [Ch. 9]
9. Memory and Storage: Basics of Semiconductor Memory, Random-Access Memories

(RAMs), Read-Only Memories (ROMs), Programmable ROMs (PROMs and EPROMs), Flash Memories. [Ch. 10] 10. Programmable Logic: FPGA [Ch. 11]
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Digital Fundamentals by Thomas L. Floyd, Prentice Hall; 9th edition (2007) 2. Digital Fundamentals: A Systems Approach by Thomas L. Floyd, Prentice Hall; 1 edition (July 13, 2012) 3. Digital Design, by M. Morris Mano, Michael D. Ciletti, 4th Edition, Prentice Hall (2007). ISBN-10: 0131989243

CMPC-202 Database Systems			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain fundamental database concepts.	C	2
2. Design conceptual, logical and physical database schemas using different data models.	C	3
3. Identify functional dependencies and resolve database anomalies by normalizing database tables.	C	3
4. Use Structured Query Language (SQL) for database definition and manipulation in any DBMS	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Databases Overview: Basic Concepts and Definitions, Traditional File Processing & Database Approach [TB1: Ch 1]
2. Data Models, Advantages of Database Approach, Costs and Risks of Database Approach, Components of the Database Environment, The Database Development Process [TB1: Ch 1]
3. E-R Model, Modelling Rules of the Organisation, Modelling Entities and Attributes, Modelling Relationships [TB1: Ch 2]
4. Enhanced E-R Model, Representing Supertypes and Subtypes, Specifying Constraints in Supertype/Subtype Relationships [TB1: Ch 3]
5. Relational Data Model, Integrity Constraints, Transforming EER Diagrams into Relations [TB1: Ch 4]
6. Introduction to Normalization, First Normal Form, Second Normal Form, Third Normal Form, Functional Dependencies and Keys [TB1: Ch 4]
7. The Physical Database Design Process, Designing Fields: Choosing Data Types, Coding Techniques, Handling Missing Data [TB1: Ch 5]

8. Denormalizing and Partitioning Data, File Organizations (Heap, Sequential, Indexed, Hashed), Creating a Unique/Nonunique Key Index, When to Use Indexes [TB1: Ch 5]
9. Introduction to SQL, The SQL Environment, Defining a Database in SQL [TB1: Ch 6]
10. Basic SQL Commands for Processing Single Tables [TB1: Ch 6]
11. SQL Commands for Processing Multiple Tables using Joins and Subqueries [TB1: Ch 7]
12. Client/Server Architectures, Databases in a Two-Tier Architecture, Three-Tier Architectures [TB1: Ch 8]
13. Web Application Components, Databases in Three-Tier Applications [TB1: Ch 8]
14. The Roles of Data and Database Administrators, Database Backup and Recovery, Types of Database Failure, Disaster Recovery [TB1: Ch 12]
15. Controlling Concurrent Access, Serializability, Locking Mechanisms, Data Dictionaries and Repositories [TB1: Ch 12]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Modern Database Management by Jeffrey A. Hoffer, V. Ramesh, and Heikki Topi. Pearson; 12th Edition (2015). ISBN-10: 1292101857
2. Fundamentals of Database Systems by R. Elmasri and S. Navathe. Pearson; 7th Edition (2015). ISBN-10: 0133970779
3. Database System Concepts by Abraham Silberschatz, Henry F. Korth and S. Sudarshan. McGraw-Hill Education; 6th Edition (2010). ISBN-10: 0073523321
4. Oracle 12c: SQL by Joan E. Casteel. Cengage Learning; 3rd Edition (2015). ISBN-10: 1305251032

CMPC-204 Software Engineering			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explains how various software development models and software development life cycles are applied.	C	4
2. Presents the fundamentals concepts of project management.	C	3
3. Important Requirements modeling, fact-finding techniques		
4. Have knowledge of software configuration management.	C C	3 4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. The Nature of Software, Unique Nature of WebApps, Software Engineering, The Software Process, Software Engineering Practice, Software Myths. [TB1: Ch. 1]
2. Generic Process Models: Framework Activity, Task Set, Process Patterns, Process Improvement, CMM, Prescriptive Process Models: Waterfall Model, Incremental Process Model, Evolutionary Process Model. [TB1: Ch. 2]

3. Specialized Process Models: Component Based Development, The Formal Methods Models, Agile Development. [TB1: Ch. 2-3]
5. Introduction to Systems Analysis and Design, Business Information Systems, Information System Components, Types of Information Systems, Evaluating Software, Make or Buy Decision. [TB1: Ch. 1]
6. Introduction to SDLC, SDLC Phases, System Planning, Preliminary Investigation, SWOT Analysis. [TB1: Ch. 2]
2. The Importance of Strategic Planning, Information Systems Projects, Evaluation of Systems Requests, Preliminary Investigation, Systems Analysis, Requirements Modeling, Fact-Finding Techniques. [TB1: Ch. 2-3]
3. Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Requirements Model. [TB1: Ch. 5]
4. Requirements Modelling Strategies, Difference between Structured Analysis and Object Oriented Analysis; Difference between FDD Diagrams & UML Diagrams. [TB2:Ch. 3]
5. Data & Process Modelling, Diagrams: Data Flow, Context, Conventions, Detailed Level DFD‘s Diagram 0, Levelling, Balancing, Logical Versus Physical Models. [TB2: Ch. 4]
6. Design Within the Context of Software Engineering, The Design Process, Design Concepts, Design Models: Data Design Elements. [TB1: Ch. 8]
7. Architecture Design Elements, Interface Design Elements, Component-Level Design Elements, Deployments Design Elements. [TB: Ch. 8]
8. System Architecture, Architectural Styles, User Interface Design: The Golden Rules, User Interface Analysis and Design, WebApps Interface Design. [TB1: Ch. 9-11]
9. Software Quality Assurance: Background Issues, Elements of Software Quality Assurance, Software Testing Strategies, Strategic Issues, Test Strategies for Conventional Software. [TB1: Ch.16-17]
10. Validation Testing, System Testing, Internal and External View of Testing: White Box Testing and Black Box Testing Techniques. [TB1: Ch. 17-18)]
11. Introduction to Project Management, Project Scheduling: Gantt Chart, Risk Management: Proactive versus Reactive Risk Strategies, Software Risks, Maintenance and Reengineering: Software Maintenance, Software Reengineering. [TB1: Ch. 28-29]

Teaching Methodology:

Lecturing, Written Assignments, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Software Engineering: A Practitioner's Approach by Roger S. Pressman, McGraw-Hill Science/Engineering/Math; 7th Edition (2009). ISBN-10: 0073375977
2. Software Engineering 8E by Ian Sommerville, Addison Wesley; 8th Edition (2006). ISBN-10: 0321313798
3. Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225
4. Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225

CMPC-205 Computer Networks			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Describe the key terminologies and technologies of computer networks	C	2
2. Explain the services and functions provided by each layer in the Internet protocol stack.	C	2
3. Identify various internetworking devices and protocols, and their functions in a network.	C	4
4. Analyze working and performance of key technologies, algorithms and protocols.	C	4
5. Build Computer Network on various Topologies	P	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to networks and protocols architecture [TB1: Ch. 1].
2. Basic concepts of networking, network topologies and the Internet [TB1: Ch. 1].
3. Layered architecture and the OSI model [TB1: Ch. 2].
4. Physical layer functionality, data link layer functionality and the TCP/IP protocol architecture [TB1: Ch. 2].
5. Multiple access techniques, WAN Technologies and protocols , circuit switching and packet switching.[TB1: Ch. 9]
6. Wireless networks, Cellular Network Generations and LTE-Advanced [TB1: Ch. 10]
7. LAN technologies, LAN protocol architecture and virtual LANs [TB1: Ch. 11]
8. MAC addressing. [TB1: Ch. 11]
9. Networking devices , bridges, hubs and switches [TB1: Ch. 11]
10. Network layer protocols, Principles of Internetworking, IPv4 and IPv6. [TB1: Ch. 14]
11. IP addressing, Internet Protocol Operation, virtual private networks and IP Security and Subnetting, CIDR. [TB1: Ch. 14].
12. Transport layer protocols, ports and sockets and connection-oriented transport protocol mechanisms [TB1: Ch. 15]
13. Routing protocols OSPF ,EIGRP,RIP and routing in packet-switching networks [TB1: Ch. 19]
14. Connection establishment, flow and congestion control, effects of congestion, TCP congestion control and datagram congestion control protocol [TB1: Ch. 20]
15. Application layer protocols, electronic mail (SMTP and MIME), Web Access: HTTP and DNS [TB1: Ch. 24]
16. Latest trends in computer networks , real-time traffic and voice over IP [TB1: Ch. 25]

Labs:

1- Introduction to Networking equipment.
2- Networking Basics commands.
3- TCP/IP Networks configuration.
4- Cabling Construction.

5- Building Peer-to-Peer Network.
6- Tools: Packet tracer, Wireshark.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Data and Computer Communications, 10th Edition by William Stallings
2. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross
3. Computer Networks, 5th Edition by Andrew S. Tanenbaum
4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

CMPC-306 Human Computer Interaction			
Credit Hours:	3(3,0)	**Prerequisites:**	Software Engineering

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
At the end of the course the students will be able to: 1. Explain context of HCI and different measures for evaluation. 2. Apply the principles of good design for people from the 3. Perspective of age and disabilities. 4. Analyze techniques for user centered design for a medium sized software.	 C C C C	 2 3 4 5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. The human: Input–output channels, Human memory, Thinking, Emotion, Individual differences, Psychology and the design of interactive systems. [Ch. 1]
2. The computer: Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning, Memory, Processing and networks. [Ch. 2]
3. The interaction: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, Interactivity, The context of the interaction, Experience, engagement and fun. [Ch. 3]

4. Interaction design basics: What is design? The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping. [Ch. 5]
5. HCI in the software process: The software life cycle, Usability engineering, Iterative design and prototyping, Design rationale. [Ch. 6]
6. Design rules: Principles to support usability, Standards, Guidelines, Golden rules and heuristics, HCI patterns. [Ch. 7]
7. Implementation support: Elements of windowing systems, Programming the application,
8. Using toolkits, User interface management systems.[Ch. 8]
9. Evaluation techniques: What is evaluation? Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, choosing an evaluation method. [Ch. 9]
10. Universal design: Universal design principles, Multi-modal interaction, Designing for diversity.[Ch. 10]
11. User support: Requirements of user support, Approaches to user support, Adaptive help systems, designing user support systems. [Ch. 11]
12. Task analysis: Differences between task analysis and other techniques, Task decomposition, Knowledge-based analysis, Entity–relationship-based techniques, Sources of information and data collection, Uses of task analysis [Ch. 15]
13. Dialog notations and design: What is dialog? Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design. [Ch. 16]
14. Models of the system: Standard formalisms, Interaction models, Continuous behavior.
15. Modeling rich interaction: Introduction, Status–event analysis, Rich contexts, Low intention and sensor-based interaction. [Ch. 18]
16. Groupware: Groupware systems, Computer-mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware, implementing synchronous groupware. [Ch. 19]
17. Ubiquitous computing and augmented realities: Ubiquitous computing applications research, Virtual and augmented reality, Information and data visualization. [Ch. 20]
18. Hypertext, multimedia and the World Wide Web: Understanding hypertext, Finding things, Web technology and issues, Static web content, Dynamic web content. [Ch. 21]

Teaching Methodology:

Lectures, Class Discussions

Course Assessment:

Midterm Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Human-Computer Interaction by Alan Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, Prentice Hall; 4th Edition (October 2012).
2. Designing the User Interface: Strategies for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, 6th Ed, Pearson Inc, 2016.
3. Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design, Benyon, D. 3rd Ed., Pearson. 2013
4. About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, 4th Ed, Wiley, 2014

CMPC-401 Capstone I			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Project Proposal
2. Introduction Software Requirement Specification
3. Software Function Specification
4. Design Documentation

Teaching Methodology:

Lectures, Semester Project, Assignments, Presentations, Interactive sessions

Course Assessment:

Sessional Marks(Assignments, Quizzes, Project, Presentations), Mid Exam, Final Exam

Reference Materials:

CMPC-402 Capstone II			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Database Design
2. Interface Design
3. Initial Prototype
4. Implementation
5. Testing

Teaching Methodology:
Lectures, Semester Project, Assignments, Presentations, Interactive sessions
Course Assessment:
Sessional Marks(Assignments, Quizzes, Project, Presentations), Mid Exam, Final Exam
Reference Materials:

Mathematics & Science Foundation Courses

MATH-101 Calculus and Analytical Geometry			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. To provide foundation and basic ground for calculus and analytical geometry background.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Real Numbers and the Real Line, Coordinates, Lines, and Increments, Functions, Shifting Graphs, Trigonometric Functions. [TB: Preliminaries]
2. Limits and Continuity: Rates of Change and Limits, Rules for Finding Limits, Target Values and Formal Definitions of Limits, Extensions of the Limit Concept, Continuity, Tangent Lines. [TB: Ch. 1]
3. Derivatives: The Derivative of a Function, Differentiation Rules, Rates of Change, Derivatives of Trigonometric Functions, The Chain Rule, Implicit Differentiation and Rational Exponents. [TB: Ch. 2]
4. Applications of Derivatives: Extreme Values of Functions, The Mean Value Theorem, The First Derivative Test for Local Extreme Values, Graphing with y‘ and y‘‘. [TB: Ch. 3]
5. Integration: Indefinite Integrals, Integration by Substitution—Running the Chain Rule Backward, Estimating with Finite Sums, Riemann Sums and Definite Integrals,

Properties, Area, and the Mean Value Theorem. Substitution in Definite Integrals. Numerical Integration. [TB: Ch. 4]

6. Applications of Integrals: Areas between Curves, Finding Volumes by Slicing, Volume of Solids of Revolution—Disks and Washers. Cylindrical Shells. Lengths of Plan Curves, Areas of Surfaces of Revolution, Moments and Centers of Mass. [TB: Ch. 5]
7. Transcendental Functions: Inverse Functions and Their Derivatives, Natural Logarithms, The Exponential Function, ax and logax, Growth and Decay, L'Hôpital's Rule, Relative Rates of Growth, Inverse Trigonometric Functions, Derivatives of Inverse Trigonometric Functions; Integrals. Hyperbolic Functions. [TB: Ch. 6]
8. Conic Sections, Parameterized Curves, and Polar Coordinates: Conic Sections and Quadratic Equations. Classifying Conic Sections by Eccentricity. Quadratic Equations and Rotations. Parameterizations of Plan Curves. Calculus with Parameterized Curves. Polar Coordinates. Graphing in Polar Coordinates. Polar Equations for Conic Sections. Integration in Polar Coordinates. [TB: Ch. 7, 9]
9. Vectors and Analytic Geometry in Space, Vectors in the Plane Dot Products, Vector Valued Function Cartesian (Rectangular) Coordinates and Vectors in Space. Dot Products. Cross Products. Lines and Planes in Space. Cylinders and Quadric Surfaces. Cylindrical and Spherical Coordinates. [TB: Ch. 9, 10]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Calculus and Analytic Geometry by George B. Thomas and Ross L. Finney, Addison Wesley; 10th Edition (1995) ISBN-10: 0201531747
2. Calculus and Analytical Geometry by Swokowski, Olinick and Pence, 6th Edition, (1994), Brooks/Cole Publishers.
3. Calculus by Howard Anton, Irl C. Bivens, Stephen Davis, Wiley; 10th Edition (2012), ISBN-10: 0470647728
4. Calculus with Analytic Geometry: Student Solution Manual by Howard Anton, Wiley; 5th Edition (1995). ISBN-10: 047110589

MATH-102 Probability and Statistics			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding cloud computing and related techniques	C	1
2. Understand the basic principles of implementing issues, ecosystem and case studies	C	2
3. Familiarity with cloud services and their techniques through labs and the Semester project**.**	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Statistics and Data Analysis: Statistical Inference, Samples, Populations, Role of Probability, Sampling Procedures; Collection of Data, Measures of Location: The Sample Mean and Median, Measures of Variability [TB1: Ch. 1]
2. Discrete and Continuous Data, Statistical Modeling, Scientific Inspection, and Graphical, General Types of Statistical Studies: Designed Experiment, Observational Study, and Retrospective Study. [TB1: Ch. 1]
3. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes‘ Rule. [TB: Ch. 2]
4. Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Joint Probability Distributions. [TB1: Ch. 3]
5. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev‘s Theorem. [TB1: Ch. 4]
6. 5. Discrete Probability Distributions: Binomial and Multinomial Distributions, Hypergeometric Distribution, Negative Binomial and Geometric Distributions, Poisson Distribution and the Poisson Process. [TB1: Ch. 5]
7. Continuous Probability Distributions: Continuous Uniform Distribution, Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Gamma and Exponential Distributions, Chi Squared Distribution, Beta Distribution. [TB1: Ch. 6]
8. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. [TB1: Ch. 8]
9. One- and Two-Sample Estimation Problems: Introduction, Statistical Inference, Classical Methods of Single Sample: Estimating the Mean, Standard Error of a Point, Prediction Intervals, Tolerance Limits, Estimating the Difference between Two Means. [TB1: Ch. 9]
10. Single Sample: Estimating a Proportion, Estimating the Difference between Two Proportions, Single Sample: Estimating the Variance, Estimating the Ratio of Two Variances. [TB1: Ch. 9]
11. One- and Two-Sample Tests of Hypotheses: Statistical Hypotheses: General Concepts, Testing a Statistical Hypothesis, The Use of P-Values for Decision Making in Testing Hypotheses. [TB1: Ch. 10]
12. Single Sample: Tests Concerning a Single Mean, Two Samples: Tests on Two Means, Choice of Sample Size for Testing Means, Graphical Methods for Comparing Means, One Sample: Test on a Single Proportion, Two Samples: Tests on Two Proportions. [TB1: Ch. 10]
13. One- and Two-Sample Tests Concerning Variances, Goodness-of-Fit Test, Test for Independence (Categorical Data), Test for Homogeneity [TB1: Ch. 10]
14. Simple Linear Regression and Correlation: Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators. [TB1: Ch. 11]
15. Multiple Linear Regression and Certain: Nonlinear Regression Models, Introduction, Estimating the Coefficients, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators. [TB1: Ch. 12]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson; 9th Edition (January 6, 2011). ISBN-10: 0321629116
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 3rd Edition (February 3, 2006), ISBN-10: 0495107573
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10: 0071544259
4. Probability: A Very Short Introduction by John Haigh, Oxford University Press (2012). ISBN-10: 0199588481

MATH-202 Linear Algebra			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Develops students‘ fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems	C	1

* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Vectors: Vectors and Linear Combinations, Lengths and Dot Products, Matrices. [TB1: Ch. 1]
2. Solving Linear Equations: Vectors and Linear Equations, the Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices. [TB1: Ch. 2]
3. Elimination = Factorization; A = LU, Transposes and Permutations
4. Vector Spaces and Subspaces: Spaces of Vectors, The Null space of A: Solving Ax = 0,
5. The Rank and the Row Reduced Form, the Complete Solution to Ax = B, Independence,
   Basis and Dimension, Dimensions of the Four Subspaces. [TB1: Ch. 3]
6. Orthogonally: Orthogonally of the Four Subspaces, Projections, Least Squares Approximations, Orthogonal Bases and Gram-Schmidt. [TB1: Ch. 4]
7. Determinants: The Properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes. [TB1: Ch. 5]
8. Eigenvalues and Eigenvectors: Introduction to Eigenvalues, Diagonalizing a Matrix, Applications to Differential Equations, Symmetric Matrices, Positive Definite Matrices,
   Similar Matrices, Singular Value Decomposition (SVD). [TB1: Ch. 6]Page 36 of 121 Revised Curriculum BSCS: Applicable from Fall 2013 | Dept. CS & IT; UOS
9. Applications: Matrices in Engineering, Graphs and Networks, Markov Matrices, Population, and Economics; Linear Programming, Fourier series: Linear Algebra for Functions, Linear Algebra for Statistics and Probability, Computer Graphics.

Numerical Linear Algebra: Gaussian Elimination in Practice, Norms and Condition
10. Numbers, Iterative Methods for Linear Algebra. [TB1: Ch. 9]
11. Complex Vectors and Matrices: Complex Numbers, Hermitian and Unitary Matrices, Matrix Factorizations. [TB1: Ch. 10

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Introduction to Linear Algebra by Gilbert Strang, Wellesley Cambridge Press; 4th Edition (February 10, 2009). ISBN-10: 0980232716Advanced Engineering Mathematics by Erwin Kreyszig, Wiley; 10th Edition (August 16, 2011).ISBN-10: 0470458364
2. Elementary Linear Algebra with Applications by Bernard Kolman, David Hill, 9th Edition, Prentice Hall PTR, 2007. ISBN-10: 0132296543
3. Strang's Linear Algebra And Its Applications by Gilbert Strang, Strang, Brett Coonley, Andy Bulman-Fleming, Andrew Bulman-Fleming, 4th Edition, Brooks/Cole, 2005
4. Elementary Linear Algebra: Applications Version by Howard Anton, Chris Rorres, 9th Edition, Wiley, 2005.

Contents of Computing Supporting Area Elective Courses

MATH-301 Multivariable Calculus			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Develop the skills to have ground knowledge of multivariate calculus and appreciation for their further computer science courses.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Multivariable Functions and Partial Derivatives: Functions of Several Variables. Limits and Continuity. Partial Derivatives. Differentiability, Linearization, and Differentials. The Chain Rule. Partial Derivatives with Constrained Variables. Directional Derivatives, Gradient Vectors, and Tangent Planes. Extreme Values and Saddle Points. Lagrange Multipliers. Taylor's Formula. [TB1: Ch. 11]
2. Multiple Integrals: Double Integrals. Areas, Moments, and Centers of Mass. Double Integrals in Polar Form. Triple Integrals in Rectangular Coordinates. Masses and Moments in Three Dimensions. Triple Integrals in Cylindrical and Spherical Coordinates. Substitutions in Multiple Integrals. [TB1: Ch. 12]
3. Laplace Transforms: Laplace Transform. Inverse Transform. Linearity. First Shifting Theorem (s-Shifting). Transforms of Derivatives and Integrals. ODEs. Unit Step

Function (Heaviside Function). Second Shifting Theorem (t-Shifting). Short Impulses. Dirac's Delta Function. Partial Fractions. Convolution. Integral Equations. Differentiation and Integration of Transform. Systems of ODEs. Laplace Transform: General Formulas. Table of Laplace Transforms. [TB2: Ch. 6]

4. Fourier Analysis: Fourier Series, Arbitrary Period. Even and Odd Function. Half-Rang Expansions. Forced Oscillations. Approximation by Trigonometric Polynomials. SturmLiouville Problems. Orthogonal Functions. Orthogonal Series. Generalized Fourier Series. Fourier Integral. Fourier Cosine and Sine Transforms. Fourier Transform. [TB2: Ch. 11]
5. Power Series, Taylor Series: Sequences, Series, Convergence Tests. Power Series. Functions Given by Power Series. Taylor and Maclaurin Series. [TB2: Ch. 15]\
6. Laurent Series. Residue Integration: Laurent Series. Singularities and Zeros. Infinity. Residue Integration Method. Residue Integration of Real Integrals. [TB2: Ch. 16]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Calculus & Analytic Geometry by Thomas, Wiley; 10th Edition (August 16, 2011). ISBN-10: 0470458364
   Advanced Engineering Mathematics by Erwin Kreyszig, Wiley; 10th Edition (August 16,
   2011). ISBN-10: 0470458364
2. Multivariable Calculus by James Stewart, Brooks Cole; 7th Edition (January 1, 2011). ISBN-10: 0538497874
3. Multivariable Calculus by James Stewart 6th Edition, 2007, Cengage Learning
4. publishers.
5. Calculus and Analytical Geometry by Swokowski, Olinick and Pence, 6th Edition, 1994, Thomson Learning EMEA, Ltd.
6. Elementary Multivariable Calculus by Bernard Kolman William F. Trench, 1971, Academic Press.
7. Multivariable Calculus by Howard Anton, Albert Herr 5th Edition, 1995, John Wiley

CSSC-301 Differential Equations			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Develops students‘ fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems	C	1
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Differential Equations: Definitions and Terminology. Initial-Value Problems. Differential Equations as Mathematical Models. [TB: Ch. 1]
2. First-Order Differential Equations: Solution Curves without a Solution. Separable Variables. Linear Equations. Exact Equations and Integrating Factors. Solutions by Substitutions. A Numerical Method. [TB: Ch. 2]
3. Modelling With First-Order Differential Equations: Linear Models. Nonlinear Models. Modelling with Systems of First-Order Differential Equations. [TB: Ch. 3]
4. Higher-Order Differential Equations: Preliminary Theory- Linear Equations. Reduction of Order. Homogeneous Linear Equations with Constant Coefficients. Undetermined Coefficients- Superposition Approach. Undetermined Coefficients- Annihilator Approach. Variation of Parameters. Cauchy-Euler Equation. Solving Systems of Linear Differential Equations by Elimination. Nonlinear Differential Equations. [TB: Ch. 4]
5. Modeling with Higher-Order Differential Equations: Linear Models: Initial-Value Problems. Linear Models: Boundary-Value Problems. Nonlinear Models. [TB: Ch. 5]
6. Series Solutions of Linear Equations: Solutions about Ordinary Points. Solutions about Singular Points. Special Functions. [TB: Ch. 6]
7. Systems of Linear First-Order Differential Equations: Preliminary Theory. Homogeneous Linear Systems. Non-homogeneous Linear Systems. Matrix Exponential. [TB: Ch. 7].
8. Numerical Solutions of Ordinary Differential Equations: Euler Methods. Runge-Kutta Methods. Multistep Methods. Higher-Order Equations and Systems. Second-Order Boundary-Value Problems. [TB: Ch. 7].

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. A First Course in Differential Equations by Dennis G. Zill, Brooks Cole; 10th Edition (March 15, 2012).ISBN-10: 1111827052Multivariable Calculus by James Stewart, Brooks Cole; 7th Edition (January 1, 2011). ISBN-10: 0538497874
2. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley; 10th Edition (August 16, 2011).ISBN-10: 0470458364
3. Differential Equations with Boundary-Value Problems by Dennis G. Zill, Michael R. Cullen, Brooks Cole; 8th Edition (March 15, 2012). ISBN-10: 1111827060 Elementary Differential Equations with Applications by C. H .Edwards, David E. Penney, Pearson; 3rd Edition (October 20, 2008). ISBN-10: 013605425

CSSC-303 Numerical Computing			
Credit Hours:	3	**Prerequisites:**	Calculus & Analytical Geometry

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
On completion of this course, students will be able to demonstrate programming proficiency using Mat Lab for all methods. The course	A	3

must serve the purpose of scientific software development for science and engineering problems.		
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to numerical algorithms and errors [TB: Ch. 1]
2. Round off Errors: Floating point systems, Round off error accumulation, The IEEE standard [TB: Ch. 2]
3. Nonlinear Equations in One Variable: Solving nonlinear equations, Bisection method, Fixed point iteration, Newton's method [TB: Ch. 3]
4. Review of Linear Algebra: Basic concepts like Vectors and matrix norms, Special classes of matrices, Singular values [TB: Ch. 4]
5. Direct Methods for solving Linear Systems: Gaussian elimination and backward substitution, LU decomposition, The Cholesky decomposition, Sparse matrices [TB: Ch. 5]
6. Linear Least Squares Problems: Least squares and the normal equations, Orthogonal transformations and QR, Householder transformations and Gram–Schmidt orthogonalization [TB: Ch. 7]
7. Eigen values and Singular Values: The power method and variants, Singular value decomposition, General methods for computing eigen values and singular values [TB: Ch. 8]
8. Polynomial Interpolation: Lagrange interpolation, Divided differences and Newton's form, Chebyshev interpolation [TB: Ch. 10]
9. Fourier Transform: The Fourier transform, Discrete Fourier transform and trigonometric interpolation, Fast Fourier transform [TB: Ch. 13]
10. Numerical Integration: Basic quadrature algorithms, Composite numerical integration [TB: Ch. 15]
11. Differential Equations: Initial value ordinary differential equations, Euler's method, Runge–Kutta methods [TB: Ch. 16]

Teaching Methodology:

Lectures, Class Assignments

Course Assessment:

Midterm Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. [TB] Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, SIAM, 2011. ISBN-10: 0898719976, ISBN-13: 978-0898719970
2. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 10th Ed., Cengage Learning, 2011. ISBN-10: 1305253663
3. Anne Greenbaum & Timothy P. Chartier, Numerical Methods: Design, Analysis, and Computer Implementation of Algorithms, Princeton University Press, 2012. ISBN-10: 0691151229 [For MatLab implementation]
4. Anthony and Philip Rabinowitz, A First Course in Numerical Analysis, 2nd Ed., Dover Publications, 2001. ISBN-10: 048641454X
5. Germund Dahlquist and Åke Björck, Numerical Methods in Scientific Computing, Society for Industrial and Applied Mathematics, 2008. ISBN-10: 0898716446

CSSC-307 Object Oriented Analysis and Design			
Credit Hours:	3(3,0)	**Prerequisites:**	Object Oriented Programming

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explains object models and designs from system requirements.	C	2
2. Presents the use the modeling concepts provided by UML.		
3. identify use cases and expand into full behavioral designs.	C	2
4. Expand the analysis into a design ready for implementation and construct designs that are reliable.	C C	2 2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Principles of Object Technology: Introduction to Object Technology, Principles of Modeling, and Principles of Object Orientation [TB: Ch. 1.1-5]
2. Introduction to UML, Unification, UML Diagrams, Unified Process & Rational Unified Process, RUP Disciplines, Case Study Analysis and Basics, Case Study, About Inception, Feasibility and Risk Analysis [TB: Ch. 1.6, 2.1-6, 3.1-2,4.1-3]
3. Understanding Requirements, Requirements Types, Use Case Modeling: Use Case Writing Styles, EBP Guidelines [TB: Ch. 5.1, 6.1-8]
4. System Use Case Diagram, Use Case Table, Activity Diagram, Supplementary Specifications, Vision Document, Glossary, Rational Rose Overview, Use Case & Activity Diagram Modeling in Rational Rose [TB: Ch. 6.9, 6.12-17, 7.2-4 & 7]
5. Elaboration Phase of RUP; Configuration Management; System Sequence Diagram, Domain Model : Identifying Business Classes, Associations, Attributes [TB: Ch.8.25,9.2-4,10.1-4,11.1-7,12.1-4]
6. Implementation of System Sequence & Domain Model: Use Case Operational Contracts, Business Sequence, Analysis Sequence & Collaboration Diagrams [TB: Ch. 11.10, 12.9, 13.1-2, 13.9, 15.1-7]
7. Use Case Dependencies. Analysis Use Case Diagram, Implementation of Sequence, Collaboration, Analysis Use Case Diagram [TB: Ch. 25.1-5, 15.6-7]
8. State Chart Diagrams and Implementation [TB: Ch. 29.1-5, 29.8, Ch. 1-13, 25, 29]
9. Design Patterns: GRASP: Information Expert, Creator, Cohesion & Coupling, Controller [Ch. 16.1-10]
10. Use Case Realization Using GRASP Patterns, Design Model: Determining Visibility [TB: Ch. 17.1-9, 18.1-3]
11. Modeling Generalization, Creating Design Class Diagram, Mapping Data Model to Domain Model [TB: Ch. 26.1-7, 27.1-10, 19.1-6, 34.5-9]
12. Implementation of Design Class Diagram, Coding patterns, Mapping Design to Code [TB: Ch. 19.6, 20.1-11]
13. More Patterns for Assigning Responsibilities, Polymorphism, Pure Fabrication, Indirection, Protected Variation. GoF Design Patterns: Adapter, Factory [TB: Ch. 22.1-4, 23.1-2]
14. Gof: Singleton, Strategy, Composition, Façade and Discuss Remaining Patterns [TB: Ch. 23.4-8]

Teaching Methodology:

Lecturing, Written Assignments.
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Applying UML and patterns: An introduction to Object-Oriented Analysis and Design and Iterative Development by Craig Larman, Prentice Hall; 3rdEdition (October 30, 2004). ISBN-10: 0131489062 Estimating Software Costs: Bringing Realism to Estimating by Capers Jones, McGraw-Hill Osborne Media; 2nd Edition (April 19, 2007).ISBN-10: 0071483004 2. The Unified Modeling Language User Guide by G. Booch, J. Rambaugh and I. Jakobson, Addison-Wesley Professional; 2ndEdition (2005). ISBN-10: 0321267974. 3. The Unified Modeling Language User Guide by G. Booch, J. Rambaugh and I. Jakobson, and Grady Booch, Addison-Wesley Professional; 2ndEdition (2004). ISBN-10: 032171895X 4. The Unified Modeling Language User Guide by Grady Booch, James Rumbaugh and Ivar Jacobson, Addison-Wesley Professional; (2005). ISBN-10: 0321267974. 5. Visual Modeling with Rational Rose 2000 and UML by Terry Quatrani, Addison Wesley, (2000). ISBN: 0201699613. 6. The Rational Unified Process Made Easy: A Practitioner's Guide to the RUP: A Practitioner's Guide to the RUP by Per Kroll, Philippe Kruchten and Grady Booch, Addison-Wesley Professional (2003). ISBN-10: 0321166094.

Contents of General Education Courses

ENGL-101 Functional English			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fundamentals and principles of management.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
Syllabus will be approved by the BOS, Department of English
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

ENGL-102 Communication Skills			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
Syllabus will be approved by the BOS, Department of English
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

ISLS-101 Islamic Studies			
Credit Hours:	2	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fundamentals and principles of Islamic Philosophy.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
Syllabus will be approved by the BOS, Department of Islamiat
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

PKST-201 Pakistan Studies			
Credit Hours:	2	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fundamentals and principles of Islamic Philosophy.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
Syllabus will be approved by the BOS, Department of History
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

ENGL-201 Technical & Report Writing			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
Syllabus will be approved by the BOS, Department of English
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

ICTC-101 Introduction to Information & Communication Technologies			
Credit Hours:	2+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Demonstrate an awareness of the main processes in an ICT system (sending, receiving, storing, retrieving, manipulating, conveying)	C	1
2. Demonstrate an awareness of some of the hardware, software and communication components used in ICT systems	C	2
3. Use a system map or a block diagram to identify the components of an ICT system	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Computers: Data and Information, Information Processing Cycle, the Components of a Computer, Advantages and Disadvantages of Using Computers. Networks and the Internet. [TB1, Ch.1]
2. Computer Software, Categories of Computers, Elements of an Information System, Examples of Computer Usage, Computer Applications in Society [TB1, Ch. 1].
3. The Internet and World Wide Web: Key Concepts of the Internet, Evolution of the Internet, the World Wide Web, E-Commerce, Other Internet Services, Netiquette [TB1, Ch. 2].
4. Application Software: Business Software, Graphics and Multimedia Software, Software for Home, Personal, and Educational Use, Web Applications, Application Software for Communications. [TB1, Ch. 3]
5. The System Unit: Processor, Data Representation, Memory, Expansion Slots and Adapter Cards, Ports and Connectors, Buses, Bays, Power Supply. [TB1, Ch. 4]
6. Input Devices: What Is Input? What Are Input Devices? The Keyboard, Pointing Devices, Mouse, Other Pointing Devices, Touch Screens And Touch-Sensitive Pads, Pen Input, Other Input For Smart Phones, Game Controllers, Digital Cameras, Voice Input, Video Input, Scanners And Reading Devices, Biometric Input, Terminals, Putting It All Together, Input Devices For Physically Challenged Users. [TB1, Ch. 5]
7. Output Devices: What is Output? Display Devices, Printers, Speakers, Headphones, and Earbuds, Other Output Devices. [TB1, Ch. 6]
8. Storage: Hard Disks, Flash Memory Storage, Cloud Storage, Optical Discs, Other Types of Storage. [TB1, Ch. 7]
9. System Software: Operating Systems, Operating System Functions, Types Of Operating Systems. [TB1, Ch. 8]
10. Stand-Alone Operating Systems, Server Operating Systems, Embedded Operating Systems, Utility Programs [TB1, Ch. 8]
11. Communications: Uses of Computer Communications, Networks, Network

Communications Standards, Communications Software, Communications over the Telephone Network, Communications Devices, Home Networks, Communications Channel, Physical Transmission Media, Wireless Transmission Media. [TB1, Ch. 9]

12. Databases: Data, and Information, The Hierarchy of Data, Maintaining Data, File Processing Versus Databases. [TB1, Ch. 10]
13. Database Management Systems, Relational, Object Oriented, and Multidimensional Databases, Web Databases, Database Administration. [TB1, Ch. 10]
14. Computer Security and Safety, Ethics, and Privacy: Computer Security Risks, Internet And Network Attacks, Unauthorized Access And Use. [TB1, Ch. 11]
15. Hardware Theft And Vandalism, Software Theft, Information Theft, System Failure, Backing Up, Wireless Security, Health Concerns Of Computer Use, Ethics And Society. [TB1, Ch. 11]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Discovering Computers by Gary B. Shelly & Misty E. Vermaat, Course Technology; 1st Edition (January 25, 2011).
2. Computing Essentials 2012 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 22nd Revised Edition (February 1, 2011).
3. Computers: Understanding Technology by Fuller, Floyd; Larson, Brian, Fourth Edition, ISBN: 978-0-76383-927-7 (OR Latest Edition.)
4. The Concepts of Information Technology by Imran Saeed, Afsan Raza, Tariq Mahmood and Zafar Hussain, 6th Edition, IT Series Publications

Contents of University Elective Courses

BUSB-402 Financial Accounting			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1.	C	1

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

Syllabus will be approved by the BOS, Department Business Administration

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

BUSB-201 Principles of Management			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fundamentals and principles of management.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Managers and Management: What as Management and What Do Managers Do? Defining Management, Management Functions, Management Roles, Management Skills, History of Management.[TB2: Ch. 1]
2. Organizational Culture and Environment: The Manager: Omnipotent or Symbolic? The Organization's Culture, The Environment - Defining Environment, The Specific Environment, The General Environment, Influence on Management Practice. [TB1: Ch. 3]
3. Decision Making The Essence of Manager's Job: The Decision Making Process, The Rational Decision Maker, Decision Making Styles, Analyzing Decision Alternatives – Certainty, Risk, Uncertainty. [TB1: Ch. 6]
4. Planning: The Foundations of Planning, The Definition of Planning, Purposes of Planning, Types of Plans, Contingency Factors on Planning, Objectives: The Foundation for Planning, Multiplicity of Objectives, Real Versus Stated Objectives, Traditional Objective Setting, Management by Objectives. [TB2: Ch. 3]
5. Organization Structure and Design: Defining Organization Structure and Design, Building, The Vertical Dimension of Organizations, Building the Horizontal Dimension of Organizations, The Contingency Approach to Organization Design, Application of Organization Design.
6. Motivation: Motivating Employees, What is Motivation? Contemporary Approaches to Motivation, Contemporary Issues in Motivation, From Theory to Practice: Suggestions for Motivating Employees. [TB2: Ch. 10]
7. Leadership: Managers Verses Leaders, Trait Theories, Behavioral Theories, Contingency Theories, Emerging Approaches to Leadership, Contemporary Issues in Leadership. [TB2: Ch. 11]
8. Communication: Communication and Interpersonal Skills, Understanding Communication, Communication Styles of Men And Women, Feedback Skills, Delegation Skills', Conflict Management Skills, Negotiation Skills [TB2: Ch. 12]
9. Controlling - Foundations of Control: What is Control? The Importance of Control, The Control Process, Types of Control, Qualities of Effective Control, The Dysfunctional Side of Control, Ethical Issues in Control; Controlling Tools and Techniques: Information Controls, Financial Controls, Operations Controls, Behavioral Controls. [TB2: Ch. 13]

10. The Personnel Function: Terminology, Who Does Personnel Work? Staff Role of The Personnel Department Personnel (Human Resource) Functions. [TB3: Ch. 1 & 2]
11. Job Design and Analysis: Job Design, Job Information and Personnel Management, Analyzing Jobs-Obtaining Job Information, Functional Job Analysis, Administration of The Job Analysis Program. [TB3: Ch. 6 & 7]
12. Human Resource Planning: Reasons for Human Resource Planning, The Planning Process. [TB3: Ch. 5]
13. Recruitment and Selections/Testing and Interview: Labor Market Considerations, Recruitment and Selection Policy Issues, The Employment Process, Sources of People, The Selection Process, The Selection Procedure, Testing: Interview. [TB3: Ch. 6 & 7]
14. Miscellaneous: Union and Management, Compensation Administration, Health And Safety [TB2: Ch. 15, 17 & 18

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Management by Robbins, S.P. & Coulter, Mary, Prentice Hall; 10th Edition (November 3, 2008). ISBN-10: 0132090716
2. Fundamentals of Management by Robbins, S.P. &DeCenzo, David A, Prentice Hall; 7th Edition (January 13, 2010). ISBN-13: 978-0132090711
3. Human Resource Management by David A. DeCenzo and Stephen P. Robbins. Wiley; 7th Edition (October 10, 2001). ISBN-10: 0471397857

PSYC-302 Introduction to Psychology			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fundamentals and principles of Islamic Philosophy.	C	1

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

Syllabus will be approved by the BOS, Department of Psychology

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

CSCC-201 Computer Organization and Assembly Language			
Credit Hours:	3	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the basics of computer organization with emphasis on the lower level abstraction of a computer system	C	1
2. Understand the digital logic, instruction set	C	2
3. Familiarity with assembly language programming.	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Microprocessor Architecture: Microprocessor Bus Structure - Addressing, Data and Control, Registers and Flags. Addressing Modes.
2. Introduction to Assembly Language, 80x86 families; program layout. [TB: Ch. 1.1, 1.2; 2,3]
3. Data Definitions, Basic Instructions. [TB: Ch. 3, 4]
4. Unsigned Arithmetic; Logic and Bit Operations. [TB: Ch. 6, 7]
5. Modules; Separate Assembly; Argument Passing [TB: Ch. 5,8]
6. Libraries; Combining Assembly and C Code [TB: Ch. 13]
7. String Instructions; Arrays [TB: Ch. 9]
9. Macros; Structures [TB: Ch. 10]
10. Floating Point Instructions [TB: Ch. 12]
11. Bit MS-DOS. [TB: Ch. 14]
12. BIOS Disk Accessing [Ref]
13. BIOS Keyboard/Video/Graphics [Ref]
14. Interrupts; TSR Programs [Terminate And Stay Resident] [Ref]
15. Accessing I/O Ports; 8253 Timer [Ref]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Textbook(s):

Assembly Language for x86 Processors by Kip R. Irvine, Prentice Hall; 6thEdition (March 7, 2010). ISBN-10: 013602212X

Reference Materials:

1. The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications by Walter A. Triebel & Avtar Singh, Prentice Hall; 4thEdition (September 8,

2002). ISBN-10: 0130930814.
2. Lab Manual to Accompany - The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications by Walter A. Triebel & Avtar Singh, Pearson; 4thEdition (2003). ASIN: B000Q652KQ
3. Principles of Computer Organization and Assembly Language by Patrick Juola, Prentice Hall; 1stEdition (January 11, 2011). ASIN: B009TGBI1Q
4. The Art of Assembly Language by Randall Hyde, No Starch Press; 2ndEdition (March 22, 2010). ISBN-10: 1593272073

CSSC-305 Computer Architecture			
Credit Hours:	3	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand structure and behavior of the various functional modules of the computer	C	2
2. How these structure and behavior interact to provide the processing needs of the user.	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to a Simple Computer: CPU Basics and Organization, The Bus, Clock, The Input/Output Subsystem, Memory Organization and Addressing, Interrupts, MARIE, Instruction Processing, Hardware vs Micro-programmed Control, Real-World Examples of Computer . [TB2: Ch. 4]
2. Architectures: Intel & MIPs Architecture [TB1: Ch. 6]
3. Instruction Set Architecture: Instruction Format, Instruction Types, Addressing, Instruction Pipelining, ISAs – Intel, MIPS, Java Virtual Machine [TB2: Ch. 5]
4. Micro-architecture: Single-Cycle Processor, Multicycle Processor, Pipeline Processors, DDL Representation, Exceptions. [TB1: 7]
5. Advanced Micro-architecture: Deep Pipelines, Branch Prediction, Superscalar Processor, Out-of-Order Processor, Register Renaming, Single Instruction Multiple Data, Multithreading, Homogeneous Multiprocessing, Heterogeneous Multiprocessor. [TB1: 7]
6. Memory: Types of Memory, The Memory Hierarchy, Cache Memory, Virtual Memory, Memory Management [TB1: 8]
7. Input/Output and Storage System: I/O and Performance, Amdahl's Law, I/O architectures, Data Transmission Modes, Magnetic Disk Technology, Optical Disk Technology, Magnatic Tape, RAID, Future of Data Storage. [TB2: Ch. 7]
8. Alternative Architectures: RISC Machines, Flynn's Taxonomy, Parallel and Multiprocessor Architecture, Alternative Parallel Processing Approaches, Quantum Computing. [TB2: Ch. 9]
9. Embedded Systems: Embedded Hardware & Embedded Software. [TB2: Ch. 10]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Digital Design and Computer Architecture & Organization by David Harris and Sarah Harris, Morgan Kaufmann; 2ndEdition (August 7, 2012). ISBN-10: 0123944244
2. Essentials of Computer Organization and Architecture by Linda Null and Julia Lobur, Jones & Bartlett Learning; 3rdEdition (December 17, 2010)
3. Computer Architecture & Organization: A Quantitative Approach (Fifth Edition) by John L. Hennessy and David A. Patterson, Morgan Kaufmann; 5thEdition (September 30,2011). ISBN-10: 012383872X
4. Digital Design and Computer Architecture & Organization by D. M. Harris and S. L. Harris and Morgan Kaufmann, Morgan Kaufmann; 1stEdition (March 16, 2007). ISBN-10: 0123704979

CSCC-301 Theory of Automata			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fundamental concepts of automata theory and formal languages to form basic models of computation which provide foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Automata: The Methods and the Madness, Introduction to Formal Proof, Inductive Proofs, the Central Concepts of Automata Theory. [TB: Ch.1]
2. Finite Automata: Introduction of Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, Finite Automata with Epsilon Transitions. [TB: Ch.2]
3. Regular Expressions and Languages, Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions. [TB: Ch.3]
4. Properties of Regular Languages, Proving Languages Not to Be Regular, Closure Properties of Regular Languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata. [TB: Ch.4]
5. Context-Free Grammars and Languages: Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages
6. Pushdown Automata: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDAs and CFGs, Deterministic Pushdown Automata. [TB: Ch.6]
7. Properties of Context-Free Languages: Normal Forms for Context-Free Grammars,

The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages, Decision Properties of CFLs. [TB: Ch.7]

8. Introduction to Turing Machines: Problems That Computers Cannot Solve, The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines, Turing Machines and Computers. [TB: Ch.8]
9. Un-decidability: A Language That Is Not Recursively Enumerable, Un-decidable Problem That Is RE, Un-decidable Problems About Turing Machines, Posts Correspondence Problem, Other Un-decidable Problems. [TB: Ch.9]
10. Intractable Problems: The Classes P and NP, an NP-Complete Problem, A Restricted Satisfiability Problem. [TB: Ch.10]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Introduction to Automata Theory, Languages, and Computation by J. Hopcroft, R. Motwani, and J. Ullman, 3rdEdition, 2006, Addison-Wesley.
2. An Introduction to Formal Language and Automata by Peter Linz, Jones & Bartlett Pub; 4 thEdition (2006). ISBN-10: 0763737984
3. Automata and Formal Languages: An Introduction by Dean Kelley, Prentice Hall (1995). ISBN-10: 0134977777

CSCC-202 Design and Analysis of Algorithms			
Credit Hours:	3	**Prerequisites:**	Discrete Structure

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Student will be enable to design algorithms for problems	C	1
2. Understanding the core logic of problem solving	C	2
3. Time and Space Complexity of Algorithm	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Role of Algorithms in Computing, Analysing Algorithms, Designing Algorithms, Growth of Functions, Asymptotic Notation, Standard Notations and Common Functions. [TB: Ch1,2,3]
2. Divide-and-Conquer, Strassen's Algorithm for Matrix Multiplication, Recursion. [TB: Ch. 4]
3. Recurrences: Substitution Method for Solving Recurrences, Recursion-Tree Method for Solving Recurrences, Master Method for Solving Recurrences. [TB: Ch. 4]
4. Sorting and Order Statistics: Heapsort Algorithm, Priority Ques, Quicksort Algorithm, Analysis of Quicksort. [TB: Ch. 6, 7]
5. Sorting in Linear Time: Lower Bounds for Sorting, Counting Sort, Radix Sort, Bucket Sort. [TB: Ch. 8]
6. Medians and Order Statistics, Binary Search Trees, Querying a Binary Search Tree, Insertion and Deletion. [TB: Ch. 9, 12]
7. Red-Black Trees: Properties of Red-Black Trees, Rotations, Insertion, Deletion; Minimum Spanning Trees: Introduction, Growing a Minimum Spanning Tree. [TB: Ch. 12]
8. Dynamic Programming: Elements of Dynamic Programming, Longest Common Subsequence, Optimal Binary Search Trees [TB: Ch. 15]
9. Greedy Algorithms: Elements of The Greedy Strategy, Huffman Codes, Matroids and Greedy Methods, Task-Scheduling Problem. [TB: Ch. 16]
10. Elementary Graph Algorithms, Representations of Graphs, Breadth-First Search, Depth-First Search, Topological Sort. [TB: Ch. 22]
11. Single-Source Shortest Paths: The Bellman-Ford Algorithm, Single-Source Shortest Paths in Directed Acyclic Graphs, Dijkstra's Algorithm. [TB: Ch. 24]
12. All-Pairs Shortest Paths: Floyd-Warshall Algorithm, Johnson's Algorithm for Sparse Graphs. [TB: Ch. 25]
13. Maximum Flow: Flow Networks, Ford-Fulkerson Method, Push-Relabel Algorithms, Relabel-to-Front Algorithm. [TB: Ch. 26]
14. String Matching: Naive String-Matching Algorithm, Rabin-Karp Algorithm, String Matching with Finite Automata, Knuth-Morris-Pratt Algorithm. [TB: Ch. 32]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, The MIT Press; 3rdEdition (2009). ISBN-10: 0262033844
2. Introduction to the Design and Analysis of Algorithms by Anany Levitin, Addison Wesley; 2ndEdition (2006). ISBN-10: 0321358287
3. Algorithms in C++ by Robert Sedgewick (1999). ASIN: B006UR4BJS
4. Algorithms in Java by Robert Sedgewick, Addison-Wesley Professional; 3rdEdition(2002). ISBN-10: 0201361205

CSCC-302 Artificial Intelligence			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Knowledge of current progresses related to AI	C	1
2. Introduction of many advances subjects taught at MS and PhD level	C	2
3. Introduction of game theory	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction: What is AI, Foundations of AI, History of AI. Intelligent Agents: Agents and Environments, The Nature of Environments, The Structure of Agents [TB: Ch. 1, 2]
2. Problem Solving by Searching: Problem Solving Agents, Searching for Solutions, Uninformed Search Strategies.
3. Breadth-First Search, Depth-First Search, Depth-limited Search, Iterative Deepening, Depth-first Search, Comparison of Uninformed Search Strategies. [TB: Ch. 3]
4. Informed Search and Exploration: Informed (Heuristic) Search Strategies: Greedy Best-first Search, A* Search, Heuristic Functions, Local Search Algorithms and Optimization Problems. [TB: Ch. 4]
5. Constraint Satisfaction Problems: Backtracking Search for CSPs, Local Search for CSPs. Adversarial Search: Games, Minimax Algorithm, Alpha-Beta Pruning. [TB: Ch. 5, 6]
6. Reasoning and Knowledge Representation: Introductions to Reasoning and Knowledge Representation, Propositional Logic, First Order Logic: Syntax and Semantics of First-Order Logic, Knowledge Engineering in First-Order Logic, [TB: Ch. 7, 8]
7. Inference in First-Order Logic: Inference rules for quantifiers, A first-order inference rule, Unification, Forward Chaining, Backward Chaining, A backward chaining algorithm, Logic programming, The resolution inference rule [TB: Ch. 9]
8. Introduction to Prolog Programming
9. Reasoning Systems for Categories, Semantic Nets and Description logics, Reasoning with Default Information: Open and closed worlds, Negation as failure and stable model semantic. Truth Maintenance Systems [TB: Ch. 10]
10. Reasoning with Uncertainty & Probabilistic Reasoning : Acting Under Uncertainty, Bayes' Rule and Its Use, [TB: Ch 13]
11. Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks. [TB: Ch. 14]
12. Learning from Observations: Forms of Learning , Inductive Learning,, Learning Decision Trees [TB: Ch. 18]
13. Knowledge in Learning, Explanation-Based Learning, Inductive Logic Programming. [TB: 19]
14. Statistical Learning, Neural Networks [TB: Ch. 20]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Artificial Intelligence: A Modern Approach, by Russell and Norvig, Prentice Hall. 2ndEdition. ISBN-10: 0137903952
2. Artificial Intelligence: A Systems Approach by M. Tim Jones, Jones and Bartlett Publishers, Inc; 1stEdition (December 26, 2008). ISBN-10: 0763773379
3. Artificial Intelligence in the 21st Century by Stephen Lucci , Danny Kopec, Mercury Learning and Information (May 18, 2012). ISBN-10: 1936420236

CSCC-306 Compiler Construction			
Credit Hours:	3	**Prerequisites:**	Theory of Automata

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the basic techniques used in compiler construction such as lexical analysis, top-down, bottom-up parsing, context-sensitive analysis, and intermediate code generation	C	2
2. - Understand the basic data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, and stack machines	C	2
3. Design and implement a compiler using a software engineering approach	C	2
4. Use generators (e.g. Lex and Yacc)	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Overview of Compilation: Principles of Compilation, Compiler Structure, High-Level View of Translation, Desirable Properties of a Compiler. [TB: Ch.1]
2. Scanners: Recognizing Words, Regular Expressions, Implementing Scanners. [TB: Ch.2]
3. Parsers: Expressing Syntax, Top-Down Parsing, Bottom-Up Parsing. [TB: Ch.3]
4. Context-Sensitive Analysis: Type Systems, Attribute-Grammar Framework, Ad Hoc Syntax-Directed Translation. [TB: Ch.4]
5. Intermediate Representations: Graphical IRs, Linear IRs, Mapping Values to Names, Symbol Tables. [TB: Ch.5]
6. The Procedure Abstraction: Procedure Calls, Name Spaces, Communicating Values Between Procedures, Standardized Linkages. [TB: Ch.6]
7. Code Shape: Assigning Storage Locations, Arithmetic Operators, Boolean and Relational Operators, Storing and Accessing Arrays, Character Strings, Structure References, Control-Flow Constructs, Procedure Calls. [TB: Ch.7]
8. Code Optimization: Scope of Optimization, Local Optimization, Regional Optimization, Global Optimization, Interprocedural Optimization. [TB: Ch.8]
9. Data-Flow Analysis: Iterative Data-Flow Analysis, Static Single-Assignment Form, Inter-procedural Analysis. [TB: Ch.9]
10. Scalar Optimizations: Taxonomy for Transformations, Example Optimizations. [TB:

Ch.10]

11. Instruction Selection: Code Generation, Extending the Simple Tree-Walk Scheme, Instruction Selection via Tree-Pattern Matching, Instruction Selection via Peephole Optimization. [TB: Ch.11]
12. Instruction Scheduling: The Instruction-Scheduling Problem, Local List Scheduling, Regional Scheduling. [TB: Ch.12]
13. Register Allocation: Background Issues, Local Register Allocation and Assignment, Moving Beyond Single Blocks, Global Register Allocation and Assignment.
15. Implementation of a prototype compiler (Class Assignment for the Semester)

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Engineering a Compiler, Second Edition by Keith Cooper and Linda Torczon, Morgan Kaufmann; 2ndEdition (February 21, 2011). ISBN-10: 012088478X
2. Compilers: Principles, Techniques, and Tools, A. V. Aho, R. Sethi and J. D. Ullman, Addison-Wesley, 2nd ed., 2006
3. Modern Compiler Design, D. Grune, H. E. Bal, C. J. H. Jacobs, K. G. Langendoen, John Wiley, 2003.
4. Modern Compiler Implementation in C, A. W. Appel, M. Ginsburg, Cambridge University Press, 2004.

CSEC-407 Data Mining			
Credit Hours:	3	**Prerequisites:**	Database Systems

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the structure of modern data mining models	C	1
2. Understand the basic principles of implementing data mining models	C	2
3. Familiarity with key algorithms for efficiency and efficacy	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Data-Mining Concepts: Introduction, Data-Mining Process, Large Data Sets, Data Warehouses for Data Mining, Business Aspects Data Mining. [TB1: Ch. 1]
2. Preparing the Data: Raw Data- Representation, Characteristics, Transformation; Missing Data, Time-Dependent Data, Outlier Analysis. [TB1: Ch. 2]
3. Data Reduction: Dimensions of Large Data Sets, Feature Reduction, Relief Algorithm, Entropy Measure for Ranking Features, PCA, Value Reduction, Feature Discretization: Chi Merge Technique, Case Reduction. [TB1: Ch. 3]
4. Learning From Data: Learning Machine, SLT, Types of Learning Methods, Common

Learning Tasks, SVMs, kNN: Nearest Neighbor Classifier, Model Selection versus Generalization, Model Estimation. [TB1: Ch. 4]

5. Statistical Methods: Statistical Inference, Assessing Differences in Data Sets, Bayesian Inference, Predictive Regression, ANOVA, Logistic Regression, Log-Linear Models, LDA. [TB1: Ch. 5]
6. Decision Trees and Decision Rules: Decision Trees, Generating & Pruning Decision Tree, CART Algorithm & Gini Index, Limitations of Decision Trees and Decision Rules. TB1: Ch. 6]
7. Artificial Neural Networks: Model of an Artificial Neuron, Architectures of ANNs, Learning Process, Learning Tasks Using ANNs, Multilayer Perceptron's, Competitive Networks and Competitive Learning, SOMs. [TB1: Ch.7]
8. Ensemble Learning: Ensemble-Learning Methodologies, Combination Schemes for Multiple Learners, Bagging and Boosting, Ada Boost. [TB: Ch. 8]
9. Cluster Analysis: Clustering, Similarity Measures, Agglomerative Hierarchical Clustering, Partitional Clustering, Incremental Clustering, DBSCAN Algorithm. BIRCH Algorithm, Agglomerative Hierarchal and Partition Clustering Algorithms, Clustering Validation. [TB: Ch. 9]
10. Association Rules: Market-Basket Analysis, Algorithm Apriori, From Frequent Item-sets to Association Rules, Improving the Efficiency of the Apriori Algorithm, FP Growth Method, Associative-Classification Method, Multidimensional Association–Rules Mining. [TB: Ch. 10]
11. Web Mining and Text Mining: Web Mining, Web Content, Structure, and Usage Mining, HITS and LOGSOM Algorithms, Mining Path–Traversal Patterns, PageRank Algorithm, Text Mining, Latent Semantic Analysis. [TB: Ch. 11]
12. Genetic Algorithms: Fundamentals of GAs, Optimization Using GAs, Schemata, TSP, Machine Learning Using GAs, GAs for Clustering. [TB: Ch. 13]
2. Fuzzy Sets and Fuzzy Logic: Fuzzy Sets, Fuzzy-Set Operations, Extension Principle and Fuzzy Relations, Fuzzy Logic and Fuzzy Inference Systems, Multifactorial Evaluation, Extracting Fuzzy Models from Data, Data Mining and Fuzzy Sets
3. Visualization Methods: Perception and Visualization, Scientific Visualization and Information Visualization, Parallel Coordinates, Radial Visualization, Visualization Using Self-Organizing Maps, Visualization Systems for Data Mining
4. Data Mining Tools: Weka, CBA and Yale, etc.

Teaching Methodology:

Lectures, Semester Project, Assignments, Presentations, Interactive sessions

Course Assessment:

Sessional Marks(Assignments, Quizzes, Project, Presentations), Mid Exam, Final Exam

Reference Materials:

1. Data Mining: Concepts, Models, Methods, and Algorithms by Mehmed Kantardzic, Wiley-IEEE Press; 2nd Edition (August 16, 2011). ISBN-10: 0470890452
2. Data Mining: Concepts and Techniques, Third Edition (The Morgan Kaufmann Series in Data Management Systems) by Jiawei Han, Micheline Kamber and Jian Pei, Morgan Kaufmann; 3rd Edition (2011). ISBN-10: 0123814790
3. Principles of Data Mining (Adaptive Computation and Machine Learning) by David J. Hand, Heikki Mannila and Padhraic Smyth, A Bradford Book (August 1, 2001). ISBN-10: 026208290X
4. Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and Amit Asthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419

5. Information-Statistical Data Mining: Warehouse Integration with Examples of Oracle Basics (The Springer International Series in Engineering and Computer Science) by Bon K. Sy and Arjun K., Springer; 1st Edition (2003). ISBN-10: 1402076509
6. Building the Data Warehouse by William H. Inmon, Wiley; 4th Edition (2005). ISBN-10: 0764599445

CSEC-302 Multimedia Systems and Design			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. To learn complete process of multimedia system specifications, formats, design, testing, and prototyping.	C	1
2. Comprehensive understanding of multimedia tools, technologies, and techniques.	C	2
3. Learn and apply the design patterns and good practices in the designing of the multimedia applications	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. What is Multimedia? Text [TB1. Ch. 1, 2]
2. Multimedia Authoring and Tools: Multimedia Authoring, Multimedia Production, Multimedia Presentation, Automatic Authoring; Editing and Authoring Tools- Adobe Premiere, Macromedia Director, Macromedia Flash, Dreamweaver; VRML. [TB2: Ch.2]
3. Handling Images. [TB1. Ch. 3]
4. Handling Sound. [TB1. Ch. 4]
5. Handling Animation. [TB1. Ch. 5]
6. Handling Video. [TB1. Ch. 6]
7. Making Multimedia. [TB1. Ch. 7]
8. Multimedia Skills. [TB1. Ch. 8]
9. Planning and Costing. [TB. Ch. 9]
10. Designing and Producing [TB1. Ch. 10]
11. Content and Talent. [TB1. Ch. 11]
12. The Internet and Multimedia [TB1. Ch. 12]
13. Designing for the World Wide Web; [TB1. Ch. 13]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Multimedia Making It Work Eighth Edition by Tay Vaughan, McGraw-Hill Osborne Media; 8 Edition (October 29, 2010). ISBN-10: 0071748466 [Text Book (TB 1)]
2. Fundamentals of Multimedia by Z. M. Li and M. S. Drew, Prentice Hall (2004), ISBN: 0-13-127256-X [Text Book (TB 2)]
3. Digital Multimedia by N. Chapman and J. Chapman. 2nd Edition, Wiley 2004, ISBN: 0-470 5890-7 [Reference Material (RM1)]
4. The Technology of Video and Audio Streaming by David Austerberry, Focal Press; 2nd Edition (2004). ISBN-10: 0240805801 [Reference Material (RM2)]
5. Multimedia Security: Watermarking, Steganography, and Forensics by Frank Y. Shih, CRC Press; 1st Edition (2012), ISBN-10: 1439873313 [Reference Material (RM3)]
6. Multimedia Computing by Daniel Cunliffe and Geoff Elliott, Lexden Publishing Ltd. (2005). ISBN-10: 1904995055 [Reference Material (RM3)]
7. Multimedia Foundations: Core Concepts for Digital Design by Vic Costello, Ed Youngblood and Susan Youngblood, Focal Press; 1st Edition (2012). ISBN-10:0240813944 [Reference Material (RM4)]

CSEC-302 Web System and Technology			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Have essential skills for website management	C	1
2. Demonstrate understanding of the basic Internet technology concepts	C	2
3. Develop a prototype of interactive World Wide Web applications	C	3, 5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Overview of WWW, Web Pages, Web Sites, Web Applications, TCP/IP, TCP/IP Application, Services, Web Servers, WAMP Configuration.
2. Introduction to HTTP, HTML & HTML5 Tags, and Dynamic Web Content.[Ch. 1]
3. CSSC and CSSC3 [Ch. 18,19]
4. Client Side Programming: Programing in JavaScript: Basics, Expressions and Control Flow, Functions, Objects, and Arrays, Accessing CSSC from JavaScript [Ch. 13, 14, 15, 20]
5. Form Handling [Ch. 11]
6. Server Side Programing: Programing in PHP, [Ch. 3, 4,5,6]
7. Introduction MySQL, MySQL Functions, Accessing MySQL via phpMyAdmin,
8. Cookies, Sessions, and Authentication [Ch. 12]
9. Introduction to Ajax, jQuery, Browsers and the DOM [W3 Schools Tutorial]
10. Designing a Social Networking Site [Ch. 21]

Teaching Methodology:
Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

1. Learning PHP, MySQL, JavaScript, and CSSC, A Step-by-Step Guide to Creating Dynamic Websites by Robin Nixon, O'Reilly Media; Second Edition (September 3, 2012). ISBN-10: 1449319262
2. Web Technologies: A Computer Science Perspective by Jeffrey C. Jackson, Prentice Hall; 1st Edition (August 27, 2006). ISBN-10: 0131856030
3. Web Technologies by Uttam Kumar Roy, Oxford University Press, USA (June 13, 2011). ISBN-10: 0198066228
4. Web Application Architecture: Principles, protocols and practices by Leon Shklar and Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10: 047051860X

CSEC-417 Optimization Techniques			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
The course provides students an exposure to solving non-linear optimization problems by various techniques, with due emphasis on their mathematical rigor in terms of their derivation / justification.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Preliminaries: Review of the theory of maxima, minima (two variables); positive definite matrices, convexity of regions and functions; quadratic function and Hessian matrix; uniqueness of minimum. [TB2: Chapt. 9, Chapt. 11 : Sec.11.1 – 11.5]
2. Classical methods for functions of one variable and *n* variables, Newton's method [TB1: Chap. 1].
3. Search methods for functions of one variable: Single search techniques: Bracketing method; Quadratic and cubic interpolation; Fibonacci search; Golden-section. [TB1: Chap. 2]
4. Search methods for functions of *n* variables: method of Hooke and Jeeves, Nelder and

Mead's Method. [TB1: Chap. 3]

5. Gradient methods: Davidon-Fletcher-Powell (DFP); Fletcher- Reeves, conjugate-gradient and direct- search methods, Newton's method, method of Steepest descent [TB1: Chap. 4].
6. Review of Lagrange multipliers technique with equality constraints; inequality constraints and slack variables; Kuhn-Tucker conditions [TB1: Chap. 5]
7. Search methods: modified Hooke and Jeeves, the Complex method [TB1: Chap. 6].
8. Penalty-function approach to constrained optimization; equality and inequality constraints, SUMT method of Fiacccco and McCormick. [TB1: Chap. 7]

Teaching Methodology:

Lectures, Class Exercises

Course Assessment:

Midterm Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Bunday, B. D., Basic Optimization Methods, Edward Arnold Ltd., 1984.
2. Chiang,Alpha.C., Fundamental Methods of Mathematical Economics, McGraw-Hill Education; 4th ed., 2004.

CSEC-308 Enterprise Application Development			
Credit Hours:	3	**Prerequisites:**	Web Systems and Technologies

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the structure of modern computer system	C	1
2. Understand the basic principles of implementing computer graphics primitive	C	2
3. Familiarity with key algorithms for modelling and rendering graphic data	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Object-Oriented Programming Review, Software Architectures Overview: Desktop, File/Server, 2-Tier Client/Server, Multi-Tier Client/Server.
2. Application and Page Framework, Page Directives, Page Life Cycle, Build Providers Compilation and its techniques, compilation implantations, Application level events.
3. Asp. Net Server Control and Client Side Scripts, JQuery, JQuery selectors, validation with JQuery.
4. Applying Style to Server Control, HTML Server Control Manipulating Pages and Server Control with JavaScript, Client-Side call-back.
5. Web Server Control: label, literal, textbox, button, link button, image button and their

server side events, Web Server Control: dropdown, list box, checkbox, checkbox list, radio button, radio button list, and their dynamic binding, Web Server Control: Image, Calendar, table, panel bullet list, hidden field, file upload controls and their server side calling.
6. Validation Server Control, Client side validation vs server side validation, Validation control's implantation. Validate a form using validation controls.
7. Master Pages, Coding Master Pages, Coding Content Pages, Nesting Master Pages.
8. HTML and CSSC Design with Asp.Net, Bootstrap and responsive design, Theme and Skins: Creating Own Theme, Multiple Skin Theme, Programmatically Working with Themes.
9. Entity framework and its approaches, LINQ, ADO.Net, Create Database and model and insert/update record using entity framework.
10. Data Binding & Data Management using store procedures, Data Grid view Server Control, List View Server Control.
11. SQL Queries, JOINS, built in function, Session and Cookies, User Authentication.
12. Basic of XML, XML Reader and XML Writer, Xml Document and Xpath Document.
13. ASP.Net AJAX Control, ASP .Net AJAX Application Control, Server Side Control, Update Panel Control.
14. Building and Consuming Services, XML Services, Protocol for Web Services.

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Professional ASP.NET 4 in C# and VB by Bill Evjen, Scott Hanselman and Devin Rader, Wrox; 1st Edition (March 9, 2010). ISBN-10: 0470502207.
2. Beginning ASP.NET 4.5.1: in C# and VB (Wrox Programmer to Programmer) 1st Edition) by Imar Spaanjaars (March 24, 2014. ISBN-13: 978-1118846773
3. Beginning ASP.NET 4.5 in C# by Matthew MacDonald, Apress; 1st Edition (August 29, 2012). ISBN-10: 1430242515.

CSEC-418 Introduction To Computational Linguistics			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fundamental concepts of automata theory and formal languages to form basic models of computation which provide foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction, Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithms, Language, Thought, and Understanding, The State of the Art and The Near-Term Future, Some Brief History [TB1-Ch1]
2. 2 Regular Expressions and Automata, Regular Expressions, Finite-State Automata, Regular Languages and FSAs [TB1-Ch2-Optional]
3. Morphology and Finite-State Transducers, Survey of (Mostly) English Morphology, Finite-State Morphological Parsing, Combining FST Lexicon and Rules, Lexicon-free FSTs: The Porter Stemmer, Human Morphological Processing [TB1-Ch3]
4. Computational Phonology and Text-to-Speech, Speech Sounds and Phonetic Transcription, The Phoneme and Phonological Rules, Phonological Rules and Transducers, Advanced Issues in Computational Phonology, Machine Learning of Phonological Rules, Mapping Text to Phones for TTS, Prosody in TTS, Human Processing of Phonology and Morphology [TB1-Ch4-Optional]
5. Probabilistic Models of Pronunciation and Spelling, Dealing with Spelling Errors, Spelling Error Patterns, Detecting Non-Word Errors, Probabilistic Models, Applying the Bayesian method to spelling, Minimum Edit Distance, English Pronunciation Variation, The Bayesian method for pronunciation, Weighted Automata, Pronunciation in Humans [TB1-Ch5]
6. N-grams, Counting Words in Corpora, Simple (Unsmoothed) N-grams, Smoothing, Backoff, Deleted Interpolation, N-grams for Spelling and Pronunciation, Entropy [TB1-Ch6]
7. HMMs and Speech Recognition, Speech Recognition Architecture, Overview of Hidden Markov Models, The Viterbi Algorithm, Advanced Methods for Decoding, Acoustic Processing of Speech, Computing Acoustic Probabilities, Training a Speech Recognizer, Waveform Generation for Speech Synthesis, Human Speech Recognition [TB1-Ch7]
8. Word Classes and Part-of-Speech Tagging, English Word Classes, Tagsets for English, Part of Speech Tagging, Rule-based Part-of-speech Tagging, Stochastic Part-of-speech Tagging, Transformation-Based Tagging, Other Issues [TB1-Ch8]
9. Context-Free Grammars for English, Constituency, Context-Free Rules and Trees, Sentence level construction, The noun phrase, coordination, agreement, The verb phrase and sub categorization, auxiliaries, spoken language syntax, grammar equivalence & normal form, finite state & context free grammars, grammars & human processing [TB1-Ch9]
10. Parsing with context free grammars, parsing as search, a basic top-down parser, problems with the basic top-down parser, the Earley algorithm, finite state parsing methods [TB1-Ch10]
11. Features and Unifications, feature structures, unification of feature structures, features structures in grammar, implementing unification, parsing with unification constraints, types and inheritance [TB1-Ch11-Optional]
12. Lexicalized and probabilistic parsing, probabilistic context free grammars, problems with PCFGs, probabilistic lexicalized CFGs, dependency grammars, human parsing [TB1-Ch12]
13. Language and complexity, the Chomsky Hierarchy, How to tell if a language is not regular, Is Natural language context free, Complexity and human processing [TB1-Ch13-Optional]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:

1. Daniel Jurafsky and James H. Martin. 2008. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Second Edition. Prentice Hall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural Language Processing. MIT Press.
3. Steven Bird. 2009. Natural Language Processing with Python. O'Reilly. (Free on SearchWorks)
4. Philipp Koehn. 2010. Statistical Machine Translation. Cambridge.
5. Yoshua Bengio. 2009. Learning Deep Architectures for AI. Technical Report. (Free from Stanford network)
6. Frederick Jelinek. 1998. Statistical Methods for Speech Recognition. MIT Press.
7. James Allen. 1995. Natural Language Understanding. Benjamin/Cummings, 2ed.
8. Psycholinguistics: Tanenhaus & Trueswell (2006), Human Sentence Processing website

CMPC-302 Information Security			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain key concepts of information security such as design principles, cryptography, risk management, and ethics.	C	2
2. Discuss legal, ethical, and professional issues in information security.	C	2
3. Apply various security and risk management tools for achieving information security and privacy.	C	3
4. Identify appropriate techniques to tackle and solve problems in the discipline of information security.	C	4
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Information security foundations, security design principles; security mechanisms [TB 1: Ch 1]
2. Vulnerabilities and protections: Malwares [TB 1: Ch 6]
3. Hash functions [TB 1: Ch 2, 21]
4. Digital signatures [TB 1: Ch 2]
5. Key management [TB 1: Ch 2,20]
6. Authentication: Access control [TB 1: Ch 3,4]
7. Symmetric cryptography: Symmetric Encryption Principles, Data Encryption Standard, 8. Advanced Encryption Standard, Cipher Block Modes of Operation [TB 1: Ch 20]
8. Asymmetric cryptography: HMAC, The RSA Public-Key Encryption Algorithm, Diffie-Hellman and Other Asymmetric Algorithms [TB 1: Ch 21]
9. Software security [TB 1: Ch 11]

10. Database security: The Need for Database Security, Database Management Systems
    1. Relational Databases, SQL Injection Attacks, Database Access Control, Inference, Database Encryption [TB 1: Ch 5]
11. Network security: Secure E-Mail and S/MIME, Domain Keys Identified Mail, Secure Sockets Layer (SSL) and Transport Layer Security (TLS), HTTPS, IPv4 and IPv6 Security, Wireless Security, Mobile Device Security [TB 1: Ch 22, 24]
12. Firewalls: The Need for Firewalls, Firewall Characteristics and Access Policy, Types of Firewalls, Firewall Basing [TB 1: Ch 9]
13. Intrusion detection: Intruders, Intrusion Detection, Analysis Approaches, Types of IDS [TB 1: Ch 8]
14. Security policies, policy formation and enforcement, risk assessment [TB 1: Ch 14,15]
15. Cybercrime, law and ethics in information security, privacy and anonymity of data [TB 1: Ch 19]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Computer Security: Principles and Practice, 3rd edition by William Stallings[TB1]
2. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
3. Computer Security, 3rd edition by Dieter Gollmann
4. Computer Security Fundamentals, 3rd edition by William Easttom
5. Official (ISC)2 Guide to the CISSP CBK, 3rd edition

SEE-416 IOT			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the structure of Internet of Things.	C	1
2. Understand the basic principles of implementing IoT with Fog and Cloud.	C	2
3. Familiarity with Programming frameworks and Big Data analytics in real IoT Applications.	C	2

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Internet of Things: An Overview, IoT emergence, Internet of EveryThing. [TB1:Ch 1, 3]
2. IoT infrastructures: Open Source Semantic web architecture for managing IoT resources in Cloud. [TB1:Ch 2]
3. Device/Cloud Collaboration Framework for Intelligence Applications IoT. [TB1: Ch,3]
4. Communication Protocols for IoT, Network Layers, Transport and Application layer [TB1: Ch 1, 13]
5. Fog Computing: Principles, Architectures, and Applications.[TB1: Ch 4]
6. Programming Frameworks for Internet of Things, Embedded device Programming languages, IoT programming languages [TB1: Ch 5]

7. Virtualization on Embedded Boards as Enabling Technology for the Cloud of Things[TB1: Ch 6]
8. Micro Virtual Machines (MicroVMs) for Cloud-Assisted Cyber-Physical Systems [TB1: Ch 7]
9. Design and Implement Scalable, Flexible, and open IoT solutions using Web technologies [TB4: Ch 1]
10. IoT data management and Analytics: IoT and Cloud, Real time Analytics in IoT and Fog Computing, [TB1: Ch 8, TB2 : Ch 1]
11. A Framework for Distributed Data Analysis for IoT [TB1:Ch 9]
12. Security and Privacy in the Internet of Things, TinyTO: Two-Way Authentication for Constrained
    Devices in the Internet of Things [TB2 : Ch 12]
13. Internet of Things Applications, Monitoring and Actuating, Internet of Vehicles and Applications[Tb1 : Ch 15, 16]
14. Cloud-Based Smart-Facilities Management, IoT Services LifeCycle, Scheduling and Resource Management, Validating Applications and use cases [TB1:Ch 17]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Internet of Things: Principles and Paradigms 1st Edition, ISBN-10: 012805395X
2. Big Data Analytics: Tools and Technology for Effective Planning, Published October 26, 2017, ISBN 9781138032392
3. *https://pdfs.semantiCSCCholar.org/2006/d0fca0546bdeb7c3f0527ffd299cff7c7ea7.pdf*
4. *Building the Web of Things, ISBN-10:9781617292682*

CMPC-308 Information Security			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
5. Explain key concepts of information security such as design principles, cryptography, risk management, and ethics.	C	2
6. Discuss legal, ethical, and professional issues in information security.	C	2
7. Apply various security and risk management tools for achieving information security and privacy.	C	3
8. Identify appropriate techniques to tackle and solve problems in the discipline of information security.	C	4
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

16. Information security foundations, security design principles; security mechanisms [TB 1: Ch 1]

17. Vulnerabilities and protections: Malwares [TB 1: Ch 6]
18. Hash functions [TB 1: Ch 2, 21]
19. Digital signatures [TB 1: Ch 2]
20. Key management [TB 1: Ch 2,20]
21. Authentication: Access control [TB 1: Ch 3,4]
22. Symmetric cryptography: Symmetric Encryption Principles, Data Encryption Standard, 8. Advanced Encryption Standard, Cipher Block Modes of Operation [TB 1: Ch 20]
23. Asymmetric cryptography: HMAC, The RSA Public-Key Encryption Algorithm, Diffie-Hellman and Other Asymmetric Algorithms [TB 1: Ch 21]
24. Software security [TB 1: Ch 11]
25. Database security: The Need for Database Security, Database Management Systems
    2. Relational Databases, SQL Injection Attacks, Database Access Control, Inference, Database Encryption [TB 1: Ch 5]
26. Network security: Secure E-Mail and S/MIME, Domain Keys Identified Mail, Secure Sockets Layer (SSL) and Transport Layer Security (TLS), HTTPS, IPv4 and IPv6 Security, Wireless Security, Mobile Device Security [TB 1: Ch 22, 24]
27. Firewalls: The Need for Firewalls, Firewall Characteristics and Access Policy, Types of Firewalls, Firewall Basing [TB 1: Ch 9]
28. Intrusion detection: Intruders, Intrusion Detection, Analysis Approaches, Types of IDS [TB 1: Ch 8]
29. Security policies, policy formation and enforcement, risk assessment [TB 1: Ch 14,15]
30. Cybercrime, law and ethics in information security, privacy and anonymity of data [TB 1: Ch 19]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

6. Computer Security: Principles and Practice, 3rd edition by William Stallings[TB1]
7. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
8. Computer Security, 3rd edition by Dieter Gollmann
9. Computer Security Fundamentals, 3rd edition by William Easttom
10. Official (ISC)2 Guide to the CISSP CBK, 3rd edition

PHYS-101 Applied Physics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the basic laws of physics, circuiting and basics of transistors.	C	2

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Zero Reference Level, Chassis Ground, Ohm's Law, Formula Variations of Ohm's Law, Graphical Representation of Ohm's Law, Linear Resistor, Non Linear Resistor, Cells in

Series and Parallel.[TB 1: Ch 1]
2. Resistive Circuits. [TB 1: Ch 2]
3. Resistors(5.1-15), Inductors(5.19-21) Capacitors(5.35-48) .[TB 1: Ch 5]
4. Energy Sources. [TB 1: Ch 6]
5. Magnetism and electromagnetism [TB 1: Ch 7].
6. Solid State. Atomic structure, Electron distribution of different atoms, Energy bands in solids, Bonds in solids, Conduction in solids, Conductors, Semiconductors and types of semiconductors, Insulators, Majority and Minority charge carriers, Mobile charge carriers and immobile ions, Drift current in good conductors.[TB 1: Ch 12]
7. P-N Junction. Formation of depletion layer, Junction or barrier voltage, Forward biased P-N Junction, Forward V/I Characteristics, Reverse biased P-N Junction, Re-verse Saturation Current, Reverse V/I Characteristics, Junction breakdown, Junction Capacitance. [TB 1: Ch 13]
8. Optoelectronics Devices. Spectral response of human eye, Light Emitting Diode (LED), Photoemissive Devices, Photomultiplier Tube, Photovoltaic Devices, Bulk type Photoconductive cells, Photodiodes, P-N junction Photodiode, PIN Photodiode, and Avalanche Photodiode. [TB 1: Ch 16]
9. DC Power Supplies. Unregulated and Regulated Power Supply, Steady and Pulsating DC Voltages, Rectifiers (17.5-17.8), Filters (17.9-17.2), Voltage Multipliers (17.24-17.30), Silicon Controlled Rectifier SCR(17.33-17.37)[TB 1: Ch 17]
10. The Basic Transistor. Transistor Biasing, Transistor Circuit Configuration. [TB 1: Ch 18]
11. Modulation and Demodulation. Carrier Waves, Modulation, Demodulation or Detection, Comparison between Amplitude Modulation (AM) and Frequency Modulation (FM). [TB 1: Ch 30]
12. Integrated Circuits. Advantages of ICs and Drawbacks of ICs, Scale of Integration, Classification of ICs by function, Linear and Digital Integrated Circuits, IC Terminology, Fabrication of IC Components, Popular Application of ICs, Operational Amplifier. [TB 1: Ch 31]
13. Fiber Optics. Structure of Optical Fibres, Classification of Optical Fibres, Fibre Characteristics, Choice of Wavelength, Optical Fibre cable, Application of Fibre Optic Communication. [TB 1: Ch 38]

Teaching Methodology:

Lecturing, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. A Practical English Grammar by A. J. Thomson and A. V. Martinet,4th Edition Oxford University Press (1986).
2. Basic English Usage by Michael Swan, Oxford UnivPr (Sd) (January 1986). ISBN-10: 0194311872
3. Functional English In Aglobal Society: Vocabulary Building and Communicative Grammar by Nicanor L. Guintomary Ann R. Sibal Brian D. Villaverde Dept. of Languages, Literature and Humanities College of Arts and Sciences Southern Luzon State University (2012).
4. AQA Functional English Student Book: Pass Level 2 by Mr David Stone, Heinemann; 1st Edition (28 Jun 2010). ISBN-10: 0435151401
5. English Composition and Grammar: Complete Course by John E. Warriner, Harcourt Brace Jovanovich; Complete Course Benchmark Edition (January 1988). ISBN-10: 0153117362

6. Companion to English: Vocabulary (Learners Companion) by George Davidson, Prim-Ed Publishing (March 1, 2003). ISBN-10: 9814070904
7. Word Power Made Easy by Norman and Lewis, Goyal Publishers (September 1, 2009). ISBN-10: 8183071007
8. 1000 Most Important Words by Norman W. Schur, Ballantine Books (July 12, 1982). ISBN-10: 0345298632
9. High School English Grammar and Composition by P.C Wren, Chand & Co (July 13, 2008). ISBN-10: 812192197X

BUSB-204 Human Resource Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. After successfully completing of this course, students will be able to understand the core aspects of Human Resource Management required in 21st Century organizations.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Managing Human Resources. [TB 1: Ch. 1]
2. Understanding the External and Organizational Environments. [TB 1: Ch. 2]
3. Ensuring Fair Treatment and Legal Compliance. [TB 1: Ch. 3]
4. HR Planning for Alignment and Change. [TB 1: Ch. 4]
5. Using Job Analysis and Competency Modeling. [TB 1: Ch. 5]
6. Recruiting and Retaining Qualified Employees. [TB 1: Ch. 6]
7. Selecting Employees to Fit the Job and the Organization. [TB 1: Ch. 7]
8. Training and Developing a Competitive Workforce. [TB 1: Ch. 8]
9. Conducting Performance Management. [TB 1: Ch. 9]
10. Developing an Approach to Total Compensation. [TB 1: Ch. 10]
11. Using Performance-Based Pay to Achieve Strategic Objectives. [TB 1: Ch. 11]
12. Providing Benefits and Services for Employees' Well-Being. [TB 1: Ch. 12]
13. Risk Management, Employee Relations, and Risk Management, Health, Safety, and Employee Well-Being. [TB 1: Ch. 13]
14. Understanding Unionization and Collective Bargaining. [TB 1: Ch. 14]

Teaching Methodology:

Lectures, Written Assignments, Class Discussion

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Managing Human Resources by Susan E. Jackson, Randall S. Schuler and Steve Werner, South-Western College Pub; 11th Edition (June 16, 2011).ISBN-10: 1111580227
2. Management of Human Resources by Gary Dessler, CarolinRekar Munro and Nina D. Cole, Pearson Education Canada; 3rd Edition (February 28, 2010). ISBN-10: 0321687140
3. Human Resource Management by Robert L. Mathis and John H. Jackson, South-

Western Cengage Learning; 13th Edition (August 19, 2010). ISBN-10: 053845315X
4. Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders by Stella M. Nkomo, Myron D. Fottlerand R. Bruce McAfee, South-Western Cengage Learning; 7th Edition (September 29, 2010). ISBN-10: 0538468076

BUSB-202 Organizational Behavior			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. This course introduces the student to multidisciplinary approaches to human behaviour in organizational settings. Attention will be paid to both public and private sector organizations.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Organizational Behavior: The Quest for People-Centered Organizations and Ethical Conduct [TB 1: Ch.1]
2. Organizational Culture, Socialization, and Mentoring [TB 1: Ch. 3]
3. Key Individual Differences and the Road to Success [TB 1: Ch. 5]
4. Values, Attitudes, Job Satisfaction, and Counterproductive Work Behaviors [TB 1: Ch. 6]
5. Social Perceptions and Attributions [TB 1: Ch.7]
6. Foundations of Motivation [TB 1: Ch.8]
7. Improving Job Performance with Goals, Feedback, Rewards, and Positive Reinforcement [TB 1: Ch.9]
8. Group Dynamics [TB 1: Ch.10]
9. Developing and Leading Effective Teams [TB 1: Ch.11]
10. Individual and Group Decision Making [TB 1: Ch.12]
11. Managing Conflict and Negotiating [TB 1: Ch.13]
12. Communicating in the Digital Age [TB 1: Ch.14]
13. Leadership, Influence, Empowerment, and Politics [[TB 1: Ch.15, 16]
14. Organizational Design, Effectiveness, and Innovation [TB 1: Ch.17]

Teaching Methodology:

Lectures, Written Assignments, Class Discussions

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Organizational Behavior by Robert Kreitnerand AngeloKinicki, McGraw-Hill/Irwin; 10 Edition (January 17, 2012). ISBN-10: 0078029368
2. Organizational Behavior by Stephen P. Robbins and Timothy A. Judge, Prentice Hall; 15th Edition (January 16, 2012). ISBN-10: 0132834871
3. Meeting the Ethical Challenges of Leadership: Casting Light or Shadow by Craig E. Johnson, SAGE Publications, Inc; 4thEdition (February 28, 2011). ISBN-10:

1412982227

ECON-402 Business Economics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. This course is mean for understanding core matters of economics so that student shall be able to understand what is going on globally. This course, along with Entrepreneurship course, shall help students to establish their own business.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to Business and the economic environment [TB 1: Ch. 1]
2. The working of competitive markets [TB 1: Ch. 2]
3. Demand and the consumer [TB 1: Ch. 3]
4. Supply decisions in a perfectly competitive market [TB 1: Ch. 4]
5. Pricing and output decisions in imperfectly competitive markets [TB 1: Ch. 5]
6. Business growth and strategy [TB 1: Ch. 6]
7. Multinational corporations and business strategy in a global economy [TB 1: Ch. 7]
8. Government, the firm and the market [TB 1: Ch. 9]
9. The economy and business activity [TB 1: Ch. 10]
10. National macroeconomic policy [TB 1: Ch. 11]
11. The global trading environment [TB 1: Ch. 12]

Teaching Methodology:

Lectures, Class Discussions

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. John Sloman and Elizabeth Jones, Essentials Economics for Business, 5th Ed., Pearson, 2017.
2. Alan Griffiths and Stuart Wall, Economics for Business & Management: A Student Text, Prentice Hall, 2005
3. Dermot McAleese, Economics for Business: Competition, Macro-stability and Globalization, 3rd Ed., Prentice Hall, 2009.

BUSB-401 Entrepreneurship			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

1. The course gives students the tools necessary to think creatively, to plan out whether their idea is marketable to investors, guide them through the launch their own business, or to support an employer in launching and growing an entrepreneurial venture.	C	2

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Entrepreneurship and the Entrepreneurial Mind-Set. [TB 1: Ch. 1]
2. Entrepreneurial Intentions and Corporate Entrepreneurship. [TB 1: Ch. 2]
3. Entrepreneurial Strategy: Generating and Exploiting New Entries. [TB 1: Ch. 3]
4. Creativity and the Business Idea. [TB 1: Ch. 4]
5. Identifying and Analyzing Domestic and International Opportunities. [TB 1: Ch. 5]
6. Intellectual Property and Other Legal Issues for the Entrepreneur. [TB 1: Ch. 6]
7. The Business Plan: Creating and Starting the Venture. [TB 1: Ch. 7]
8. The Marketing Plan. [TB 1: Ch. 8]
9. The Organizational Plan. [TB 1: Ch. 9]
10. The Financial Plan. [TB 1: Ch. 10]
11. Sources of Capital. [TB 1: Ch. 11]
12. Informal Risk Capital, Venture Capital, and Going Public. [TB 1: Ch. 12]
13. Strategies for Growth and Managing the Implication of Growth. [TB 1: Ch. 13]
14. Succession Planning and Strategies for Harvesting and Ending the Venture. [TB 1: Ch. 15]

Teaching Methodology:

Lectures, Written Assignments, Class Discussions

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepherd, McGraw-Hill/Irwin; 9th Edition (September 27, 2012). ISBN-10: 0078029198
2. Entrepreneurship: Ideas in Action by Cynthia L. Greene, South-Western Educational Pub; 5th Edition (January 6, 2011). ISBN-10: 0538496894
3. Entrepreneurship by William D. Bygrave and Andrew Zacharakis, Wiley; 2nd Edition (October 12, 2010). ISBN-10: 0470450371
4. Entrepreneurship: Theory, Process, and Practice by Donald F. Kuratko, South-Western College Pub; 8th Edition (November 14, 2008). ISBN-10: 0324590911
5. Entrepreneurship: Successfully Launching New Ventures by Bruce R. Barringer and Duane Ireland, Prentice Hall; 4th Edition (October 27, 2011)

CSEC-303 Big Data Analytics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the Big Data Platform and its Use cases.	C	2

2. Provide an overview of Apache Hadoop, HDFS Concepts and Interfacing with HDFS.	C	3
3. Understand Map Reduce Jobs and learn Apache Spark.	C	3
4. Apply analytics on Structured, Unstructured Data and Exposure to Data Analytics with Scala.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Overview of Big Data: This includes topics such as history of big data, its elements, career related knowledge, advantages, disadvantages and similar topics. [TB 1: Ch. 13, TB2: Ch. 7]
2. Big Data in Real Life: This module focuses on the application perspective of Big Data covering topics such as using big data in marketing, analytics, retail, hospitality, consumer good, defense etc.
3. Technologies for Handling Big Data: Big Data is primarily characterized by distributed data processing frameworks like Hadoop. This module cover topics such as Introduction to Hadoop, functioning of Hadoop, Cloud computing (features, advantages, applications) [TB 1: Ch. 3]
4. Hadoop EcoSystem: This includes learning about Hadoop and its ecosystem which includes HDFS, MapReduce, YARN, HBase, Hive, Pig, Sqoop, Zookeeper, Flume, Oozie etc.
5. Deeply Understanding MapReduce: This module should cover the entire framework of MapReduce and uses of mapreduce. [TB :3 Ch. 1,2]
6. Databases and Data Warehouses: This module should cover all about databases, data warehouses, data mining, and their related introductory knowledge. [TB 1: Ch. 14]
7. Data Storage using HDFS: This includes an entire module of HDFS, HBase and their respective ways to store and manage data along with their commands. [TB 3: Ch. 12]
8. Big Data Semester Project: Discussion about how to collect real data, store data in HDFS, process distributed data using Apache Spark. Justify how it improves performance.
9. Learn Scala Basics: Learn variables, functions, loops, class, objects, case classes
10. Learn Scala: Learn Tuples, Map, Fold, Split, Array Concatenation, Lists, Iterators
11. Apache Spark: Learn How Spark is better than Hadoop, Resilient Distributed Datasets, Immutability, Learn Spark Configurations, Spark Context. [TB 3: Ch. 13]
12. Apache Spark: Understand Map Partition with Index, Accumulators, Broadcasts, and How to run an Apache Spark Job on Cluster [TB 3: Ch. 14]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Cady, Field. *The Data Science Handbook*. John Wiley & Sons, 2017.
2. Stephens-Davidowitz, Seth, and Steven Pinker. Everybody lies: Big data, new data, and what the internet can tell us about who we really are. HarperLuxe, 2017.
3. Bill Chambers and Matei Zaharia. Spark: The Definitive Guide: Big Data Processing Made Simple, OReilly, 2018.

CSEC-305 E-Commerce Applications Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the concepts and standards related to the discipline of E-Commerce.	C	2
2. Analyze complex real world problems found in E-Commerce.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. E-Commerce: An overview of e-Commerce, Brick 'N Mortar stores vs Service-based companies, e-Commerce Models, e-Commerce popular sites: iStockphoto, WooThemes, eBay, Amazon, Play.com. [TB 1: Ch.1]
2. Planning an e-Commerce Framework: Designing a framework, Patterns, ModelView-Controller, Registry, Singleton, Structure, Building a framework, Routing requests. [TB 1: Ch.2]
3. Products and Categories: Product information, Category information, Structuring Content, Versioning, Building products, categories, and content functionality, Routing products and categories. [TB 1: Ch.3]
4. Product Variations and User Uploads: Giving user's choice, giving users control, shopping. [TB 1: Ch.4]
5. Enhancing the User Experience: The importance of user experience, Search, Providing wish lists, Making Recommendations, Stock Checking, Customer's Feed Back, Processing reviews/comments. [TB 1: Ch.5]
6. The Shopping Basket: Creating a Basket, Basket Contents, Managing the Basket, Cleaning the Basket. [TB 1: Ch.6]
7. The Checkout and Order Process: The Process, Authentication, Payment Method, Order Processed. [TB 1: Ch.7]
8. Shipping and Tax: Shipping Methods, Shipping Costs, Shipping Rules, Tracking, Tax Calculation. [TB 1: Ch.8]
9. Discounts, Vouchers, and Referrals: Discount codes, Purchasable Voucher Codes, Referrals. [TB 1: Ch.9]
10. Checkout: Checkout process consideration, Order process review, Authentication & Confirmation. [TB 1: Ch.10]
11. Taking Payment for Orders: Taking payment, Payment System, Payment gateway, Taking Payment Online, Taking payment offline. [TB 1: Ch.11]
12. User Account Features: User Account Area, Changing Details, Viewing & Managing Orders. [TB 1: Ch.12]
13. Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping, etc. [TB 1: Ch.3]
14. Deploying, Security, and Maintenance, SEO. [TB 1: Ch.14, 15]

Teaching Methodology:

Lectures, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:
1. PHP 5 E-commerce Development by Michael Peacock, Packt Publishing (January 20, 2010). ISBN-10: 184719964X 2. E-Commerce, Kenneth Laudon and Carol Guercio Traver, 13th Edition, Pearson, 2017. 3. PHP 5 E-commerce Development, Michael Peacock, Packt Publishing, 2010. 4. Introduction to E-Commerce, Jeffrey F. Rayport, McGraw-Hill, 2nd Edition, 2007. 5. Electronic Commerce, Gary Schneider, Course Technology; 12th Edition 2016

CSEC-306 Enterprise Resource Planning Systems			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. To comprehend the technical aspects of ERP systems.	C	2
2. To understand the steps and activities in the ERP life cycle.	C	2
3. Understand the concepts of reengineering and able to map business processes using mapping techniques.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction to Enterprise Resource Planning Systems. [TB 1: Ch. 1] 2. ERP Technology. [TB 1: Ch. 2] 3. ERP and Business Process Reengineering. [TB 1: Ch. 3 4. Systems Diagramming and the Process Map. [TB 1: Ch. 41] 5. ERP Life Cycle: Planning and Package Selection. [TB 1: Ch. 5] 6. ERP Life Cycle: Implementation and Operation and Maintenance. [TB 1: Ch. 6] 7. ERP Sales, CRM and Knowledge Management. [TB 1: Ch. 7 8. ERP Financials. [TB 1: Ch. 8] 9. Human Capital Management, Self-Service and Outsourcing. [TB 1: Ch. 9] 10. Manufacturing Systems and Supply Chain. [TB 1: Ch. 10] 11. Auditing ERP. [TB 1: Ch. 11] 12. Business Intelligence and Performance Management. [TB 1: Ch. 12]
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Modern ERP: Select, Implement & Use Today's Advanced Business Systems by Marianne Bradford, lulu.com (October 19, 2009). ISBN-10: 0557012910 2. Managerial Issues of Enterprise Resource Planning Systems by David Olson, McGraw-Hill/Irwin; 1st Edition (September 10, 2003). ISBN-10: 0072861126 3. Enterprise Resource Planning by Bret Wagner by Ellen Monk, Course Technology; 3rd

Edition (February 4, 2008). ISBN-10: 1423901797
4. ERP Systems by DimpiSrivastava by AartiBatra, I K International Publishing House (February 15, 2010). ISBN-10: 9380578148

CSEC-312 Mobile Application Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Discuss different architectures & framework for Mobile Application development.	C	1
2. Develop mobile applications using current software development environments.	C	3
3. Compare the different performance tradeoffs in mobile application development.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. What is Android? Obtaining the Required Tools, Installing and Configuring the Android SDK Manager, Creating Your First Android Application, Anatomy of an Android Application. [Tb1: Ch 1]
2. The Big Picture, How to Get Started, Your First Android Project, A bit About Eclipse, Enhancing Your First Project [Tb2: Ch 1-6]
3. Understanding Activities, Linking Activities Using Intents, Fragments, Calling Built-In Applications Using Intents, Displaying Notifications. [Tb1: Ch 2]
4. Understanding the Components of a Screen, Adapting to Display Orientation, Managing Changes to Screen Orientation, Utilizing the Action Bar, Creating the User Interface Programmatically, and Listening for UI Notifications. [Tb1: Ch 3]
5. Using Basic Views, Using Picker Views, Using List View to Display Long Lists, Understanding Specialized Fragments. [Tb1: Ch 4]
6. Using Image Views to Display Pictures, Using Menus with Views, Analog Clock and Digital Clock Views. [Tb1: Ch 5]
7. Saving and Loading User Preferences, Persisting Data to Files, Creating and Using Databases. [Tb1: Ch 6]
8. Sharing Data in Android, using a Content Provider, Creating Your Own Content Providers, Using the Content Provider. [Tb1: Ch 7]
9. Sending SMS Messages Programmatically, Getting Feedback after Sending a Message, Sending SMS Messages Using Intent, Receiving SMS Messages, Sending E-mail. [Tb1:Ch 8]
10. Displaying Maps, Getting Location Data, Monitoring a Location, Building a Location Tracker. [Tb1:Ch 9]
11. Consuming Web Services Using HTTP, Accessing Web Services Using the Get Method, Consuming JSON Services, Sockets Programming. [Tb1:Ch 10]
12. Creating Your Own Services, Establishing Communication between a Service and an Activity, Binding Activities to Services, Understanding Threading. [Tb1:Ch 11]
13. Android games Development, Publishing Android Applications [Tb3, Tb1: Ch12]

14. Handling Telephone Calls, Fonts. [Tb2:Ch 41, 42]
Teaching Methodology:
Lectures, Written Assignments, Project, Report Writing
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2015. 2. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition, 2014. 3. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 2nd Edition, 2014.

CSEC-309 Cloud Computing			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand about fundamental concepts of distributed computing, how these techniques work inside today's most widely-used cloud computing systems.	C	1
2. Understanding the basic principles of cloud deployment and Service models.	C	2
3. Deployment of service models of Cloud through simulator/Vmware/Openstack etc.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Distributed systems, Characteristics, Design goals, Types of distributed systems [TB2:1] 2. What is Cloud Computing? Different perspectives, Properties and characteristics, Benefits [TB1: Preface] 3. Service and deployment models of Cloud computing, Service models: IaaS, PaaS, SaaS[TB1:2] 4. From IaaS to PaaS, PaaS and SaaS properties, Issues, characteristics and Implementation[TB9] 5. Modern On-Demand Computing, Amazon's Elastic Cloud, Amazon EC2 Service, Characteristics, Amazon SimpleDB, Amazon Simple Queue Service (Amazon SQS), Amazon CloudFront, Amazon Elastic Block Store (EBS) [TB1: 2] 6. Virtualization, From emulation to virtualization, Goals of virtualization, Types of

Virtualization Hosted and Hypervisor, Server Virtualization, CPU Virtualization [TB1:4, 5]

7. Memory Virtualization: Background, Virtualization Techniques: Emulated TLB, Shadow Page Tables, Hardware supported Memory Virtualization, Nested Page Tables [6]
8. Virtualization Practicum. [TB 1: Appendix A]
9. Cloud Federation: Characterization and Conceptual Model, Voluntary or independent model, Horizontal, Vertical, Hybrid model, Architectural models for cloud federation: Semantics based, Market-oriented, Reservoir, Market-oriented, Reservoir, Service oriented architecture, Conceptual Model, Segments in a Federation [TB1: 5, 7]
10. Presence in the Cloud, Presence Protocols, Leveraging Presence, Presence Enabled, The Future of Presence, The Interrelation of Identity, Presence, and Location in the Cloud, Federated Identity Management, Cloud and SaaS Identity Management, Federating Identity, Identity-as-a-Service (IaaS), Compliance-as-a-Service (CaaS), The Future of Identity in the Cloud [TB1: 5]
11. Presence Protocols: XMPP, SIMPLE, SIP [8]
12. Privacy and Its Relation to Cloud-Based Information Systems, Privacy Risks and the Cloud, Cloud Security Challenges, Software-as-a-Service Security, Security Management (People), Security Governance, Risk Management, Risk Assessment, Security Portfolio Management, Security Awareness.[TB1:6]
13. End-User Access to Cloud Computing, YouTube, YouTube API Overview, Widgets, YouTube Player APIs, The YouTube Custom Player, YouTube Data API, Zimbra, Zimbra Collaboration Suite (ZCS), Facebook, Facebook Development, Zoho, Zoho CloudSQL, DimDim Collaborations[TB1:8]
14. Mobile Internet Device and the Cloud, [TB1: 9]
15. Cloud, IOT and Fog Computing [3,4]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, LLC (2010). ISBN 978-1-4398-0680-7
2. Distributed Computing: Principles and Applications Book by Mei-Ling L. Liu. ISBN-13: 978-0201796445
3. Internet of Things: Principles and Paradigms,book by rajkumar buyya and Amir vahid DastjerDi(Eds.), publisher: Morgan kaufmann, ISBN: 978-0-12-805395-9
4. https://arxiv.org/abs/1601.02752
5. *https://www.vmware.com/pdf/virtualization.pdf*
6. *https://www.vmware.com/pdf/virtualization_considerations.pdf*
7. https://www.researchgate.net/publication/270581440_Cloud_Federation_characterization_and_conceptual_model
8. https://xmpp.org/
9. Architecting the Cloud: Design Decision for Cloud Computing Service Models (SAAS, PAAS and IAAS) Publisher: Wiley India Private Limited; 2014 edition, ISBN-10: 8126550333

CSEC-310 Systems Programming			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Introduction to systems programming, system programming languages and application of those languages to systems level problems.	C	2
2. Design, write, and test moderately complicated low-level programs using a systems programming language	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to the Microsoft Windows Operating System,
2. File Processing, Memory Management, Memory Mapped Files and DLLs,
3. Process management, Threads and scheduling, Thread synchronization,
4. Inter-process Communication, Input/Output, Device Drivers (USB or Parallel Port),
5. File System Drivers, Filter Drivers
6. Introduction to Assembly Language, 80x86 families; program layout. [TB 1: Ch. 1.1, 1.2; 2,3]
7. Data Definitions, Basic Instructions. [TB 1: Ch. 3, 4]
8. Unsigned Arithmetic; Logic and Bit Operations. [TB 1: Ch. 6, 7]
9. Modules; Separate Assembly; Argument Passing [TB 1: Ch. 5,8]
10. Libraries; Combining Assembly and C Code [TB 1: Ch. 13]
11. String Instructions; Arrays [TB 1: Ch. 9]
12. Macros; Structures [TB 1: Ch. 10]
13. Floating Point Instructions [TB 1: Ch. 12]
14. Bit MS-DOS. [TB 1: Ch. 14]
15. BIOS Disk Accessing
16. BIOS Keyboard/Video/Graphics
17. Interrupts; TSR Programs
18. Accessing I/O Ports; 8253 Timer

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Assembly Language for x86 Processors by Kip R. Irvine, Prentice Hall; latest Edition ISBN-10: 013602212X
2. Windows System Programming 3rd edition, Johnson M. Hart, Addison Wesley
3. The Windows NT Device driver book 2nd edition, Art Baker, Prentice Hall.

CSEC-311 Management Information Systems			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand basic concepts of information technology management, its application, development themes, development methodologies, development tools and technologies of Information Systems.	C	2
2. Able to solve common business problems and produce effective solutions to business problems.	C	3
3. Able to design a database application to solve a business problem.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction: Overview of Business Strategy Frameworks, Brief Overview of Organizational Strategies, Brief Overview of Information Systems Strategy [TB1: Ch. 1]
2. Understanding the IS Organization, What a Manager Can Expect from the IS Organization, What the IS Organization Does Not Do, IT Governance. [TB1: Ch. 8]
3. Evolution of Information Resources, Information Resources as Strategic Tools, How Can Information Resources Be Used Strategically? Strategic Alliances, Risks. Information Technology and Organizational Design, Information Technology and Management Control Systems, Information Technology and Culture. [TB1: Ch. 2 Ch.3]
4. Information Technology and the Design of Work. Information Technology and Changing Business Processes. Architecture and Infrastructure [TB1: Ch. 4,5,6,]
5. Information Systems Sourcing. Using Information Ethically [TB2: Ch. 7,9]
6. Techniques: Project management techniques, Organizational techniques, People techniques. IT Project Development Methodologies, Managing Business Knowledge [TB1: Ch. 11, 12]
7. Organizational Theory. Management and Control. Types of Business. Management, System Theory, Types of Business Information System, Interaction of Business Systems. System Content. [TB2: Ch.4, 5, 6]
8. Computer System Concepts, Computers in Business, System Development [TB2: 10, 11, 14]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

4. Experiencing MIS, D. M. Kroenke, A. Gemino and P. Tingling. P. 4th Edition. Toronto: Pearson.2016.
5. Business driven information systems, P. Baltzan, B. Detlor, and C. Welsh, 4th Ed., McGraw Hill Ryerson Press, 2015.
6. Fundamentals of Information Systems by Ralph Stair and George Reynolds, Course Technology; 6th Edition (January 1, 2011). ISBN-10: 0840062184
7. Information Systems Development: Methodologies, Techniques & Tools by David Avison and Guy Fitzgerald, McGraw-Hill; 4th Edition (May 1, 2006). ISBN-10: 0077114175
8. Information Systems Analysis and Design by Shouhong Wang and Hai Wang, Universal Publishers (January 1, 2012). ISBN-10: 1612330754

CSEC-401 Game Application Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Introduction to game development theory, framework, production and management.	C	2
2. Learn how to create a complete computer game from start to finish.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Building The Foundation, Historical Elements How Did We Get Here
2. Platform And Player Modes, What Is The Framework? [TB 1: Ch. 2]
3. Goals and Genres? What Are The Possibilities? [TB 1: Ch. 3]
4. Player Elements, Player Motivation, Geographic, Psychographics. [TB 1: Ch. 4]
5. Demographics, Gender, Generation, Rating, Applying Player Market to Platform. [TB 1: Ch. 4]
6. Story and Character Development: Classic Charters, Traditional Story Structure, Story Element. [TB 1: Ch. 5]
7. Plot, Game Story Devices, Game Characters [TB 1: Ch. 5]
8. Character Development Element, Point-of-view, Visual Character Development, Verbal Character Development, Movement, [TB 1: Ch. 5]
9. Visual Character Development, Verbal Character Development, Movements, Chracter Description, Game Storytelling and Documentation [TB 1: Ch. 5]
10. Gameplay: Rules to Play, Interactivity Modes, Game theory, Challenges, balance [TB 1: Ch. 6]
11. Levels: Level Design, Structure, Time, Space. [TB 1: Ch. 7]
12. Interface: Playe-Centerd Design, Interface & Game Feature, Interface Types, Usability. [TB 1: Ch. 8]
13. Audio: The Importance of Game Audio, Sound Effect, Voiceover, Music. [TB 1: Ch. 9]
14. Role & Responsibilities: Company Role, Team Roles, Tools, Business Side of Game Development. [TB 1: Ch. 10]
15. Production and Management, Development Phases, Game Documentation [TB 1: Ch. 11]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Game Development Essentials by Jeannie Novak, Delmar Cengage Learning; 3rd Edition (August 17, 2011). ISBN-10: 1111307652
2. Game Development Essentials: An Introduction by Jeannie Novak, Delmar Cengage Learning; 3rd Edition (2011). ISBN-10: 1111307652
3. Game Development Essentials: Mobile Game Development by Kimberly Unger and

Jeannie Novak, Delmar Cengage Learning; 1st Edition (2011). ISBN-10: 1418052655
4. Game Development Essentials: Game Interface Design by Kevin Saunders and Jeannie Novak, Delmar Cengage Learning; 2nd Edition (2012). ISBN-10: 1111642885
5. Game Development Essentials: Online Game Development by Rick Hall and Jeannie Novak, Delmar Cengage Learning; 1 Edition (2008). ISBN-10: 1418052671
6. Beginning 3D Game Development with Unity: All-in-one, multi-platform game development by Sue Blackman, Apress; 1st Edition (2011). ISBN-10: 1430234229
7. Game Coding Complete by Mike McShaffry and David Graham, Course Technology PTR, 4th Edition, (2012). ISBN-10: 1133776574
8. The Essential Guide to Flash Games: Building Interactive Entertainment with Action Script by Jeff Fulton and Steve Fulton, friends of ED; 1st Edition (2010). ISBN-10: 1430226145

CSEC-403 Semantic Web Techniques			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. This course introduces techniques that are useful stand-alone and can be integrated for building a semantic web.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to the semantic web.
2. Introduction to ontologies.
3. Ontology languages for the semantic web.
4. Resource Description Framework (RDF).
5. Lightweight ontologies: RDF Schema.
6. Web Ontology Language (OWL).
7. Query language for RDF: SPARQL.
8. Ontology Engineering.
9. Semantic web and Web 2.0 and applications of Semantic Web.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Introduction to the Semantic Web and Semantic Web Services, Liyang Yu, Chapman and Hall/CRC, 2007
2. Build Flexible Applications with Graph Data, Toby Segaran, Colin Evans, Jamie Taylor,302 pages O'Reilly Media, 2009
3. Foundations of Semantic Web Technologies, Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph.

CSEC-404 Virtual Reality			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand fundamental techniques, processes, technologies and equipment used in virtual reality systems.	C	2
2. Acquire the basic knowledge about the physiology of human vision, hearing, and perception.	C	2
3. Understand the human interaction with virtual reality interfaces.	C	2
4. Introduce and review recent applications of virtual reality.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Definition of VR, Modern Experiences, Historical Perspective. [TB1: Ch 1]
2. Overview of VR Systems: Hardware, Sensors, Displays, Software, Virtual World Generator, Game Engines, Human Senses, Perceptual Psychology, Psychophysics. [TB1: Ch 2]
3. Geometric Modelling, Transforming Rigid Bodies, Yaw, Pitch, Roll, Axis-angle Representation, Quaternions, 3D Rotation Inverses and Conversions, Homogeneous Transforms, Transforms to Displays, Look-at and Eye Transforms, Canonical View and Perspective Transforms, Viewport Transforms. [TB1: Ch 3]
4. Light Propagation, Lenses and Images, Diopters, Spherical Aberrations, Optical Distortion; More Lens Aberrations; Spectral Properties; The Eye as an Optical System; Cameras. [TB1: Ch 4]
5. Parts of the Human Eye, Photoreceptors and Densities, Scotopic and Photopic Vision, Display Resolution Requirements, Eye Movements, Neural Vision Structures, Sufficient Display Resolution, Other Implications of Physiology on VR. [TB1: Ch 5]
6. Depth Perception, Motion Perception, Vection, Stroboscopic Apparent Motion, Color Perception, Combining Information From Multiple Cues And Senses, Implications Of Perception On VR. [TB1: Ch 6]
7. Graphical Rendering, Ray Tracing, Shading, BRDFs, Rasterization, Barycentric Coordinates, VR Rendering Problems, Anti-Aliasing, Distortion Shading, Image Warping (Time Warp), Panoramic Rendering. [TB1: Ch 7]
8. Velocities, Acceleration, Vestibular System, Virtual World Physics, Simulation, Collision Detection, Avatar Motion, Vection. [TB1: Ch 8]
9. Tracking Systems, Estimating Rotation, IMU Integration, Drift Errors, Tilt and Yaw Correction, Estimating Position, Camera-Feature Detection Model, Perspective N-Point Problem, Sensor Fusion, Lighthouse Approach, Attached Bodies, Eye Tracking, Inverse Kinematics, Map Building, SLAM. [TB1: Ch 9]
10. Remapping, Locomotion, Manipulation, Social Interaction, Specialized Interaction Mechanisms. [TB1: Ch 10]
11. Sound Propagation, Ear Physiology, Auditory Perception, Auditory Localization, Fourier Analysis, Acoustic Modeling, Hrtfs, Rendering, Auralization. [TB1: Ch 11]
12. Perceptual Training, Recommendations for Developers, Best Practices, VR Sickness, Experimental Methods That Involve Human Subjects. [TB1: Ch 12]
13. Touch, Haptics, Taste, Smell, Robotic Interfaces, Telepresence, Brain-Machine Interfaces. [TB1: Ch 13]

Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Virtual Reality by Steven M. LaValle. Cambrigde University Press (2017). 2. Fundamentals of Computer Graphics by Peter Shirley, MichaelAshikhmin, and Steve Marschner. A K Peters/CRC Press; 3rd Edition (2009). ISBN: 1568814690

CSEC-405 Mobile Computing			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Grasp the concepts and features of mobile computing technologies and applications.	C	1
2. Difficulties in Mobile App Development and standing of Mobile Application Development Today.	C	2
3. Design and implement Mobile Application	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to Mobile Computing, Architecture of Mobile Software Applications, Introduction to Mobile Development Frameworks and Tools. [TB2: Ch. 1,2]
2. Creating Consumable Web Services for Mobile Devices: Intro to Web Services, Web Services Languages (Formats), Creating and Debugging Web Services [TB2: Ch. 3].
3. Memory Management: Design Patterns for Limited Memory, Strategies for Allocating Variable to Memory, Memory Management in Mobile Java, Symbian OS Memory Management. [TB1]
4. Mobile Applications: Components of Mobile Application, Workflow for Application Development, Techniques for Composing Application, Application Models in Mobile Java, Symbian OS Application Infrastructure. [TB1]
5. Mobile User-Interface Design: Effective Use of Screen, Understanding Mobile Application Users, Understanding Mobile Information Design, Understanding Mobile Platforms, Using the Tools of Mobile Interface Design. [TB 2: Ch. 4]
6. Dynamic Linking: Introduction to DLL, Implementation Techniques & Plugins, Managing Memory in DLL, Rules of Thumb for Using DLL, Mobile Java and Dynamic Linking, Symbian OS Dynamic Libraries. [TB1]
7. Concurrency: Introduction, Infrastructure for Concurrent Programming, Faking Concurrency, MIDP Java and Concurrency, Symbian OS and Concurrency. [TB1]
8. Managing Resources: Resource-Related Concerns in Mobile Devices, Common Concerns, MIDP Java, Symbian OS. [TB1]
9. Security: Secure Coding and Design, Infrastructure for Enabling Secure Execution,

Features in MIDP Java, Symbian OS Security. [TB1] 10. Introduction to Mobile Application Development with Android [TB2: Ch. 6] 11. Introduction to Mobile Application Development with IOS [TB2: Ch. 7] 12. Introduction to Mobile Application Development with Windows Phone [TB2: Ch. 8] 13. Introduction to Mobile Application Development with Blackberry [TB2: Ch. 9]
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Programming Mobile Devices: An Introduction for Practitioners by TommiMikkonen, Wiley; 1st Edition (March 19, 2007). ISBN-10: 0470057386. 2. Professional Mobile Application Development by Jeff McWherter& Scott Gowell, Wrox; 1st Edition (September 4, 2012). ISBN-10: 1118203909 3. Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML by Reza B'Far and Roy T. Fielding, Cambridge University Press (2004). ISBN-10: 0521817331. 4. Mobile Design and Development: Practical concepts and techniques for creating mobile sites and web apps (Animal Guide) by Brian Fling, O'Reilly Media; 1st Edition (2009). ISBN-10: 0596155441. 5. Fundamentals of Mobile and Pervasive Computing by Frank Adelstein, Sandeep KS Gupta, Golden Richard III and Loren Schwiebert, McGraw-Hill Professional; 1st Edition (2004). ISBN-10: 0071412379. 6. Mobile Design Pattern Gallery: UI Patterns for Mobile Applications by Theresa Neil, O'Reilly Media (2012). ISBN-10: 1449314325. 7. Programming Android: Java Programming for the New Generation of Mobile Devices by ZigurdMednieks, Laird Dornin, G. Blake Meike and Masumi Nakamura, O'Reilly Media; 2nd Edition (2012). ISBN-10: 1449316646. 8. Beginning Android 4 Application Development by Wei-Meng Lee, Wrox; 1st Edition (March 6, 2012). ISBN-10: 1118199545

CSEC-406 Data Warehousing			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Learn concepts and skills for designing data warehouses and creating data integration workflows.	C	2
2. Able to use tools for data warehousing: MS SQL and Teradata.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction to Data Warehousing: Brief History, Characteristics, Architecture, Data Staging and ETL, Multidimentional Model, Meta-data, Accessing Data Warehouse,

ROLAP, MOLAP, and HOLAP. [TB1: Ch. 1]
2. Data Warehouse System Lifecycle: Risk Factors, Top-Down vs Bottom-Up, Data Mart Design Phases, Methodological Framework – Data-Driven, Requirement-Driven; Testing Data Marts. [TB1: Ch. 2]
3. Analysis and Reconciliation of Data Sources: Inspecting and Normalization Schemata, Integration Problems, Integration Phases, Defining Mapping. [TB 1: Ch. 3]
4. User Requirement Analysis: Interviews, Glossary-based Requirement Analysis, Additional Requirements. [TB 1: Ch. 4]
5. Conceptual Modeling: Dimensional Fact Model, Events and Aggregation, Temporal Aspects, Overlapping Fact Shcemata, Formalizing the Dimensional Fact Model. [TB 1: Ch. 6]
6. Conceptual Design: ER Schema-based Design, Relational Schema-based Design, XML Schema-based Design, Mixed-approach Design. Requirement-driven Approach Design. [TB 1: Ch. 6]
7. Workload and Data Volume [TB1: Ch. 7]
8. Logical Modeling: MOLAP and HOLAP Systems, ROLAP Systems, Views, Temporal Scenarios. [TB1: Ch. 8]
9. Logical Design: From Fact Schemata to Start Schemata, View Materialization, View Fragmentation. [TB1: Ch. 9]
10. Data-staging Design: Population Reconciled Databases, Cleansing Data, Populating Dimensional Tables, Populating Fact Tables, Populating Materialized View
11. Indexes for the Data Warehouse: B*-Tree Indexes, Bitmap Indexes, Projection Indexes, Join & Star Indexes, Spatial Indexes, Join-Algorithm. [TB1: Ch. 11]
12. Physical Design: Optimizers, Index Selection, Splitting a Database into Tablespaces, Allocating Data Files, Disk Block Size. [TB1: Ch. 12]
13. Data Warehouse Project Documentation: Data Warehouse Levels, Data Mart Level, Fact Level
14. Case Studies, Tools for Data Warehousing: MS SQL and Teradata

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Data Warehouse Design: Modern Principles and Methodologies by MatteoGolfarelli and Stefano Rizzi, McGraw-Hill Osborne Media; 1st Edition (May 26, 2009). ISBN-10: 0071610391
2. Building the Data Warehouse by William H. Inmon, Wiley; 4th Edition (2005). ISBN-10: 0764599445
3. The Data Warehouse Lifecycle Toolkit : Expert Methods for Designing, Developing, and Deploying Data Warehouses by Ralph Kimball, Laura Reeves, Margy Ross and Warren Thornthwaite, Wiley (August 13, 1998). ISBN-10: 0471255475
4. Data Warehousing Fundamentals for IT Professionals by PaulrajPonniah, Wiley; 2ndEdition (2010). ISBN-10: 0470462078
5. Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and AmitAsthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419

CSEC-408 Business Intelligence and Analytics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Content:

1. Business Intelligence - An Introduction, Value Drivers, Performance Metrics and Key Performance Indicators, Use Cases for BI. [TB 1: Ch. 1, 2]
2. BI Success Factors. Strategic Versus Tactical Planning, BI Strategy and Plan. [TB 1: Ch. 3,4]
3. BI Environment, BI and Analytics Platform and Strategy, Organizational BI Framework, Services & Systems Evaluation. [TB 1: Ch. 5]
4. Business Process and Information Flow: Information Need & Flow, Information Processing & Information Flow, Information Flow Model, Modeling Frameworks. [TB 1: Ch. 6]
5. Data Requirements Analysis: Business Uses of Information, Metrics: Facts, Qualifiers, and Models, Defining Business Rules, Data Requirement Analysis, Assessing Suitability. [TB 1: Ch. 7]
6. Data Warehouses and the Technical BI Architecture: Data Modeling and Analytics, Analytical Platforms, Operational Data Stores. Business Metadata: What is Metadata? Types of Metadata, Semantics Metadata Processes for Business Analytics. [TB 1: Ch. 8, 9]
7. Data Profiling: Data Sources, Data Profiling Activities, Data Model Inference, Attribute Analysis, Relationship Analysis, Management Issues. [TB 1: Ch. 10]
8. Business Rules: The Value of Proposition of Business Rules, The Business Rules Approach, Defining Business Rules, Business Rule Systems, Sources of Business Rules, Management Issues. [TB 1: Ch. 11]
9. Data Quality: Virtuous Cycle of Data Quality, Types of Data Flow, Business Impacts of Data Flow, Dimensions of Data Quality, Data Quality Assessment, Data Quality Rules, Data Quality Monitoring and Improvement, Data Quality for Business Analytics, Data Cleansing. [TB 1: Ch. 13]
10. Data Integration: Improving Data Accessibility, Extracting/ Transformation/Loading, Data Latency and Data Synchrony, Data Replication and Change Data Capture, Data Integration and Cloud Computing, Information protection, Merge/Purge and Record Consolidation. [TB 1: Ch. 13]
11. Deriving Insight from Data: Customer Profiles, Behavior, and Lifetime Value; Demographics, Psychographics, Geographic; Geographic Data, Behavior Analysis. [TB 1: Ch. 15, 16]
12. Knowledge Discovery & Delivery: Business Drivers, KD Virtuous Cycle, Direct Versus Unidirectional Knowledge Discovery, Data Mining Activities, Data Mining Techniques. [TB 1: Ch. 17]
13. BI User Types, Standards Reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, Dimensional Analysis, Alerts/ Notifications, Visualizations, Scorcards and Dashboards, Geographical Visualizations, Integrated Analysis. [TB 1: Ch. 18]
14. Installations, Configuring and Maintaining the BI Server, Creating Repositories from Relational Sources, Creating Repositories from OLAP Data Sources, Creating Reports Using Answers and Dashboards.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Business Intelligence by David Loshi, Morgan Kaufmann; 2nd Edition (October 31, 2012). ISBN-10: 0123858895 2. Oracle Business Intelligence 11g Developers Guide by Mark Rittman, McGraw-Hill Osborne Media; 1st Edition (September 18, 2012). ISBN-10: 0071798749 3. Delivering Business Intelligence with Microsoft SQL Server 2012 3/E by Brian Larson, McGraw-Hill Osborne Media; 3rd Edition (March 16, 2012). ISBN-10: 0071759387 4. Business Intelligence by Elizabeth Vitt, Michael Luckevich, and StaciaMisner, Microsoft Press (December 22, 2008). ISBN-10: 073562660X 5. The Data Warehouse Mentor: Practical Data Warehouse and Business Intelligence Insights, by Robert Laberge, 1st Edition, McGraw-Hill Companies, (2012). ASIN: B008UYJJ8C 6. Business Intelligence: A Managerial Approach by Turban, Sharda, Delen, King, 2nd Edition, Prentice Hall (2011). ISBN: 13-978-0-136-10066-9 7. Business Intelligence in Plain Language: A practical guide to Data Mining and Business Analytics by Jeremy Kolb, Applied Data Labs Inc. (2012). ASIN: B009K7INOY

CSEC-409 Database Administration & Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fully understand the concepts and technical issues of database administration.	C	2
2. Develop understanding of internal functionality of DBMS.	C	3
3. Able to perform database administration tasks like backup and recovery and performance tuning of databases.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Installation; SQL* Plus; Oracle Enterprise Manager; DBA Tools. Oracle Architectural Components: Oracle Server; Oracle Instance.
2. Physical Structure; SGA; Shared Pool; Library Cache; Data Dictionary Cache; Large Pool; User Process; Server Process; Background Processes.
3. Managing an Oracle Instance: Parameter File; Creating SPFILE; Oracle Managed Files; Startup and Shutdown Database; Alert Log File; Background Trace File; User Trace File.
4. Creating Database and Data dictionary.
5. Managing Control Files and Redo Log Files.
6. Managing Tablespaces, Operations with Tablespaces.
7. Data File Management, Segments, Block.
8. Managing Undo Data, Undo Data Statistics: Managing Tables and Users:
9. Indexes Management, Maintaining Data Integrity, Constraints. Managing Privileges.

10. Basic Oracle Net Architecture: Types of Networks, Oracle Net Services, Oracle Shared Server, Connection Manager, Oracle Net Connections. 11. Server Side Configuration: The Listener Process; Configuring Listener, Sessions, Creating and Managing Listener. 12. Client Side Configuration: Host Naming Method, Local Naming Method, Net Assistant, Configurations. Usage and Configuration of Oracle Shared Server. 13. Backup and Recovery, Instance and Media Recovery, Configuration of Archive log mode, User Managed Complete Recovery, Loading Data into Database, Tuning Tools, Sizing Shared Pool, Sizing Buffer Cache, I/O Issues. 14. Tuning Rollback Segments, Latches, Rollback Segment Tuning Shared Servers, Types of Locks, Block Efficiency, Storage hierarchy, Avoiding Dynamic allocation, Statistics, PCTFREE and PCTUSED, Monitoring Index Usage.
Teaching Methodology:
Lectures, Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Final Exam
Reference Materials:
1. Oracle Database 11g DBA Handbook by Bob Bryla and Kevin Loney, McGraw-Hill Osborne Media; 1st Edition (December 6, 2007). ISBN-10: 0071496637 2. Database Administration: The Complete Guide to DBA Practices and Procedures by Craig S. Mullins, Addison-Wesley Professional; 2nd Edition (October 21, 2012). ISBN-10: 0321822943 3. Database Systems: A Practical Approach to Design, Implementation and Management by Thomas M. Connolly and Carolyn E. Begg, Addison-Wesley; 5th Edition (2009). ISBN-10: 0321523067 4. Oracle Database 11g The Complete Reference by Kevin Loney, McGraw-Hill Osborne Media; 1st Edition (2008). ISBN-10: 0071598758 5. Oracle Database 11g Release 2 Performance Tuning Tips & Techniques (Oracle Press) by Rich Niemiec, McGraw-Hill Osborne Media; 1st Edition (2012). ISBN-10: 0071780262 6. Online Material URL http://otn.oracle.com

CSEC-411 Business Process Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the key Terms and concepts in Business Process Management.	C	2
2. Learn about the major methodologies and techniques for implementing BPM.	C	2
3. Learn what a BPM management and process-centric organization is and how it works.	C	2
4. Understand the metrics and measurements critical to managing processes	C	3
5. Learn how to identify critical processes.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Introduction: Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. [TB 1: Ch. 1]
2. Evolution of Enterprise Systems Architectures: Traditional Application Development, Enterprise Applications and their Integration, Enterprise Modeling and Process Orientation, Workflow Management, Enterprise Services Computing. [TB 1: Ch. 2]
3. Business Process Modeling: Foundation, Conceptual Model and Terminology, Abstraction Concepts, From Business Functions to Business Processes, Activity Models and Activity Instances, Process Models and Process Instances, Process Interactions, Modeling Process Data, Modeling Organization, Modeling Operation, Business Process Flexibility, Architecture of Process Execution Environments. [TB 1: Ch. 3]
4. Process Orchestrations: Control Flow Patterns, Petri Nets, Event-driven Process Chains, Workflow Nets, Graph-Based Workflow Language, Business Process Model and Notation. [TB 1: Ch. 4]
5. Process Choreographies: Motivation and Terminology, Development Phases, Process Choreography Design, Process Choreography Implementation, Service Interaction Patterns, Choreography Modeling in BPMN. [TB 1: Ch. 5]
6. Properties of Business Processes: Data Dependencies, Object Lifecycle Conformance, Structural Soundness, Soundness, Relaxed Soundness, Weak Soundness, Lazy Soundness, Soundness Criteria Overview. [TB 1: Ch. 6]
7. Business Process Management Architectures: Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes: Case Handling. [TB 1: Ch. 7]
8. Business Process Management Methodology: Dependencies between Processes, Methodology Overview, Phases in Detail. [TB 1: Ch. 7]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2nd Edition (May 3, 2012). ISBN-10: 3642286151.
2. Business Process Management Common Body Of Knowledge by Yvonne LedererAntonucci, et. al., CreateSpace Independent Publishing Platform (March 8, 2009). ISBN-10: 1442105666
3. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Edition (January 21, 2011). ISBN-10: 3642151892
4. Business Process Management, Second Edition: Practical Guidelines to Successful Implementations by John Jeston and Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
5. Process Management: Practical Guidelines to Successful Implementation by T.S. Malik, Global India Publications Pvt Ltd; 1st Edition (December 31, 2009). ISBN-10: 9380228368
6. Business Process Management: Practical Guidelines to Successful Implementations by John Jeston& Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561

7. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody-Cassidy Press (October 17, 2011). ISBN-10: 0982368119
8. Workflow Modeling: Tools for Process Improvement and Application Development by Alec Sharp and Patrick McDermott, Artech House; 2nd Edition (October 31, 2008). ISBN-10: 1596931922
9. Process Analysis and Improvement: Tools and Techniques by Seppanen, Marvic S., Kumar, Sameer & Chandra, Charu (2005). McGraw-Hill
10. Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals (The MK/OMG Press) by Paul Harmon and Business Process Trends, Morgan Kaufmann; 2nd Edition (July 27, 2007). ISBN-10: 0123741521

CSEC-412 Knowledge Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Appraise current thought on knowledge management in the light of contemporary debates on knowledge productivity, strategic capability and organizational learning.	C	2
2. Apply theories of knowledge management relevant to current workplace practice.	C	3
3. Apply the tools and techniques of knowledge management.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. History and paradigms of knowledge management; Types of knowledge: Explicit Knowledge, Tacit Knowledge, Embedded Knowledge, Embrained knowledge, Embodied knowledge, Encoded knowledge, Encultured knowledge; Organizational Internal & External Knowledge; Managers' Knowledge; Personal knowledge. Knowledge Economy: Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents; Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies. [TB1: Ch. 1, 2, 4]
2. KM Processes: Knowledge Discovery/ Detection, Knowledge Capture and Codification, Knowledge Organization, Knowledge Sharing, Explicit Knowledge Sharing, Knowledge transfer, Knowledge Acquisition, Knowledge Verification, Knowledge Utilization, Knowledge Creation, Knowledge Reuse; [TB1: Ch. 3]
3. KM Frameworks and Models: The SECI Model, Alen Frost's Model, Boisot's KM Model, Hedlund's KM Model, Earl's KM Model, Carayannis's KM Model, Wiig's KM Model, Edvinsson's Model of Intellectual Capital, Snowden's KM Model, Inkpen&Dinur's KM Model. [TB1: Ch. 4]
4. KM Frameworks and Models: Van Buren's Model of IC Management, Bukowitz& Williams's KM Model, Gamble & Blackwell's KM Model, Demerest's KM Model, Frid's KM Model, Stankosky&Baldanza's KM Framework, Kogut& Zander's KM Model, Botha et. al. KM Model, Integrated Knowledge Management Model. [TB1: Ch.

4]

5. 4 Knowledge Capture and Codification: Tacit Knowledge Capture at the Individual, Group, and Organizational Levels, xplicit Knowledge Codification, Cognitive Maps, Decision Trees, Knowledge Taxonomies, The Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence; Strategic and Practical Implications of Knowledge Capture and Codification [TB2: Ch. 4]
6. Knowledge Sharing and Communities of Practice: Sociograms and Social Network Analysis, Knowledge-Sharing Communities, Types of Communities, Roles and Responsibilities in CoPs, Knowledge Sharing in Virtual CoPs, Obstacles to Knowledge Sharing, Strategic and Practical Implications of Knowledge Sharing. [TB2: Ch. 5]
7. Knowledge Application: Knowledge Application at the Individual Level, Characteristics of Individual Knowledge Workers, Bloom ' s Taxonomy of Learning Objectives, Task Analysis and Modeling, Knowledge Application at the Group and Organizational Levels, Knowledge Reuse, Knowledge Repositories, E-Learning and Knowledge Management Application, Strategic & Practical Implications of Knowledge Application. [TB3: Ch.6]
8. The Role of Organizational Culture: Different Types of Cultures, Organizational Culture Analysis, The Effects of Culture on Individuals, Organizational Maturity Models, KM Maturity Models, CoP Maturity Models, Transformation to a Knowledge-Sharing Culture, Impact of a Merger on Culture, Impact of Virtualization on Culture, Strategic and Practical Implications of Organizational Culture. [TB2: Ch.7]
9. Knowledge Management Tools: Knowledge Capture and Creation Tools, Content Creation Tools, Data Mining and Knowledge Discovery, Blogs, Mashups, Content Management Tools, Folksonomies and Social Tagging/Bookmarking, Personal Knowledge Management (PKM), Knowledge Sharing and Dissemination Tools, Groupware and Collaboration Tools, Wikis, Social Networking, Web 2.0, and KM 2.0, Knowledge Acquisition and Application Tools, Intelligent Filtering Tools, Adaptive Technologies, Strategic and Practical Implications of KM Tools and Techniques. [TB2: Ch. 8]
10. Knowledge Management Strategy: Developing a Knowledge Management Strategy, Knowledge Audit, Gap Analysis, The KM Strategy Road Map, Balancing Innovation and Organizational Structure, Types of Knowledge Assets Produced. [TB2: Ch. 9]
11. The Value of Knowledge Management: KM Return on Investment (ROI) and Metrics, The Benchmarking Method, The Balanced Scorecard Method, The House of Quality Method, The Results-Based Assessment Framework, Measuring the Success of Communities of Practice. [TB2: Ch. 10]
12. Organizational Learning and Organizational Memory: How Do Organizations Learn and Remember? Frameworks to Assess Organizational Learning and Organizational Memory, The Management of Organizational Memory, Organizational Learning, The Lessons Learned Process, Organizational Learning and Organizational Memory Models, A Three-Tiered Approach to Knowledge Continuity. [TB2: Ch. 11]
13. The KM Team: Major Categories of KM Roles, Senior Management Roles, KM Roles and Responsibilities within Organizations, The KM Profession, The Ethics of KM. [TB2: Ch. 12]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Essentials of Knowledge Management: Concepts, Theories and Practices by M. A. Pasha

& S. Pasha, Innovators Knowledge Services (2012). ISBN:978-969-9791-04-8
2. Knowledge Management in Theory and Practice by KimizDalkir, The MIT Press; 3nd Edition (March 4, 2011). ISBN-10: 0262015080
3. The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms by AmritTiwana, Prentice Hall; 2nd Edition (August 29, 2002). ISBN-10: 013009224X
4. Principles of Knowledge Management: Theory, Practice and Cases by ElieGeisler and NilminiWickramasinghe, M.E.Sharpe (January 15, 2009). ISBN-10: 0765613220
5. Knowledge Management: Concepts, Methodologies, Tools and Applications (6-volume set) by Murray E. Jennex, IGI Global; Reprint Edition (August 10, 2007). ISBN-10: 1599049333

Revised Curriculum of BS Information Technology for Main Campus, Sub Campuses, and Affiliated Colleges



Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall 2019)

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Guidelines for Affiliated Colleges

- BSIT program shall be offered under Term System observing University of Sargodha's Affiliation Rules & Regulation.
- There shall be two terms in a calendar academic year.
- The affiliated college(s)/institutions shall follow the prescribed curriculum and course matrix. Necessary modification/changes shall be communicated to the affiliated Colleges/Institutions, if any.
- For domain elective courses, the affiliated institution(s)/college(s) shall follow "Regular Track". However, the administration of any affiliated institution must get prior permission from the competent authority to offer any specialization tracks/courses approved by the BOS. For this purpose, the institution's administration needs to show/demonstrate the availability of appropriate human resource along with necessary educational provisions before the start of the term in which specialization track/course shall be offered. The recommendations of the Convener BOS shall be solicited to allow the Institution to offer the requested specialization track/course already approved by the BOS.

The Discipline of Information Technology

In early days, 'Computer Science' was used as a common term for computing. With the passage of time, the nature of basic principles, methods, techniques and concepts evolved. Even some new concepts refuted the old ones. Before 1990s, computing was limited to three disciplines – Computer Science (CS), Computer Engineering (CE), and Information Systems (ISs). By 1990s, the global community realized that the field of computing had grown in many dimensions. Different academic institutions started offering different degree programs in Software Engineering (SE).

The inventions of personal computers revolutionized the conventional concepts of calculation and changed the way data was stored, retrieved and controlled. Computers became essential tools at every level and networked computer systems became the information backbone of organizations (Kotkin, 2000). It also expedited the pace of inventions (Thomson, 2007) resulting many innovations in communication and computation technologies which brought a paradigm shift in the business world - from data processing to information processing; converting industrial society into an information society (Cohen, 2009). While this paradigm shift improved productivity, it also brought new challenges regarding the development, operation, maintenance, and up-gradation of organizational information management infrastructure (Samuelson, 1995).

By the end of 1990s, the academia realized that the existing computing degree programs were not producing graduates who had the right mix of knowledge and skills to meet organizational challenges (Lunt, et. al., 2005). Consequently, universities developed new degree programs in Information Technology (IT) to fill this crucial void (Denning, 2001); Hence IT was introduced as a new family member of computing disciplines (Lunt, et. al., 2005).

According to Curricula 2005: The Overview Report: "Information technology is a label that has two meanings. In the broadest sense, the term information technology is often used to refer to all of computing. In academia, it refers to undergraduate degree programs that prepare students to meet the computer technology needs of business, government, healthcare, schools, and other kinds of organizations". Curriculum Guidelines for Undergraduate Degree Programs in Information Technology (2008) explains that "Information Technology (IT) in its broadest sense encompasses all aspects of computing technology. IT, as an academic discipline, is concerned with issues related to advocating for users and meeting their needs within an organizational and societal context through the selection, creation, application, integration and administration of computing technologies." Figure 1[1], depicts the key pillars of academic discipline of Information Technology

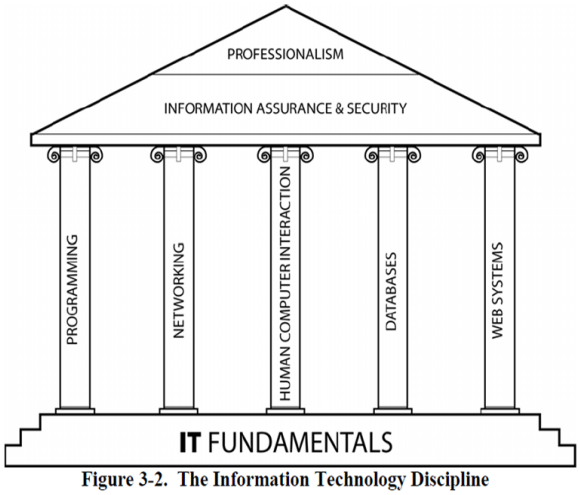


Figure 3-2. The Information Technology Discipline

[1]Curriculum Guidelines for Undergraduate Degree Programs in Information Technology (2008)

Information Technology as an academic discipline, as defined by The Information Technology Association of America (ITAA), is "the study, design, development, application, implementation, support or management of computer-based information systems, particularly software applications and computer hardware". It deals with the use of electronic computers and computer software to securely convert, store, protect, process, transmit, input, output, and retrieve information. [Wikipedia]

Vision of Information Technology Education

As defined in cc2008 "Information Technology is very much an integrative discipline; it pulls together the IT pillars of databases, human-computer interaction, networking, programming, and web systems and uses a solid background in each of them to enable graduates to solve all types of computing and informational problems, regardless of their origin. As a discipline, IT emphasizes the pervasive themes of user centeredness and advocacy, information assurance and security, and the management of complexity through abstraction and modeling, best practices, patterns, standards, and the use of appropriate tools." In the light of this explanation, the curriculum committee formalized the Vision Statement for IT education in Pakistan as follows:

The IT education in Pakistan will focus on imparting the knowledge and training which enable students

- to understand and contribute to the scientific, mathematical and theoretical foundations on which information technologies are built;
- to use and apply current technical concepts, techniques, skills, tools and practices to analyze the local and global impact of IT on individuals, organizations, and society and to identify their computing needs, and select, design, create, implement, administer and evaluate a computer-based system, process, component, or program to meet the desired needs and integrate them into the user environment;
- to develop students' interpersonal and organizational skills to communicate effectively with a range of audience, create operative project plans and work in a collaborative environment;
- to strengthen students' understanding of professional, ethical, legal and social issues and responsibilities;
- to develop students' capacity for innovation and passion for lifelong learning.

IT curriculum thus aims to achieve the targets set in the vision statement. It should strive to meet the professional demands of the industry and academia both in terms of immediate needs and the capacity for longer term development to avail the opportunities and face the challenges of the modern world. The committee is of the view that the curriculum must focus on building a solid foundation in the early stages of learning. Thus, Information Technology concepts should be taken up as early as the start of 1st year. These should gradually be strengthened through developing the core competencies and desired skill-sets during the second, third and fourth years. The students must also be provided opportunities to bring together the knowledge gained in a wide variety of courses to solve realistic problems in a team-based environment through lab sessions, practical assignments, course projects and a capstone design project.

Information Technology Programs' Rational

The digital revolution not only reshaped the way scientists conduct their research but also expedite the pace of inventions. Consequently, the latest advancements in technologies for communication, computation, and delivery of information brought a paradigm shift in the business world - from data processing to information processing - converting computer technology into information technology (IT) and industrial society into an "information society". While this paradigm shift improves productivity, it also created new work place challenges regarding the development, operation, maintenance, and up-gradation of organizational IT infrastructure. Inventions like the Internet, the World Wide Web, email, bulletin board systems, virtual communities, E-business and other online technologies forced organizations to find IT based solutions to all kinds of business challenges. For this, organizations need appropriate systems that work properly and professionals who make these systems secured, upgraded, and maintained. In parallel, employees require support from these professionals to make technology effective for enhancing organizational productivity. This has created a huge demand of IT professionals both locally and globally. Meeting this demand is the key rationale behind the IT programs. In this regard, the IT programs offer a curriculum structure that can produce graduates who can meet above discussed challenges of the 21st century's knowledge driven complex work places. The curriculum structure will create, expand, disseminate and teach the information technology body of knowledge through academics, applications and research which positively impact society (locally, nationally, and internationally). It will also provide an integration of all components that allow accessing all of the new knowledge and technologies for meeting the above discussed challenges.

Underlying Principles of Information Technology Programs

Curriculum plays an important role within education as it outlines the planned and structured learning experiences that an academic program provides. For an effective academic program the curriculum must meet the needs of the stakeholders and face the emerging challenges. The Department of CS & IT (UOS) realizes the rapidly changing needs of today's knowledge intensive technology driven complex work places and the changing patterns of 21st century universities' education which have removed the identity of place, the identity of time, the identity of the scholarly community, and the identity of the student community. To meet these challenges, the Department has revised the existing curriculum. The revised curriculum is based on following underlying principles:



i. The curriculum should be a broad based and provides students with the flexibility to work across many disciplines & professions.
ii. The curriculum should prepare graduates to succeed in a rapidly changing field.
iii. The curriculum should provide guidance for the expected level of mastery of topics by graduates.
iv. Should provide realistic, adoptable recommendations that provide guidance and flexibility, allowing curricular designs that are innovative and track recent developments in the field.
v. The curriculum contents should be relevant and compatible with a variety of institu-

tions.

vi. The size of the essential knowledge must be managed.
vii. The curriculum should identify the fundamental skills and knowledge that all graduates should possess.
viii. The curriculum should provide the greatest flexibility in organizing topics into courses and curricula.

In the light of these principles, the curriculum of the program has adopted a balanced and multidisciplinary approach and presents a blend of study areas which spread across the boundaries of fundamental knowledge of traditional disciplines to advanced knowledge of the emerging disciplines. Body of knowledge (BOK) of the program covers knowledge areas which are required for the program's accreditation from the Accreditation Council and knowledge area which are required for professional certification and professional development.

It is universally accepted that each profession needs both a specific skill set and an appropriate mindset. Developing an appropriate mindset of the prospective computing graduates requires a body of knowledge which enriches students' experiences, thoughts, beliefs, assumptions, and attitudes about the special characteristics of that specific domain. Therefore, the course contents and related practical experiences are designed to meet the professional requirements of the respective domain. To achieve the curricula have focused on following six (6) key areas:

i. Knowledge: Theoretical learning of concepts and principles regarding a particular subject(s).
ii. Skills: Capability of using learnt knowledge and applying it according to the context
iii. Competencies: The ability to do things satisfactory- not necessarily outstandingly or even well, but rather to a minimum level of acceptable performance.
iv. Expertise: Level of proficiency and innovative ways of applying learnt knowledge. (Competitive edge)
v. Dispositions: Habits of mind or tendencies to respond to certain situations in certain ways. The role of dispositions in computing education is very important. For example, having the disposition to be a programmer is much better that just having programming skills.
vi. Values: Moral, ethical and professional practices.

To strengthen the curriculum further, specialization tracks/courses have also been integrated within the curriculum's BOK. These specialization tracks/courses are designed according to what the industry is looking for in an employee and the learning interests of students. Furthermore, life skills including desired dispositions, soft skills, public speaking, critical thinking & reasoning, 21st Century literacies, personal attributes, entrepreneurship, attitude towards lifelong learning, professional practices and other social skills have not considered discrete items, rather threaded into the entire fabric of the curriculum.

Curriculum
for
BS Information Technology Program

Details of BS Information Technology

Program's Aims & Objectives

The aim of the BS (IT) program is to produce entrepreneurs of great character, competence, vision and drive equip with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in information technology domain or proceed to further or higher education or training. One of the key objectives of the program is to equip students with skills and knowledge that enable them to take on appropriate professional positions in IT and grow into leading roles. The goals of the program are to produce, in coordination with organizational management, IT graduates who have ability to:

- Apply knowledge of computing and mathematics appropriate to the discipline.
- Analyze a problem, and identify and define the computing requirements appropriate to its solution.
- Design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
- Function effectively on teams to accomplish a common goal.
- Understand the professional, ethical, legal, security and social issues and responsibilities.
- Communicate effectively with a range of audiences.
- Analyze the local and global impact of computing on individuals, organizations, and society.
- Recognize the need for and an ability to engage in continuing professional development.
- Use the current techniques, skills, and tools necessary for computing practice.
- Use and apply the latest technical concepts and practices in the core information technologies.
- Identify and analyze user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems.
- Integrate IT-based solutions into the user environment.
- Understand the best practices and standards and their application.
- Assist in the creation of an effective project plan.

Program's Outcome

BSIT program will produce entrepreneurs of great character, competence, vision and drive equip with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in information technology domain or proceed to further or higher education or training.

Program's Structure

The structure of BSIT program is very dynamic and provides basis for various options including Breadth-Based, Depth-Based, and Integrated Breadth & Depth-Based specializations. Student may choose a particular option, which is the most appropriate to their planned future career. Followings are the program's details:

Specialization Tracks

Following specialization tracks are being offered:

1. Regular Track [Public-Private campuses and affiliated colleges will follow track]
2. General Track [Main and public sub campuses]

Degree Requirement

To become eligible for award of BS degree, a student must satisfy the following requirements:

a) Must have studied and passed the prescribed courses, totaling at least 130 credit hours.
b) Must have earned CGPA (Cumulative Grade Point Average) of at least 2.0 on a scale of 4.0.

Duration

The minimum duration for completion of BS degree is four years. According to HEC maximum period of seven years is to complete BS degree requirements.

Eligibility Criteria

The minimum requirements for admission in a Bachelor degree program in Information Technology, is **at least 50% marks in Intermediate (HSSC) examination with Mathematics or equivalent qualification with Mathematics certified by IBCC**.

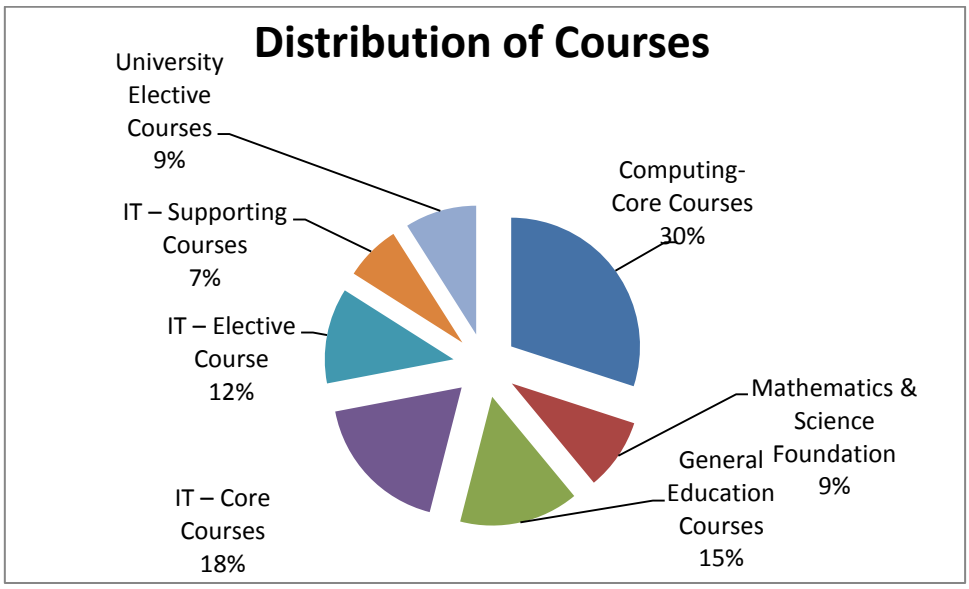
Assessment& Evaluation

University's semester and examination rules & regulations shall be followed for assessment & evaluation.

Distribution of Courses

Followings are the distribution of total credit hours:

Distribution of Courses		
Major Areas	**Credit Hours**	%
Computing Foundation Core Courses	39	30%
Mathematics & Science Foundation	12	9%
General Education Courses	19	15%
IT – Core Courses	24	18%
IT – Elective Course	15	12%
IT – Supporting Courses	09	7%
University Elective Courses	12	9%
Total	**130**	**100%**



Course Coding Scheme

Discipline Code	Course Level	Course Number
4 Letters	1 Digit	2 Digits
XXXX	0-9	00-99

Discipline Code	
CMPC	Computing Core Foundation
ITCC	Information Technology Core
ITSCC	Information Technology Supporting
ITEC	Information Technology Elective
PKST	Social Studies
MATH	Mathematics
ENGL	English
MNG	Management
ICTC	Information & Communication Technologies
PHYS	Physics

Course Level	
Level	**Course Type**
1	Foundation, Core Level 1 Courses
2	Foundation, Core Level 1 Courses
3	Core Level 2 + Specialization Level 1
4	Specialization Level 2

Scheme of Study for BS (Information Technology)

For Main and Public Sub Campuses

4-Year Program (8 Regular Semesters)

Semester - I

Code	Course Title	Credit Hours	Pre-requisite
ICTC-101	Introduction to ICT	2-1	
CMPC-101	Programming Fundamentals	3-1	
ENGL-101	English Composition & Comprehension	3-0	
MATH-101	Calculus & Analytical Geometry	3-0	
PHYS-101	Applied Physics/Quantum Computing	3-0	
	Total	14-2	

Semester - II

Code	Course Title	Credit Hours	Pre-requisite
CMPC-102	Object Oriented Programming	3-1	Programming Fundamentals
ENGL-102	Communication & Presentation Skills	3-0	
ITSC-1xx	IT Supporting Course – I	3-0	
MATH-102	Probability & Statistics	3-0	
xxxx-1xx	University Elective – 1	3-0	
xxxx-1xx	University Elective – 2	3-0	
	Total	18-1	

Semester - III

Code	Course Title	Credit Hours	Pre-requisite
CMPC-203	Data Structures & Algorithms	3-1	Object-Oriented Programming
CMPC-205	Discrete Structures	3-0	
ITSCC-201	Professional Practices	3-0	
ITSC-2xx	IT Supporting Course – II	3-0	
MATH-203	Linear Algebra	3-0	
	Total	15-1	

Semester - IV

Code	Course Title	Credit Hours	Pre-requisite
CMPC-204	Operating Systems	3-1	Data Structures & Algorithms
CMPC-206	Software Engineering	3-0	
CMPC-208	Computer Networks	3-1	
ITCC-202	IT Project Management	3-0	
xxxx-20x	University Elective – 3	3-0	
	Total	15-2	

Semester - V

Code	Course Title	Credit Hours	Pre-requisite
CMPC-301	Database Systems	3-1	Data Structures & Algorithms

CMPC-303	Information Security	3-0	
ITSC-3xx	IT Supporting Course – III	3-0	
ITCC-301	System and Network Administration	3-1	Operating Systems
ITEC-3xx	IT Elective – 1	3-0	
	Total	15-2	

Semester - VI

Code	**Course Title**	**Credit Hours**	**Pre-requisite**
ITCC-302	Web Technologies	3-0	
xxxx-3xx	University Elective – 4	3-0	
ITEC-3xx	IT Elective – 2	3-0	
ITEC-3xx	IT Elective – 3	3-0	
ENGL-302	Technical & Business Writing	3-0	
	Total	15-0	

Semester - VII

Code	**Course Title**	**Credit Hours**	**Pre-requisite**
ITCC-403	Virtual Systems and Services	3-1	
CMPC-401	Final Year Project – I	0-3	
ITCC-407	IT Infrastructure	3-0	
ITEC-4xx	IT Elective – 4	3-0	
PKST-401	Pakistan Studies	2-0	
	Total	11-4	

Semester - VIII

Code	**Course Title**	**Credit Hours**	**Pre-requisite**
CMPC-402	Final Year Project – II	0-3	
ITCC-402	Cyber Security	3-0	
ITEC-4xx	IT Elective – 5	3-0	
ITCC-406	Database Administration and Management	3-1	
ISLS-402	Islamic Studies/ Ethics	2-0	
	Total	11-4	

Scheme of Study for BS (Information Technology)

For Public-Private Sub Campuses and Affiliated Collages

4-Year Program (8 Regular Semesters)

Semester - I

Code	Course Title	Credit Hours	Pre-requisite
ICTC-101	Introduction to ICT	2-1	
CMPC-101	Programming Fundamentals	3-1	
ENGL-101	English Composition & Comprehension	3-0	
MATH-101	Calculus & Analytical Geometry	3-0	
PHYS-101	Applied Physics/Quantum Computing	3-0	
	Total	14-2	

Semester - II

Code	Course Title	Credit Hours	Pre-requisite
CMPC-102	Object Oriented Programming	3-1	Programming Fundamentals
ENGL-102	Communication & Presentation Skills	3-0	
ITSC-102	Digital Logic Design	3-0	
MATH-102	Probability & Statistics	3-0	
BUSB-102	Business Economics	3-0	
BUSB-202	Principles of Management	3-0	
	Total	18-1	

Semester - III

Code	Course Title	Credit Hours	Pre-requisite
CMPC-203	Data Structures & Algorithms	3-1	Object-Oriented Programming
CMPC-205	Discrete Structures	3-0	
ITSCC-201	Professional Practices	3-0	
ITSC-201	Enterprise Systems	3-0	
MATH-203	Linear Algebra	3-0	
	Total	15-1	

Semester - IV

Code	Course Title	Credit Hours	Pre-requisite
CMPC-204	Operating Systems	3-1	Data Structures & Algorithms
CMPC-206	Software Engineering	3-0	
CMPC-208	Computer Networks	3-1	
ITCC-202	IT Project Management	3-0	
BUSB-202	Entrepreneurship	3-0	
	Total	15-2	

Semester - V

Code	Course Title	Credit Hours	Pre-requisite
CMPC-301	Database Systems	3-1	Data Structures & Algorithms
CMPC-303	Information Security	3-0	
ITSC-305	Design and Analysis of Algorithms	3-0	
ITCC-301	System and Network Administration	3-1	Operating Systems
ITEC-303	Mobile Application Development	3-0	
	Total	15-2	

Semester - VI

Code	Course Title	Credit Hours	Pre-requisite
ITCC-302	Web Technologies	3-0	
BUSB-302	Human Resources Management	3-0	
ITEC-302	Cloud computing	3-0	
ITEC-304	Network Design and Management	3-0	
ENGL-302	Technical & Business Writing	3-0	
	Total	15-0	

Semester - VII

Code	Course Title	Credit Hours	Pre-requisite
ITCC-403	Virtual Systems and Services	3-1	
CMPC-401	Final Year Project – I	0-3	
ITCC-407	IT Infrastructure	3-0	
ITEC-405	Mobile and Wireless Networks	3-0	
PKST-401	Pakistan Studies	2-0	
	Total	11-4	

Semester - VIII

Code	Course Title	Credit Hours	Pre-requisite
CMPC-402	Final Year Project – II	0-3	
ITCC-402	Cyber Security	3-0	
ITEC-420	Data Warehousing	3-0	
ITCC-406	Database Administration and Management	3-1	
ISLS-402	Islamic Studies/ Ethics	2-0	
	Total	11-4	

Computing Core Courses – 39 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
1	CMPC-101	-	Programming Fundamentals	4 (3+1)
2	CMPC-102	CMPC-101	Object Oriented Programming	4 (3+1)

3	CMPC-205	-	Discrete Structures	3 (3+0)
4	CMPC-203	CMPC-102	Data Structure and Algorithms	3 (3+1)
5	CMPC-204	-	Operating Systems	4 (3+1)
6	CMPC-206	-	Software Engineering	3 (3+0)
7	CMPC-208	-	Computer Networks	3 (3+1)
8	CMPC-301	-	Database Systems	4 (3+1)
9	CMPC-303	-	Information Security	3 (3+0)
10	CMPC-401	-	Capstone Project	6 (0+6)

Mathematics and Science Foundation Courses - 12 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
11	MATH-101	-	Calculus and Analytical Geometry	3 (3+0)
12	MATH-102	-	Probability and Statistics	3 (3+0)
13	MATH-203	-	Linear Algebra	3 (3+0)
14	PHYS-101	-	Applied Physics	3 (3+0)

General Education Courses – 19 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
15	ENGL-101	-	English Composition & Comprehension (English-I)	3 (3+0)
16	ENGL-102	ENGL-101	Communication and Presentation Skills (English-II)	3 (3+0)
17	ENGL-302	ENGL-102	Technical and Business Writing (English-III)	3 (3+0)
18	PKST-401	-	Islamic Studies	2 (2+0)
19	ISLS-402	-	Pakistan Studies	2 (2+0)
20	ICTC-101	-	Introduction to Information & Communication Technologies	3 (2+1)
21	ITSCC-201	-	Professional Practices	3 (3+0)

IT — Core Courses (24 Credits Hours)				
#	**Code**	**Pre-req**	**Course Name**	**Cr. Hrs.**
22	ITCC-402		Cyber Security	3 (3+0)
23	ITCC-406		Database Administration & Management	4 (3+1)
24	ITCC-202		IT Project Management	3 (3+0)
25	ITCC-407		Information Technology Infrastructure	3(3+0)
26	ITCC-301		Systems and Network Administration	4 (3+1)
27	ITCC-403		Virtual Systems and Services	4 (3+1)
28	ITCC-302		Web Systems and Technologies	3 (3+0)

IT — Supporting Courses (09 Credits Hours - Any 3 Courses)				
#	**Code**	**Pre-req**	**Course Name**	**Credit hours**
29	ITSC-201	-	Enterprise Systems	3 (3+0)
30	ITSC-301		Operation Research	3 (3+0)
31	ITSC-302	-	Object Oriented Analysis & Design	3 (3+0)
32	ITSC-303	-	Optimization Techniques	3 (3+0)
33	ITSC-102	-	Digital Logic Design	3 (3+ 0)
34	ITSC-305	-	Design and Analysis of Algorithm	3 (3+ 0)

University Electives Courses (12 Credits Hours)				
#	**Code**	**Pre-req**	**Course Name**	**Cr. Hrs.**
35	BUSB-102	-	Business Economics	3 (3+0)
36	BUSB-302	-	Human Resource Management	3 (3+0)
37	BUSB-202	-	Principles of Management	3 (3+0)
38	BUSB-204	-	Entrepreneurship	3 (3+0)

Information Technology Elective Courses

Regular Track IT Elective Courses (15 Credit Hours - Any 5 Courses)				
39	ITEC-303	-	Mobile Application Development	3(3+0)
40	ITEC-405	-	Mobile and Wireless Networks	3(3+0)
41	ITEC-302	-	Cloud Computing	3(3+0)
42	ITEC-404	-	Internet of EveryThing	3(3+0)
43	ITEC-420	-	Data Warehousing	3(3+0)
44	ITEC-407	-	Knowledge Management	3(3+0)
45	ITEC-304	-	Network Design and Management	3 (3+0)
46	ITEC-409	-	Business Intelligence and Analytics	3(3+0)

General Track IT Elective Courses (15 Credit Hours - Any 5 Courses)				
47	ITEC-303	-	Mobile Application Development	3(3+0)
48	ITEC-401	-	E-Commerce Applications Development	3(3+0)
49	ITEC-405	-	Mobile and Wireless Networks	3(3+0)
50	ITEC-302	-	Cloud Computing	3(3+0)
51	ITEC-404	-	Internet of EveryThing	3(3+0)
52	ITEC-420	-	Data Warehousing	3(3+0)
53	ITEC-406	-	Semantic Web	3(3+0)
54	ITEC-407	-	Knowledge Management	3(3+0)

55	ITEC-304	-	Network Design and Management	3(3+0)
56	ITEC-409	-	Business Intelligence and Analytics	3(3+0)
57	ITEC-410	-	Data Mining	3(3+0)
58	ITEC-411	-	Enterprise Resource Planning	3(3+0)
59	ITEC-412	-	Network Programming	3(3+0)
60	ITEC-413	-	Information Systems and Audit	3(3+0)
61	ITEC-414	-	Routing and Switching	3(3+0)
62	ITEC-415	-	Business Process Management	3(3+0)
63	ITEC-416	-	Artificial Intelligence	3(3+0)

Course Contents for BS Information Technology

Contents of Computing Core Courses

CMPC-101 Programming Fundamentals			
Credit Hours:	4(3,1)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Problem solving skills	C	1
2. Coding skills	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction, Introduction to Computer Programming: Machine Languages, Assembly Languages and High-Level Languages. History of C, C Standard Library, Typical C Program Development Environment, Memory Concepts, white spaces, comments. [Ch. 1]
2. Principles of Structured and Modular Programming: Algorithms, Pseudo code, flowchart representation. Basic Data Types (variables, constants). [Ch. 2]
3. Unary (increment/decrement) and Binary (arithmetic, relational, arithmetic assignment) operators. Arithmetic (Expression) in C. C Programming Basics: Programming Practices, Summary. [Ch. 1, 2, 3]
4. Decision Statements: if statement, if-else statement, Multi if-else-if statement. Decision Statements: Nested if-else statements, Switch Statement. [Ch. 3]
5. Decision Statements: Conditional operator, Logical Operators, Programming Practices, and Summary. Program Control: Repetition Essentials, Counter-Controlled Repetition. for loop. [Ch. 3]
6. Loops: while loop, do while loop [Ch. 4]
7. Nested loop structures. Other Control Statements, break and continue Statements, Logical Operators, Confusing Equality (==) and Assignment (=) Operators. Programming Practices, Summary. [Ch. 4]
8. Arrays: Defining Arrays, Array Examples (finding max, min value from the array). Searching techniques (linear search, Binary search). Sorting Arrays: selection sort, bubble sort. Case Study: Computing Mean, Median and Mode Using Arrays. [Ch. 6]
9. Strings: String Library Functions Characters and Strings: Fundamentals of Strings and Characters. Strings: Character-Handling Library, Programming Practices, Summary. [Ch. 8]
10. Functions: Function declaration, definition, Passing Arguments to functions, Returning values from functions. Functions: Arguments pass by reference and pass by copy. [Ch. 8]
11. Functions: Passing arrays and strings to functions. Functions: Inline functions, Default arguments, Local and global variables, Summary. [Ch. 8]
12. Pointers: Pointers and their purpose. Pointer expressions. Pointers: Pointers and arrays, Pointers in functions. [Ch. 8]

13. Pointers: Static and dynamic memory allocation, Memory Management using Pointers. Problems with pointers, program practice, Summary.[Ch. 8]
14. Structures: Purpose, Defining structures, Initializing Structures, Accessing Structure Members. Example (complex number or Time). Structures: Passing Structures to functions, Structures using pointers. [Ch.10]
15. File Processing: Data Hierarchy, Files and Streams, Creating a Sequential-Access File, Reading Data from a Sequential-Access File. File Processing: Random-Access Files, Creating a Random-Access File, Writing Data Randomly to a Random-Access File, Reading Data from a Random-Access File. [Ch.10]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. C How to Program by Paul Deitel and Harvey Deitel, Prentice Hall; 7th Edition (March 4, 2012)
2. Programming in C by Stephen G. Kochan, Addison-Wesley Professional; 4 edition (September 25, 2013). ISBN-10: 0321776410

CMPC-102 Object Oriented Programming			
Credit Hours:	4(3,1)	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. **Describe** the key terminologies of object oriented programming	C	2
2. **Explain** the Classes and objects paradigm	C	3
3. **Identify** various programming techniques in object oriented.	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1- Objects and Classes, Abstraction, Encapsulation [TB1: Ch9-11]
2- Final Classes, Nested and Inner Classes. [TB2: Ch. 5]
3- Inheritance, Abstract Classes, Concrete Classes, Inheritance and Encapsulation.[TB1:Ch12]
4- The is-a Relationship, Inheritance via Abstract Classes, Extending the Hierarchy, Up casting and Down casting, Interfaces.[TB1: Ch12]
5- Composition, the has-a Relationship.[TB1: Ch12]
6- Polymorphism.[TB1:Ch 13]
7- Polymorphism, Dynamic (or Late) Binding. [TB1:Ch 13]
8- Interfaces and Polymorphism.[TB1: Ch13]
9- The Wrapper Classes, Boxing and Un-Boxing, Packages.[TB1: Ch14, Ch9.4]
10- Exceptions and Exception Handling.[TB2:Ch 7]
11- File Systems and Paths, File and Directory Handling and Manipulation, Input/output Streams, Reading Binary Data, Writing binary Data, Writing Text(Characters), Reading

Text (Characters), Logging with Print Stream, Random Access Files, Object Serialization. [TB1: Ch. 15]
12- Collections, for-each Loop.[TB1: Ch16, 17]
13- GUI Concepts, Components and Containers, Abstract Windows Toolkit and Swing, Windows and Frames, Layout Managers, Panels.[TB1: Ch. 18]
14- Event-Driven Programming, The delegation Event Model.[TB1:Ch 19]
15- Event Classes, Mouse Events, Keyboard Events, Using Actions.[TB1: Ch19]
16- Component and J Component, Buttons, Labels, Text Fields, Text Areas, Dialog Boxes, Checkboxes and Radio Buttons, Menus, J-Slider, J-Tabbed Pane.[TB1: Ch. 19]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1- Java Programming: From the Ground Up by Ralph Bravaco and Shai Simonson, McGraw-Hill Higher Education New York, 2010, ISBN 978–0–07–352335–4
2- Ivor Horton's Beginning Java by Ivor Horton, John Wiley & Sons, Inc, 7th Edition, 2011, ISBN: 978-0-470-40414-0

CMPC-205 Discrete Structures			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1- The course provides a solid theoretical foundation of discrete structures as they apply to computer science problems and structures.	C	2
2- The students will learn how to use mathematical notation and solve problems using mathematical tools.	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Logic: Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Methods of Proof. [TB: Ch. 1]
2. Sets & Functions, Sequences and Summations. [TB: Ch. 2]
3. Algorithms: the Growth of Functions, Complexity of Algorithms, the Integers and Division, Matrices. [TB: Ch. 3]
4. Number Theory and Cryptography. [TB: Ch. 4]
5. Advanced Counting Techniques: Recurrence Relations, Solving Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion-Exclusion & its Application. [TB: Ch. 8]
6. Relations and Their Properties, n-ary Relations and Their Applications, Representing Re-

lations, Closures of Relations, Equivalence Relations, Partial Orderings. [TB: Ch. 9]
7. Graph: Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. [TB: Ch. 10]
8. Trees: Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees. [TB: Ch. 11]

Teaching Methodology:

Lectures, Class Exercises

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. K. H. Rosen, Discrete Mathematics and Its Applications, McGraw-Hill Science/Engineering/Math, 7th Ed. 2011. ISBN-10: 0073383090[TB]
2. R. Johnsonbaugh, Discrete Mathematics, Pearson; 7th Ed., 2008. ISBN-10: 0131593188
3. S. B. Maurer and A. Ralston, Discrete Algorithmic Mathematics, A K Peters/CRC Press; 3rd Ed., 2004. ISBN-10: 1568811667
4. B. Kolman, R. Busby and S. C. Ross, Discrete Mathematical Structures, Pearson, 6th Ed. 2008. ISBN-10: 0132297515

CMPC-203 Data Structure and Algorithms			
Credit Hours:	4(3,1)	**Prerequisites:**	Object Oriented Programming

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Learn the theory, practice and methods of data structures and algorithm design.	C	2
2. Learn and practice elementary data structures such as stacks, queues, linked lists, sequences, trees and graphs and the algorithms designed for manipulating these data structures.	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Data Structure, primitive java, Reference Types, Algorithm Analysis.[TB1:Ch1, 2, 5]
2. Java collections API (The Java Collections Framework). [TB1:Ch 6]
3. Recursion, Sorting Algorithms (Bubble Sort, Selection Sort, Insertion Sort, Shell Sort).[TB1: Ch 6, 7]
4. Sorting Algorithms (Merge Sort, Quick Sort, Heap Sort, Speed Limit for comparison Sorts, Radix Sort, Bucket Sort), Randomization. [TB1: Ch 7, 8]
5. Stack and Queue. [TB1:Ch 16, TB2:Ch 6, 7]
6. Linked Lists. [TB1:Ch 16]
7. Linked Lists. [TB1:Ch 16, TB2:Ch8]
8. Hash Table. [TB1: Ch 20]
9. Trees. [TB1:Ch18]
10. Binary Search Trees, Priority Queue: the Binary Heap. [TB1: Ch 19, Ch 21]

11. Splay Trees, Merging Priority Queues. [TB1:Ch22, Ch23]
12. Graphs (Simple Graphs, Graph Terminology, Paths and Cycles, Isomorphic Graphs, the Adjacency Matrix for a Graph, the Incidence Matrix for a Graph, the Adjacency List for a Graph, Digraphs). [TB1:Ch14, TB2:16]
13. Graphs(Paths in a Digraph, Weighted Digraphs and Graphs, Euler Paths and Hamilto-nian Cycles, Dijkstra's Algorithm, Graph Traversal Algorithms) [TB1:Ch14, TB2:16]
14. Data Structure Applications (Balanced-Symbol Checker, A Simple Calculator, File Compression, A Cross-reference Generator, The Josephus problem, Event-Driven Simulation) [TB: Ch 11, 12, 13]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Data Structures & Problem Solving Using Java by Mark Allen Weiss,Addison-Wesley, 4thEdition (October 7, 2009). ISBN-10: 0321541405
2. Schaum's Outline of Data Structures with Java by John Hubbard, McGraw-Hill; 2ndEdition (May 26, 2009). ASIN: B0035X1BQ6
3. Data Structures: Abstraction and Design Using Java by Koffman and Wolfgang, Wiley; 2nd Edition (January 26, 2010). ISBN-10: 0470128704
4. Data Structures and Algorithm Analysis in Java by Mark Allen Weiss, Prentice Hall; 3rdEdition (November 28, 2011). ISBN-10: 0132576279

CMPC-204 Operating Systems			
Credit Hours:	4(3,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1- Describe the general understanding of the principles and concepts governing the functions of operating systems	C	3
2- Explain the layered approach that makes design, implementation and operation.	C	3
3- Identify aspect of complex operating system	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1- Introduction: Over view of: Operating Systems, Operating-System Structure, Operating-System Operations, Process management, Memory Management, Storage Management, Protection and Security, Protection and Security, Distributed Systems, Special-Purpose Systems, Computing Environments. [TB: Ch1]
2- Operating-System Structures: Operating-System Services, Operating-System Structure, User Operating-System Interface, Virtual Machines, System Calls, Operating System Generation, Types of System Calls, System Boot, System Programs.[TB: Ch2]
3- Processes: Process Concept, Process Scheduling, Operations on Processes, Inter process Communication, Communication in Client- Server Systems. Threads: Multithreading Models, Thread Libraries, Threading Issues. [TB: Ch. 3, 4]
4- CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling, Algorithm Evaluation. [TB: Ch. 5]
5- Process Synchronization: Background, Monitors, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classic Problems of Synchronization. [TB: Ch. 6]
6- Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock. [TB: Ch. 7]
7- Main Memory: Swapping, Contiguous Memory Allocation, Paging, and Structure of the Page Table, Segmentation, and Example: The Intel Pentium. [TB: Ch.8]
8- Virtual Memory: Allocating Kernel Memory, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing. [TB: Ch. 9]
9- File-System Implementation: File-System Structure, Log-Structured File Systems, File-System Implementation, Directory Implementation, Allocation Methods, Free Space Management, Efficiency and Performance, Recovery. [TB: Ch. 11]
10- I/O Systems: STREAMS, Hardware, Performance, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Bibliographical Notes, Hardware Operations. [TB: Ch. 13]
11- Security: The Security Problem, Computer-Security, Program Threats, Classifications, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks. [TB:Ch.15]
12- Case studies: Linux, Windows Operating Systems.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1- Operating System Concepts Essentials by Abraham Silberschatz, Peter B. Galvin and Greg Agne, Wiley; 8th Edition (July 5, 2008). ISBN-10:0470128720
2- Applied Operating Systems Concepts by Silberschatz A., Peterson, J.L., & Galvin P.C.Wiley; 8th Edition (2011). ISBN-10: 1118112733

CMPC-206 Software Engineering			
Credit Hours:	3(3,0)	**Prerequisites:**	**None**

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1: Explains how various software development models and software development life cycles are applied.	C	4
2: Presents the fundamentals concepts of project management.	C	3
3: Important Requirements modeling, fact-finding techniques		
4: Have knowledge of software configuration management.	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. The Nature of Software, Unique Nature of WebApps, Software Engineering, The Software Process, Software Engineering Practice, Software Myths. [TB1: Ch. 1]
2. Generic Process Models: Framework Activity, Task Set, Process Patterns, Process Improvement, CMM, Prescriptive Process Models: Waterfall Model, Incremental Process Model, Evolutionary Process Model. [TB1: Ch. 2]
3. Specialized Process Models: Component Based Development, The Formal Methods Models, Agile Development. [TB1: Ch. 2-3]
4. Introduction to Systems Analysis and Design, Business Information Systems, Information System Components, Types of Information Systems, Evaluating Software, Make or Buy Decision. [TB1: Ch. 1]
5. Introduction to SDLC, SDLC Phases, System Planning, Preliminary Investigation, SWOT Analysis. [TB1: Ch. 2]
6. The Importance of Strategic Planning, Information Systems Projects, Evaluation of Systems Requests, Preliminary Investigation, Systems Analysis, Requirements Modeling, Fact-Finding Techniques. [TB1: Ch. 2-3]
7. Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Requirements Model. [TB1: Ch. 5]
8. Requirements Modelling Strategies, Difference between Structured Analysis and Object Oriented Analysis; Difference between FDD Diagrams & UML Diagrams. [TB2:Ch. 3]
9. Data & Process Modelling, Diagrams: Data Flow, Context, Conventions, Detailed Level DFD's Diagram 0, Levelling, Balancing, Logical Versus Physical Models. [TB2: Ch. 4]
10. Design Within the Context of Software Engineering, The Design Process, Design Concepts, Design Models: Data Design Elements. [TB1: Ch. 8]
11. Architecture Design Elements, Interface Design Elements, Component-Level Design Elements, Deployments Design Elements. [TB: Ch. 8]
12. System Architecture, Architectural Styles, User Interface Design: The Golden Rules, User Interface Analysis and Design, WebApps Interface Design. [TB1: Ch. 9-11]
13. Software Quality Assurance: Background Issues, Elements of Software Quality Assurance, Software Testing Strategies, Strategic Issues, Test Strategies for Conventional Software. [TB1: Ch.16-17]
14. Validation Testing, System Testing, Internal and External View of Testing: White Box Testing and Black Box Testing Techniques. [TB1: Ch. 17-18)]
15. Introduction to Project Management, Project Scheduling: Gantt Chart, Risk Management: Proactive versus Reactive Risk Strategies, Software Risks, Maintenance and

Reengineering: Software Maintenance, Software Reengineering. [TB1: Ch. 28-29]
Teaching Methodology:
Lecturing, Written Assignments, Report Writing
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Software Engineering: A Practitioner's Approach by Roger S. Pressman, McGraw-Hill Science/Engineering/Math; 7th Edition (2009). ISBN-10: 0073375977 2. Software Engineering 8E by Ian Sommerville, Addison Wesley; 8th Edition (2006). ISBN-10: 0321313798 3. Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225 4. Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225

CMPC-208 Computer Networks			
Credit Hours:	4(3,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1- Describe the key terminologies and technologies of computer networks	C	2
2- Explain the services and functions provided by each layer in the Internet protocol stack.	C	2
3- Identify various internetworking devices and protocols, and their functions in a network.	C	4
4- Analyze working and performance of key technologies, algorithms and protocols.	C	4
5- Build Computer Network on various Topologies	P	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
1. Introduction to networks and protocols architecture [TB1: Ch. 1]. 2. Basic concepts of networking, network topologies and the Internet [TB1: Ch. 1]. 3. Layered architecture and the OSI model [TB1: Ch. 2]. 4. Physical layer functionality, data link layer functionality and the TCP/IP protocol architecture [TB1: Ch. 2]. 5. Multiple access techniques, WAN Technologies and protocols , circuit switching and packet switching.[TB1: Ch. 9] 6. Wireless networks, Cellular Network Generations and LTE-Advanced [TB1: Ch. 10] 7. LAN technologies, LAN protocol architecture and virtual LANs [TB1: Ch. 11] 8. MAC addressing. [TB1: Ch. 11] 9. Networking devices , bridges, hubs and switches [TB1: Ch. 11]

10. Network layer protocols, Principles of Internetworking, IPv4 and IPv6. [TB1: Ch. 14]
11. IP addressing, Internet Protocol Operation, virtual private networks and IP Security and Subnetting, CIDR. [TB1: Ch. 14].
12. Transport layer protocols, ports and sockets and connection-oriented transport protocol mechanisms [TB1: Ch. 15]
13. Routing protocols OSPF ,EIGRP,RIP and routing in packet-switching networks [TB1: Ch. 19]
14. Connection establishment, flow and congestion control, effects of congestion, TCP congestion control and datagram congestion control protocol [TB1: Ch. 20]
15. Application layer protocols, electronic mail (SMTP and MIME), Web Access: HTTP and DNS [TB1: Ch. 24]
16. Latest trends in computer networks , real-time traffic and voice over IP [TB1: Ch. 25]

Labs:

1- Introduction to Networking equipment.
2- Networking Basics commands.
3- TCP/IP Networks configuration.
4- Cabling Construction.
5- Building Peer-to-Peer Network.
6- Tools: Packet tracer, Wireshark.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Data and Computer Communications, 10th Edition by William Stallings
2. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross
3. Computer Networks, 5th Edition by Andrew S. Tanenbaum
4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

CMPC-301 Database Systems			
Credit Hours:	4(3,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain fundamental database concepts.	C	2
2. Design conceptual, logical and physical database schemas using different data models.	C	3
3. Identify functional dependencies and resolve database anomalies by normalizing database tables.	C	3
4. Use Structured Query Language (SQL) for database definition and manipulation in any DBMS	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:
1. Databases Overview: Basic Concepts and Definitions, Traditional File Processing & Database Approach [TB1: Ch 1] 2. Data Models, Advantages of Database Approach, Costs and Risks of Database Approach, Components of the Database Environment, The Database Development Process [TB1: Ch 1] 3. E-R Model, Modelling Rules of the Organisation, Modelling Entities and Attributes, Modelling Relationships [TB1: Ch 2] 4. Enhanced E-R Model, Representing Supertypes and Subtypes, Specifying Constraints in Supertype/Subtype Relationships [TB1: Ch 3] 5. Relational Data Model, Integrity Constraints, Transforming EER Diagrams into Relations [TB1: Ch 4] 6. Introduction to Normalization, First Normal Form, Second Normal Form, Third Normal Form, Functional Dependencies and Keys [TB1: Ch 4] 7. The Physical Database Design Process, Designing Fields: Choosing Data Types, Coding Techniques, Handling Missing Data [TB1: Ch 5] 8. Denormalizing and Partitioning Data, File Organizations (Heap, Sequential, Indexed, Hashed), Creating a Unique/Nonunique Key Index, When to Use Indexes [TB1: Ch 5] 9. Introduction to SQL, The SQL Environment, Defining a Database in SQL [TB1: Ch 6] 10. Basic SQL Commands for Processing Single Tables [TB1: Ch 6] 11. SQL Commands for Processing Multiple Tables using Joins and Subqueries [TB1: Ch 7] 12. Client/Server Architectures, Databases in a Two-Tier Architecture, Three-Tier Architectures [TB1: Ch 8] 13. Web Application Components, Databases in Three-Tier Applications [TB1: Ch 8] 14. The Roles of Data and Database Administrators, Database Backup and Recovery, Types of Database Failure, Disaster Recovery [TB1: Ch 12] 15. Controlling Concurrent Access, Serializability, Locking Mechanisms, Data Dictionaries and Repositories [TB1: Ch 12]
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Modern Database Management by Jeffrey A. Hoffer, V. Ramesh, and Heikki Topi. Pearson; 12th Edition (2015). ISBN-10: 1292101857 2. Fundamentals of Database Systems by R. Elmasri and S. Navathe. Pearson; 7th Edition (2015). ISBN-10: 0133970779 3. Database System Concepts by Abraham Silberschatz, Henry F. Korth and S. Sudarshan. McGraw-Hill Education; 6th Edition (2010). ISBN-10: 0073523321 4. Oracle 12c: SQL by Joan E. Casteel. Cengage Learning; 3rd Edition (2015). ISBN-10: 1305251032

CMPC-303 Information Security			
Credit Hours:	3(3,0)	**Prerequisites:**	Computer Networks

Course Learning Outcomes (CLOs):		

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain key concepts of information security such as design principles, cryptography, risk management, and ethics	C	2
2. Discuss legal, ethical, and professional issues in information security.	A	2
3. Apply various security and risk management tools for achieving information security and privacy.	C	3
4. Identify appropriate techniques to tackle and solve problems in the discipline of information security.	C	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Information security foundations, security design principles; security mechanisms [TB:Ch1]
2. Vulnerabilities and protections: Malwares [TB:Ch6]
3. Hash functions [TB:Ch2, 21]
4. Digital signatures [TB:Ch2]
5. Key management [TB:Ch2,20]
6. Authentication: Access control [TB:Ch3,4]
7. Symmetric cryptography: Symmetric Encryption Principles, Data Encryption Standard, 8. Advanced Encryption Standard, Cipher Block Modes of Operation [TB:Ch20]
9. Asymmetric cryptography: HMAC, The RSA Public-Key Encryption Algorithm, Diffie-Hellman and Other Asymmetric Algorithms [TB:Ch21]
10. Software security [TB:Ch11]
11. Database security: The Need for Database Security, Database Management Systems
1. Relational Databases, SQL Injection Attacks, Database Access Control, Inference, Database Encryption [TB:Ch5]
12. Network security: Secure E-Mail and S/MIME, DomainKeys Identified Mail, Secure Sockets Layer (SSL) and Transport Layer Security (TLS), HTTPS, IPv4 and IPv6 Security, Wireless Security, Mobile Device Security [TB:Ch22, 24]
13. Firewalls: The Need for Firewalls, Firewall Characteristics and Access Policy, Types of Firewalls, Firewall Basing [TB:Ch9]
14. Intrusion detection: Intruders, Intrusion Detection, Analysis Approaches, Types of IDS [TB:Ch8]
15. Security policies, policy formation and enforcement, risk assessment [TB:Ch14,15]
16. Cybercrime, law and ethics in information security, privacy and anonymity of data [TB:Ch19]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Computer Security: Principles and Practice, 3rd edition by William Stallings[TB1]
2. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
3. Computer Security, 3rd edition by Dieter Gollmann

4. Computer Security Fundamentals, 3rd edition by William Easttom Official (ISC)2 Guide to the CISSP CBK, 3rd edition

CMPC-401 Capstone Project			
Credit Hours:	6(0,6)	**Prerequisites:**	**None**

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Gives an opportunity for participants to put their leadership competencies into practice.	C	2
2. Allows the student to identify and develop a project that puts into practice the leadership skills and competencies learned during the courses of study.	A	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
1. Project Proposal 2. Introduction 3. Software Requirements Specification 4. Software Function Specification Detailed guideline and documentation temples are available with the Department.
Teaching Methodology:
Lecturing, Written Assignments, Report Writing
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:

Contents of Mathematics and Science Foundation Courses

MATH-101 Calculus and Analytical Geometry			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Understand the foundation and basic ground for calculus and analytical geometry background.	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Real Numbers and the Real Line, Coordinates, Lines, and Increments, Functions, Shifting Graphs, Trigonometric Functions. [TB: Preliminaries]
2. Limits and Continuity: Rates of Change and Limits, Rules for Finding Limits, Target Values and Formal Definitions of Limits, Extensions of the Limit Concept, Continuity, Tangent Lines. [TB: Ch. 1]
3. Derivatives: The Derivative of a Function, Differentiation Rules, Rates of Change, Derivatives of Trigonometric Functions, The Chain Rule, Implicit Differentiation and Rational Exponents. [TB: Ch. 2]
4. Applications of Derivatives: Extreme Values of Functions, The Mean Value Theorem, The First Derivative Test for Local Extreme Values, Graphing with y‘ and y‘‘. [TB: Ch. 3]
5. Integration: Indefinite Integrals, Integration by Substitution—Running the Chain Rule Backward, Estimating with Finite Sums, Riemann Sums and Definite Integrals, Properties, Area, and the Mean Value Theorem. Substitution in Definite Integrals. Numerical Integration. [TB: Ch. 4]
6. Applications of Integrals: Areas between Curves, Finding Volumes by Slicing, Volumes of Solids of Revolution—Disks and Washers. Cylindrical Shells. Lengths of Plan Curves, Areas of Surfaces of Revolution, Moments and Centers of Mass. [TB: Ch. 5]
7. Transcendental Functions: Inverse Functions and Their Derivatives, Natural Logarithms, The Exponential Function, ax and logax, Growth and Decay, L'Hôpital's Rule, Relative Rates of Growth, Inverse Trigonometric Functions, Derivatives of Inverse Trigonometric Functions; Integrals. Hyperbolic Functions. [TB: Ch. 6]
8. Conic Sections, Parameterized Curves, and Polar Coordinates: Conic Sections and Quadratic Equations. Classifying Conic Sections by Eccentricity. Quadratic Equations and Rotations. Parameterizations of Plan Curves. Calculus with Parameterized Curves. Polar Coordinates. Graphing in Polar Coordinates. Polar Equations for Conic Sections. Integration in Polar Coordinates. [TB: Ch. 7, 9]
9. Vectors and Analytic Geometry in Space, Vectors in the Plane Dot Products, Vector-Valued Function Cartesian (Rectangular) Coordinates and Vectors in Space. Dot Products. Cross Products. Lines and Planes in Space. Cylinders and Quadric Surfaces. Cylindrical and Spherical Coordinates. [TB: Ch. 9, 10]

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Calculus and Analytic Geometry by George B. Thomas and Ross L. Finney, Addison Wesley; 10th Edition (1995) ISBN-10: 0201531747
2. Calculus and Analytical Geometry by Swokowski, Olinick and Pence, 6th Edition, (1994), Brooks/Cole Publishers.
3. Calculus by Howard Anton, Irl C. Bivens, Stephen Davis, Wiley; 10th Edition (2012), ISBN-10: 0470647728

4. Calculus with Analytic Geometry: Student Solution Manual by Howard Anton, Wiley; 5th Edition (1995). ISBN-10: 0471105899

MATH-102 Probability and Statistics			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Understand the concepts of data analysis, presentation, counting techniques, probability and decision making.	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Statistics and Data Analysis: Statistical Inference, Samples, Popula-tions, and the Role of Probability, Sampling Procedures; Collection of Data, Measures of Location: The Sample Mean and Median, Measures of Variability, Discrete and Continuous Data, Statistical Modeling, Scientific Inspection, and Graphical, General Types of Statistical Studies: Designed Experiment, Observational Study, and Retrospective Study. [TB: Ch. 1]
2. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. [TB: Ch. 2]
3. Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Joint Probability Distributions. [TB: Ch. 3]
4. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. [TB: Ch. 4]
5. Discrete Probability Distributions: Binomial and Multinomial Distributions, Hypergeometric Distribution, Negative Binomial and Geometric Distributions, Poisson Distribution and the Poisson Process. [TB: Ch. 5]
6. Continuous Probability Distributions: Continuous Uniform Distribution, Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Gamma and Exponential Distributions, Chi-Squared Distribution, Beta Distribution. [TB: Ch. 6]
7. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. [TB: Ch. 8]
8. One- and Two-Sample Estimation Problems: Introduction, Statistical Inference, Classical Methods of Single Sample: Estimating the Mean, Standard Error of a Point, Pre-diction In-

tervals, Tolerance Limits, Estimating the Difference between Two Means. [TB: Ch. 9]

9. Single Sample: Estimating a Proportion, Estimating the Difference between Two Proportions, Single Sample: Estimating the Variance, Estimating the Ratio of Two Variances. [TB: Ch. 9]
10. One- and Two-Sample Tests of Hypotheses: Statistical Hypotheses: General Concepts, Testing a Statistical Hypothesis, The Use of P-Values for Decision Making in Testing Hypotheses. [TB: Ch. 10]
11. Single Sample: Tests Concerning a Single Mean, Two Samples: Tests on Two Means, Choice of Sample Size for Testing Means, Graphical Methods for Comparing Means, One Sample: Test on a Single Proportion, Two Samples: Tests on Two Proportions. [TB: Ch. 10]
12. One- and Two-Sample Tests Concerning Variances, Goodness-of-Fit Test, Test for Independence (Categorical Data), Test for Homogeneity [TB: Ch. 10]
13. Simple Linear Regression and Correlation: Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators. [TB: Ch. 11]
14. 14. Multiple Linear Regression and Certain: Nonlinear Regression Models, Introduction, Estimating the Coefficients, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators. [TB: Ch. 12]

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson; 9th Edition (January 6, 2011). ISBN-10: 0321629116
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 3rd Edition (February 3, 2006), ISBN-10: 0495107573
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. AluSrinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10: 0071544259
4. Probability: A Very Short Introduction by John Haigh, Oxford University Press (2012). ISBN-10: 0199588481

MATH-203 Linear Algebra			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Understand the fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Vectors: Vectors and Linear Combinations, Lengths and Dot Products, Matrices. [TB1: Ch. 1]
2. Solving Linear Equations: Vectors and Linear Equations, the Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices. [TB1: Ch. 2]
3. Elimination = Factorization; A = LU, Transposes and Permutations
4. Vector Spaces and Subspaces: Spaces of Vectors, The Null space of A: Solving Ax = 0, The Rank and the Row Reduced Form, the Complete Solution to Ax = B, Independence, Basis and Dimension, Dimensions of the Four Subspaces. [TB1: Ch. 3]
5. Orthogonally: Orthogonally of the Four Subspaces, Projections, Least Squares Approximations, Orthogonal Bases and Gram-Schmidt. [TB1: Ch. 4]
6. Determinants: The Properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes. [TB1: Ch. 5]
7. Eigenvalues and Eigenvectors: Introduction to Eigenvalues, Diagonalizing a Matrix, Applications to Differential Equations, Symmetric Matrices, Positive Definite Matrices, Similar Matrices, Singular Value Decomposition (SVD). [TB1: Ch. 6]
8. Applications: Matrices in Engineering, Graphs and Networks, Markov Matrices, Population, and Economics; Linear Programming, Fourier series: Linear Algebra for Functions, Linear Algebra for Statistics and Probability, Computer Graphics.
9. Numerical Linear Algebra: Gaussian Elimination in Practice, Norms and Condition Numbers, Iterative Methods for Linear Algebra. [TB1: Ch. 9]
10. 10. Complex Vectors and Matrices: Complex Numbers, Hermitian and Unitary Matrices, Matrix Factorizations. [TB1: Ch. 10]

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Introduction to Linear Algebra by Gilbert Strang, Wellesley Cambridge Press; 4th Edition (February 10, 2009). ISBN-10: 0980232716
2. Elementary Linear Algebra with Applications by Bernard Kolman, David Hill, 9th Edition, Prentice Hall PTR, 2007. ISBN-10: 0132296543
3. Strang's Linear Algebra And Its Applications by Gilbert Strang, Strang, Brett Coonley, Andy Bulman-Fleming, Andrew Bulman-Fleming, 4th Edition, Brooks/Cole, 2005
4. Elementary Linear Algebra: Applications Version by Howard Anton, Chris Rorres, 9th Edition, Wiley, 2005.
5. Linear Algebra and Its Applications by David C. Lay, 2nd Edition, Addison-Wesley, 2000.
6. Linear Algebra by Harold M. Edwards, Birkhäuser; 1st Edition (2004). ISBN-10: 0817643702
7. Linear Algebra: A Modern Introduction by David Poole by Brooks Cole; 3rd Edition (May 25, 2010).ISBN-10: 0538735457

PHYS-101 Applied Physics			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Understand the basic laws of physics, circuiting and basics of transistors.	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Zero Reference Level, Chassis Ground, Ohm's Law, Formula Variations of Ohm's Law, Graphical Representation of Ohm's Law, Linear Resistor, Non Linear Resistor, Cells in Series and Parallel.[Ch 1]
2. Resistive Circuits. [Ch 2]
3. Resistors(5.1-15), Inductors(5.19-21) Capacitors(5.35-48) .[Ch 5]
4. Energy Sources. [Ch 6]
5. Magnetism and electromagnetism [Ch 7].
6. Solid State. Atomic structure, Electron distribution of different atoms, Energy bands in solids, Bonds in solids, Conduction in solids, Conductors, Semiconductors and types of semiconductors, Insulators, Majority and Minority charge carriers, Mobile charge carriers and immobile ions, Drift current in good conductors.[Ch 12]
7. P-N Junction. Formation of depletion layer, Junction or barrier voltage, Forward biased P-N Junction, Forward V/I Characteristics, Reverse biased P-N Junction, Re-verse Saturation Current, Reverse V/I Characteristics, Junction breakdown, Junction Capacitance. [Ch 13]
8. Optoelectronics Devices. Spectral response of human eye, Light Emitting Diode (LED), Photoemissive Devices, Photomultiplier Tube, Photovoltaic Devices, Bulk type Photoconductive cells, Photodiodes, P-N junction Photodiode, PIN Photodiode, and Avalanche Photodiode. [Ch 16]
9. DC Power Supplies. Unregulated and Regulated Power Supply, Steady and Pulsating DC Voltages, Rectifiers (17.5-17.8), Filters (17.9-17.2), Voltage Multipliers (17.24-17.30), Silicon Controlled Rectifier SCR(17.33-17.37)[Ch 17]
10. The Basic Transistor. Transistor Biasing, Transistor Circuit Configuration. [Ch 18]
11. Modulation and Demodulation. Carrier Waves, Modulation, Demodulation or Detection, Comparison between Amplitude Modulation (AM) and Frequency Modulation (FM). [Ch 30]
12. Integrated Circuits. Advantages of ICs and Drawbacks of ICs, Scale of Integration, Classification of ICs by function, Linear and Digital Integrated Circuits, IC Terminology, Fabrication of IC Components, Popular Application of ICs, Operational Amplifier. [Ch 31]
13. Fibre Optics. Structure of Optical Fibres, Classification of Optical Fibres, Fibre Characteristics, Choice of Wavelength, Optical Fibre cable, Application of Fibre Optic Communication. [Ch 38]

Teaching Methodology:

Lecturing, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:

1. A Practical English Grammar by A. J. Thomson and A. V. Martinet,4th Edition Oxford University Press (1986).
2. Basic English Usage by Michael Swan, Oxford UnivPr (Sd) (January 1986). ISBN-10: 0194311872
3. Functional English In Aglobal Society: Vocabulary Building and Communicative Grammar by Nicanor L. Guintomary Ann R. Sibal Brian D. Villaverde Dept. of Lan-guages, Litera-ture and Humanities College of Arts and Sciences Southern Luzon State University (2012).
4. AQA Functional English Student Book: Pass Level 2 by Mr David Stone, Heinemann; 1st Edition (28 Jun 2010). ISBN-10: 0435151401
5. English Composition and Grammar: Complete Course by John E. Warriner, Harcourt Brace Jovanovich; Complete Course Benchmark Edition (January 1988). ISBN-10: 0153117362
6. Companion to English: Vocabulary (Learners Companion) by George Davidson, Prim-Ed Publishing (March 1, 2003). ISBN-10: 9814070904
7. Word Power Made Easy by Norman and Lewis, Goyal Publishers (September 1, 2009). ISBN-10: 8183071007
8. 1000 Most Important Words by Norman W. Schur, Ballantine Books (July 12, 1982). ISBN-10: 0345298632
9. High School English Grammar and Composition by P.C Wren, Chand & Co (July 13, 2008). ISBN-10: 812192197X

Contents of General Education Courses

ENGL-101 English Composition and Comprehension			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. can articulate clearly, take and pass on messages, deal with customers effectively, read, understand and follow a wide range of documents and write fluently and accurately, using accepted business conventions of format, spelling, grammar and punctuation.	C	2
2. This course is developed to strengthen students these skills which enable them to deal with the practical problems and challenges of life – at home, in education and at work.	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Punctuation: Periods, Question Marks, Exclamation Marks, Semicolons, Colons, Com-mas, Apostrophes, Quotation Marks.
2. Writing Mechanics: Capitals, Abbreviations; Vocabulary: Frequently Confused Words, Frequently Misused Words,
3. Vocabulary: Phrases, Synonyms, Antonyms, Idioms, General Vocabulary

4. Use Of Articles And One, A Little/ A Few, This, That, Care, Like, Love, Hate, Prefer, Wish, All, Each, Every, Both, Neither, Either, Some, Any, No, None; Interrogatives: Wh-? Words And How?
5. Kinds of Nouns; Kinds of Adjectives; Adverbs: Kinds, Form, Position and Use
6. Prepositions; Possessive, Personal and Reflexive Pronouns; Relative Pronouns and Clauses
7. Classes of Verbs: Ordinary Verbs, Auxiliary Verbs (Be, Have, Do); May and Can for Permission and Possibility; Can and Be Able for Ability; Ought, Should, Must, Have To, Need for Obligation; Must, Have, Will and Should for Deduction and Assumption; The Auxiliaries Dare and Used
8. The Present Tenses
9. The Past and Perfect Tenses
10. The Future; The Infinitive
11. The Gerund & The Participles; Commands, Requests, Invitations, Advice, Suggestions; The Subjunctive
12. The Passive Voice; Indirect Speech
13. Conjunctions, Purpose
14. Clauses: Noun Clauses; Clauses of Reason, Result, Concession, Comparison, Time

Numerals, Dates, and Weights And Measures; Spelling Rules;

Phrasal Verbs; List Of Irregular Verbs

Teaching Methodology:

Lecturing, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. A Practical English Grammar by A. J. Thomson and A. V. Martinet,4th Edition Oxford University Press (1986).
2. Basic English Usage by Michael Swan, Oxford UnivPr (Sd) (January 1986). ISBN-10: 0194311872
3. Functional English In Aglobal Society: Vocabulary Building and Communicative Grammar by Nicanor L. Guintomary Ann R. Sibal Brian D. Villaverde Dept. of Lan-guages, Literature and Humanities College of Arts and Sciences Southern Luzon State University (2012).
4. AQA Functional English Student Book: Pass Level 2 by Mr David Stone, Heinemann; 1st Edition (28 Jun 2010). ISBN-10: 0435151401
5. English Composition and Grammar: Complete Course by John E. Warriner, Harcourt Brace Jovanovich; Complete Course Benchmark Edition (January 1988). ISBN-10: 0153117362
6. Companion to English: Vocabulary (Learners Companion) by George Davidson, Prim-Ed Publishing (March 1, 2003). ISBN-10: 9814070904
7. Word Power Made Easy by Norman and Lewis, Goyal Publishers (September 1, 2009). ISBN-10: 8183071007
8. 1000 Most Important Words by Norman W. Schur, Ballantine Books (July 12, 1982). ISBN-10: 0345298632
9. High School English Grammar and Composition by P.C Wren, Chand & Co (July 13, 2008). ISBN-10: 812192197X

ENGL-102 Communication and Presentation Skills			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. To sensitize students to their communicative behavior 2. To enable them to reflect and improve on their communicative behavior/performance 3. To build capacities for self-criticism and facilitate growth 4. To lead students to effective performances in communication	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Communication Skills: What Is Communication, The Importance of Communication, What Are Communication Skills? The Communication Process : Source, Message, Encoding, Channel , Decoding , Receiver, Feedback, Context . Perspectives in Communication: Introduction, Visual Perception, Language, Other Factors Affecting Communication Perspective, Past Experiences, Prejudices, Feelings, Mood, Relationship, Environment.
2. Internal Representation: Introduction, Internal Representation of Our World, Language as a Representational System, Verbal Clues, Visual Representation System, Auditory Representational System, Kinaesthetic Representational System, Auditory Digital Representational System, Eye Movements as an Indication, Visual Recall, Visual Con-struct, Auditory Recall, Auditory Construct, Kinaesthetic, Internal Auditory, Phrases for Use in Response to Each Representational System.
3. Elements of Communication: Introduction, Face to Face Communication, Tone of Voice, Body Language, Verbal Communication, Physical Communication. Communication Styles: Introduction, The Communication Styles Matrix, Direct Communication Style, Spirited Communication Style, Systematic Communication Style, Considerate Communication Style, Examples of Communication for Each Style, Direct Style, Spirited Style, Systematic Style Considerate Style.
4. Listening: Real Vs. Introduction, Self-Awareness, Pseudo Listening, Active Listening, Blocks to Listening, Assessing Your Listening, Four Steps to Effective Listening, Total Listing, Becoming an Active Listener.
5. Expressing: The Four Kinds of Expression, Whole Message, Contaminated Messages, Preparing Your Message, Practicing Whole Message, Rules of Effective Expression. Body Language: Body Movement, Spatial Relationships. Paralanguage and Meta-messages: The Element of Paralanguage, Changing Your Paralanguage, Meta-message, Coping with Meta-message. Hidden Agendas: The Eight Agendas, Purpose of the Agenda.
6. Clarifying Language: Understanding a Model, Challenging the Limits of a Model, Challenging Distortion in a Model. Assertiveness: Your Legitimate Right, Three Communication Styles, Identifying Communication Style, Your Assertive Goals, Assertive Expression and Listening, Combining Assertive Expression and Listening, Responding to Criticism, Special Assertive Strategies.
7. Making Contact: Fear of Stranger, Guidelines for Making Contact, The Art of Conversa-

tion, Putting It All Together. Negotiations: Four Stages of Negotiation, Dealing with Conflicts, Rules of Principles Negotiation, When The Going Get Tough.

8. Prejudgment: Prejudgment Traps, Stereotypes, Approval and Disapproval in Prejudgment, Parataxic Distortion, Perpetuating Illusion, Clarifying First Impression. Validation Strategies: What is validation, Why Does Validation Work? What Validation Is Not? Components of Validation, Successful Validation Strategies, The Power of Validation.
9. Influencing Others: What is Persuasion? Persuading Audience, Ineffective Strategies for Influencing Change, Effective Strategies, for Influencing Others, Your Plan for Influencing Change, Lisa‘s Plan for Influencing Change Art of Persuasion.
10. Public Speaking: Defining Your Purpose, Outlining The Subject, Presentation, Organization, Audience Analysis, Style, Supporting Materials, The Outline, Delivery, Deal-ing with Stage Fright.
11. Preparing A Formal Oral Presentation: Presentation Design: Introduction, Consistency, Aspects of Consistency Language, Color, Fonts, Images, Contrast, Alignment, Simplicity, White Spaces, Charts, Graphics & Tables, How to Choose Which Type of Graph to Use? Graph Types, Multimedia Presentations, Adding Quotations.
12. Delivering Presentation: Introduction, Delivery, Managing Voice, Passion, Language, Movement, Facial Expressions, Body Language, Some Useful Tips: Active Listening, Inventing Stories, Feedback, Preliminary Preparations Proximity, Tension & Nerves, Questions, Tips to Handle Questions, Habits, Handling Tough Situations, Common Mistakes & Their Remedies, Dealing with Unexpected Disasters, Presentation for International Audience, Dealing People with Disabilities, Things to Remembers, Last Minute Tips.
13. Interviewing: Clarifying What You Want, If You are the Interviewer, If You Are the Interviewee.
14. Effective Written Communication: Introduction, When and When Not to Use Written Communication, Complexity of the Topic, Amount of ‗Discussion‘ Required, Shades of Meaning Formal Communication, Writing Effectively, Subject Lines, Put the Main Point First, Know Your Audience, Organization of the Message.
15. Building Rapport: Introduction, Six Steps to Building Rapport, Match the Person‘s Sensory Modality, Mirror the Person‘s Physiology, Match the Person‘s Voice, Match the Person‘s Breathing, Match the Way the Person Deals with Information, Match Common Experiences, Calibration, Perceptual Positions.

Teaching Methodology:

Lecturing, Written Assignments, Report Writing, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Effective Communication Skills, MTD Training &Ventus Publishing ApS.(2010) ISBN 978-87-7681-598-1 (TB1)
2. Messages: The Communication Skills Book by Matthew McKay PhD , Martha Davis PhD, and Patrick Fanning, New Harbinger Publications; Third Edition (March 3, 2009). ISBN-10: 1572245921
3. Secrets of Successful Presenters: A Guide for Successful Presenters by Dr. M. A. Pa-sha &Dr. S. Pasha, Lambert Academic Publishing (2012). ISBN-10:3659217557
4. Communication Skills in English by Prof P N Kharu, Dr.Varinder Gandhi Publisher: Laxmi. EAN: 9788131806920

5. Essential Communication Skills: Teacher Edition with Talking Points by Patty Ann, Patty Ann; 1st Edition (July 5, 2012). ASIN: B008HYUDWQ
6. Communication Skills Magic: Improve Your Relationships & Productivity through Better Understanding Your Personality Style and the Personality Styles of Those Around You by E.G. Sebastian, CreateSpace Independent Publishing Platform (Janu-ary 5, 2010). ISBN-10: 1450513344
7. People Skills: How to Assert Yourself, Listen to Others, and Resolve Conflicts by Robert Bolton,Touchstone (June 6, 1986). ISBN-10: 067162248X
8. The Handbook of Communication Skills by Owen Hargie, Routledge; 4th Edition, Taylor & Francis, (12-Oct-2012).

ENGL-302 Technical and Business Writing			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Effectively plan and structure technical reports and to recognize the various stages in writing a technical report.	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Writing for Readers: Academic, Public, and Work Communities; Analyzing Electron-ic Communities; c. Myths and Realities about Writing.
2. Discovering and Planning: Discovering Topics; Generating Ideas; Organizing Infor-mation; Planning in Digital Environments.
3. Purpose, Thesis, and Audience: Identifying Your Focus and Purpose; Creating a The-sis; Understanding Your Readers.
4. Drafting: Moving from Planning to Drafting, Drafting Collaboratively, Drafting in Digi-tal Environments.
5. Revising, Editing, and Proofreading: Making Major Revisions; Making Minor Revi-sions; Revising Collaboratively; Revising in Digital Environments; Editing; Editing Collaboratively; Proofreading.
6. Paragraphs: Unfocused Paragraphs; Revising for Focus; Incoherent Paragraphs; Re-vising for Coherence; Poorly Developed Paragraphs; Revising for Development; Us-ing Special-Purpose Paragraphs.
7. Clear and Emphatic Sentences: Unclear Sentences; Revising for Clear Sentences; Re-vising for Variety and Emphasis.
8. Reasoning Critically: Recognizing Critical Reasoning, Building a Chain of Reasoning, Representing Your Reasoning.
9. Reading Critically: Reading to Understand; Reading to Respond and Evaluate; Using Journals to Turn Reading into Writing.
10. Arguing Persuasively: Recognizing an Issue, Developing Your Stance, Creating an Ar-gumentative Thesis, Developing Reasons and Evidence, Acknowledging Other Perspec-

tives, Arguing Logically, Writing a Position Paper.

11. Designing Documents: Goals of Document Design, Format Choice, Layout, Type Choice, Visuals, Sample Documents. Creating a Visual Argument: Presenting an Is-sue, Providing Evidence.
12. Writing in Online Communities: Online Expectations, E-mail Conventions, Online Communities, Web Pages, Avoiding Plagiarism and Behaving Ethically Online.
13. Speaking Effectively: Oral Presentations, Preparing an Oral Presentation, Managing Speech Anxiety, Fielding Questions.
14. Academic Writing: Social and Natural Sciences: Goals of Writing in the Social and Natural Sciences, Audiences in the Social and Natural Sciences, Writing Tasks in the Social and Natural Sciences, Types of Writing in the Social and Natural Sciences,
15. Abstract, Informative Report, Lab Report, Research Report,
16. Public Writing: Goals of Public Writing, Public Audiences, Public Writing Tasks, Types of Public Writing, Public Flyer, Letter to the Editor, Oral Presentation.
17. Researching and Writing: Beginning Your Research, Types of Research Writing, De-veloping a Research Question, Developing a Preliminary Thesis, Creating a Re-search File and a Timeline, Reading and Notetaking, Summarizing, Paraphrasing, and Synthe-sizing.

Teaching Methodology:

Lecturing, Written Assignments, Report Writing, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Writer's Companion – The Longman by Chris M. Anson, Robert A. Schwegler and Marcia F. Muth, Pearson Longman, 4th Edition (2007) . ISBN10: 0-20556-252-3
2. Technical English: Writing, Reading, and Speaking by Pickett and Laster. 8th Edition.
3. The Technical Writer‘s Companion byAlred, Gerald, Charles T. Brusaw and Walter E. Oliu, 3rd Edition. ISBN 0-312-25978-6.

PKST-401 Islamic Studies			
Credit Hours:	2(2,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1- Enhance understanding of the students regarding Islamic Civiliza-tion	C	2
2- Improve Students skill to perform prayers and other worships	C	2
3- Enhance the skill of the students for understanding of issues related to faith and religious life.	C	2

* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

The approved Syllabus of respective department of UOS will be followed
Teaching Methodology:
Lecturing, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:

ISLS-402 Pakistan Studies			
Credit Hours:	2(2,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1: Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.	C	2
2: Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
The approved Syllabus of respective department of UOS will be followed
Teaching Methodology:
Lecturing, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:

ICTC-101 Introduction to Information and Communication Technology			
Credit Hours:	3(2,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Get basic understanding of computer software, hardware, and associated technologies.	C	2
2. Learn how computers are used in the workplace, how commu-	C	2

nications systems can help boost productivity, and how the Internet technologies can influence the workplace.		

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Computers: Data and Information, Information Processing Cycle, the Components of a Computer, Advantages and Disadvantages of Using Computers. Networks and the Internet. Computer Software, Categories of Computers, Elements of an Information System, Examples of Computer Usage, Computer Applications in Society [Ch. 1].
2. The Internet and World Wide Web: Key Concepts of the Internet, Evolution of the Internet, The World Wide Web, E-Commerce, Other Internet Services, Netiquette [Ch. 2].
3. Application Software: Business Software, Graphics and Multimedia Software, Soft-ware for Home, Personal, and Educational Use, Web Applications, Application Soft-ware for Communications. [Ch. 3]
4. The System Unit: Processor, Data Representation, Memory, Expansion Slots and Adapter Cards, Ports and Connectors, Buses, Bays, Power Supply. [Ch. 4]
5. Input Devices: What Is Input? What Are Input Devices? The Keyboard, Pointing Devices, Mouse, Other Pointing Devices, Touch Screens And Touch-Sensitive Pads, Pen Input, Other Input For Smart Phones, Game Controllers, Digital Cameras, Voice In-put, Video Input, Scanners And Reading Devices, Biometric Input, Terminals, Putting It All Together, Input Devices For Physically Challenged Users. [Ch. 5]
6. Output Devices: What is Output? Display Devices, Printers, Speakers, Headphones, and Ear buds, Other Output Devices. [Ch. 6]
7. Storage: Hard Disks, Flash Memory Storage, Cloud Storage, Optical Discs, Other Types of Storage. [Ch. 7]
8. System Software: Operating Systems, Operating System Functions, Types Of Operating Systems, Stand-Alone Operating Systems, Server Operating Systems, Embedded Operating Systems, Utility Programs [Ch. 8]
9. Communications: Uses of Computer Communications, Networks, Network Communications Standards, Communications Software, Communications over the Telephone Network, Communications Devices, Home Networks, Communications Channel, Physical Transmission Media, Wireless Transmission Media. [Ch. 9]
10. Databases: Data, and Information, The Hierarchy of Data, Maintaining Data, File Processing Versus Databases, Database Management Systems, Relational, Object-Oriented, and Multidimensional Databases, Web Databases, Database Administration
11. Computer Security and Safety, Ethics, and Privacy: Computer Security Risks, Internet And Network Attacks, Unauthorized Access And Use, Hardware Theft And Vandal-ism, Software Theft, Information Theft, System Failure, Backing Up, Wireless Security, Health Concerns Of Computer Use, Ethics And Society

Teaching Methodology:

Lecturing, Written Assignments, Class Discussion

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Discovering Computers by Gary B. Shelly & Misty E. Vermaat, Course Technology; 1st Edition (January 25, 2011).
2. Computing Essentials 2012 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 22nd Revised Edition (February 1, 2011).
3. Computers: Understanding Technology by Fuller, Floyd; Larson, Brian, Fourth Edi-tion, ISBN: 978-0-76383-927-7 (OR Latest Edition.)
4. The Concepts of Information Technology by Imran Saeed, AfsanRaza, Tariq Mah-mood and ZafarHussain, 6th Edition, IT Series Publications.
5. The Essential Guide to Computing: The Story of Information Technology by by E Garrison Walters, Prentice Hall PTR (August 11, 2000). ISBN-10: 0130194697
6. Computer Applications by Tasleem Mustafa, Tariq Mahmood, Imran Saeed and Za-hidJaved, IT Publication Series

ITSCC-201 Professional Practice			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand responsibilities with respect to the society	C	2
2. Understand historical, social, economic, ethical, and professional issues related to the discipline of Computing	C	2
3. It identifies key sources for information and opinion about pro-fessionalism and ethics.	C	2
4. Analyze, evaluate, and assess ethical and professional computing case studies.	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. The Engineering Profession [TB: Ch. 1]
2. The Structure of Organizations [TB: Ch. 2]
3. Finance and Accounting [TB: Ch. 3]
4. Anatomy of a Software House [TB: Ch. 4]
5. Computer Contracts [TB: Ch. 5]
6. Intellectual Property Rights [TB: Ch. 6]
7. The Framework of Employee Relations Law and Changing Management Practices [TB: Ch. 7]
8. Human Resource Management and Software Engineering [TB: Ch. 8]
9. Health and Safety at Work [TB: Ch. 9]
10. Software Liability: Liability and Practice [TB: Ch. 10]
11. Computer Misuse and the Criminal Law [TB: Ch. 11]
12. Regulation and Control of Personal Information: Data Protection, Defamation and Related Issues

[TB: Ch. 12]
13. The British Computer Society Code of Conduct [Online]
14. IEEE Code of Ethics [Online]
15. ACM Code of Ethics and Professional Conduct [Online]
16. ACM/IEEE Software Engineering Code of Ethics and Professional Practice [Online]

Teaching Methodology:

Lecturing, Written Assignments, Class Discussion

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
2. Online Resources
3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
4. Applied Professional Ethics by Gregory R. Beabout, University Press Of America (1993). ISBN-10: 0819193747.
5. The Dark Side of Software Engineering: Evil on Computing Projects by Johann Rost and Robert L. Glass, Wiley-IEEE Computer Society Pr; 1st Edition (2011). ISBN-10: 0470597178
6. Software Engineering Best Practices: Lessons from Successful Projects in the Top Companies by Capers Jones, McGraw-Hill Osborne Media; 1st Edition (2009). ISBN-10: 007162161X

Contents of University Elective Courses

BUSB-102 Business Economics			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
This course is mean for understanding core matters of economics so that student shall be able to understand what is going on globally. This course, along with Entrepreneurship course, shall help students to establish their own business.	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Business and the economic environment [TB: Ch. 1]
2. The working of competitive markets [TB: Ch. 2]
3. Demand and the consumer [TB: Ch. 3]
4. Supply decisions in a perfectly competitive market [TB: Ch. 4]
5. Pricing and output decisions in imperfectly competitive markets [TB: Ch. 5]

6. Business growth and strategy [TB: Ch. 6]
7. Multinational corporations and business strategy in a global economy [TB: Ch. 7]
8. Government, the firm and the market [TB: Ch. 9]
9. The economy and business activity [TB: Ch. 10]
10. National macroeconomic policy [TB: Ch. 11]
11. The global trading environment [TB: Ch. 12]

Teaching Methodology:

Lectures, Class Discussions

Course Assessment:

Midterm Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. John Sloman and Elizabeth Jones, Essentials Economics for Business, 5th Ed., Pearson, 2017.[TB]
2. Alan Griffiths and Stuart Wall, Economics for Business & Management: A Student Text, Prentice Hall, 2005
3. Dermot McAleese, Economics for Business: Competition, Macro-stability and Globalisation, 3rd Ed., Prentice Hall, 2009.

BUSB-302 **Human Resources Management**			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able :	**Domain**	**BT Level***
1- Core aspects of Human Resource Management required in 21st Century organizations	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1- Managing Human Resources. [TB: Ch. 1]
2- Understanding the External and Organizational Environments. [TB: Ch. 2]
3- Ensuring Fair Treatment and Legal Compliance. [TB: Ch. 3]
4- HR Planning for Alignment and Change. [TB: Ch. 4]
5- Using Job Analysis and Competency Modeling. [TB: Ch. 5]
6- Recruiting and Retaining Qualified Employees. [TB: Ch. 6]
7- Selecting Employees to Fit the Job and the Organization. [TB: Ch. 7]
8- Training and Developing a Competitive Workforce. [TB: Ch. 8]
9- Conducting Performance Management. [TB: Ch. 9]
10- Developing an Approach to Total Compensation. [TB: Ch. 10]
11- Using Performance-Based Pay to Achieve Strategic Objectives. [TB: Ch. 11]
12- Providing Benefits and Services for Employees' Well-Being. [TB: Ch. 12]
13- Risk Management, Employee Relations, and Risk Management, Health, Safety, and Employee Well-Being. [TB: Ch. 13]

14- Understanding Unionization and Collective Bargaining. [TB: Ch. 14]
Teaching Methodology:
Lecturing, Written Assignments, Problem Solving
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1- Managing Human Resources by Susan E. Jackson, Randall S. Schuler and Steve Werner, South-Western College Pub; 11th Edition (June 16, 2011).ISBN-10:1111580227[TB] 2- Management of Human Resources by Gary Dessler, CarolinRekar Munro and Nina D. Cole, Pearson Education Canada; 3rd Edition (February 28, 2010). ISBN-10: 0321687140

BUSB-202 Principles of Management			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to :	**Domain**	**BT Level***
1. Cover topics fundamentals and principles of management, administrative police, objectives, and procedures and problems of organizational control and leadership.	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Managers and Management: What as Management and What Do Managers Do? Defining Management, Management Functions, Management Roles, Management Skills, History of Management.[TB2: Ch. 1]
2. Organizational Culture and Environment: The Manager: Omnipotent or Symbolic? The Organization's Culture, The Environment - Defining Environment, The Specific Environment, The General Environment, Influence on Management Practice. [TB1: Ch. 3]
3. Decision Making The Essence of Manager's Job: The Decision Making Process, The Rational Decision Maker, Decision Making Styles, Analyzing Decision Alternatives – Certainty, Risk, Uncertainty. [TB1: Ch. 6]
4. Planning: The Foundations of Planning, The Definition of Planning, Purposes of Planning, Types of Plans, Contingency Factors on Planning, Objectives: The Foundation for Planning, Multiplicity of Objectives, Real Versus Stated Objectives, Traditional Objective Setting, Management by Objectives. [TB2: Ch. 3]
5. Organization Structure and Design: Defining Organization Structure and Design, Building, The Vertical Dimension of Organizations, Building the Horizontal Dimension of Organizations, The Contingency Approach to Organization Design, Application of Organization

Design.

6. Motivation: Motivating Employees, What is Motivation? Contemporary Approaches to Motivation, Contemporary Issues in Motivation, From Theory to Practice: Suggestions for Motivating Employees. [TB2: Ch. 10]
7. Leadership: Managers Verses Leaders, Trait Theories, Behavioral Theories, Contingency Theories, Emerging Approaches to Leadership, Contemporary Issues in Leadership. [TB2: Ch. 11]
8. Communication: Communication and Interpersonal Skills, Understanding Communication, Communication Styles of Men And Women, Feedback Skills, Delegation Skills', Conflict Management Skills, Negotiation Skills [TB2: Ch. 12]

Teaching Methodology:

Lecturing, Written Assignments, Class Discussion

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Management by Robbins, S.P. & Coulter, Mary, Prentice Hall; 10th Edition (Novem-ber 3, 2008). ISBN-10: 0132090716
2. Fundamentals of Management by Robbins, S.P. &DeCenzo, David A, Prentice Hall; 7th Edition (January 13, 2010). ISBN-13: 978-0132090711
3. Human Resource Management by David A. DeCenzo and Stephen P. Robbins. Wiley; 7th Edition (October 10, 2001). ISBN-10: 0471397857
4. Principles of Management by Charles W. L. Hill and Steven McShane, McGraw-Hill/Irwin; 1st Edition (2006). ISBN-10: 0073530123
5. Principles of Management by Mason Carpenter, Flat World Knowledge, Inc. (2009). ISBN-10: 0982043074
6. Management by Richard L. Daft, South-Western College Pub; 10th Edition (January 27, 2011). ISBN-10: 0538479531
7. Fundamentals of Management by Stephen P. Robbins, David A. DeCenzo and Mary Coulter, Prentice Hall; 7th Edition (January 13, 2010). ISBN-10: 0136109829

BUSB-204 Entrepreneurship			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to :	**Domain**	**BT Level***
1. Understand the entrepreneurship process. This course exposes them to the concepts, practices and tools of the entrepreneurial world. This will be accomplished through a combination of readings, cases studies and projects designed to convey the unique environment of the entrepreneurs and new ventures. 2. The course gives students the tools necessary to think creatively, to plan out whether their idea is marketable to investors, guide them through the launch their own business, or to support an employer in launching and growing an entrepreneurial venture..	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective

domain

Course Content:

1. Entrepreneurship and the Entrepreneurial Mind-Set. [TB: Ch. 1]
2. Entrepreneurial Intentions and Corporate Entrepreneurship. [TB: Ch. 2]
3. Entrepreneurial Strategy: Generating and Exploiting New Entries. [TB: Ch. 3]
4. Creativity and the Business Idea. [TB: Ch. 4]
5. Identifying and Analyzing Domestic and International Opportunities. [TB: Ch. 5]
6. Intellectual Property and Other Legal Issues for the Entrepreneur. [TB: Ch. 6]
7. The Business Plan: Creating and Starting the Venture. [TB: Ch. 7]
8. The Marketing Plan. [TB: Ch. 8]
9. The Organizational Plan. [TB: Ch. 9]
10. The Financial Plan. [TB: Ch. 10]
11. Sources of Capital. [TB: Ch. 11]
12. Informal Risk Capital, Venture Capital, and Going Public. [TB: Ch. 12]
13. Strategies for Growth and Managing the Implication of Growth. [TB: Ch. 13]
14. Succession Planning and Strategies for Harvesting and Ending the Venture. [TB: Ch. 15]

Teaching Methodology:

Lecturing, Written Assignments, Case Studies

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepherd, McGraw-Hill/Irwin; 9th Edition (September 27, 2012). ISBN-10: 0078029198
2. Entrepreneurship: Ideas in Action by Cynthia L. Greene, South-Western Educational Pub; 5th Edition (January 6, 2011). ISBN-10: 0538496894
3. Entrepreneurship by William D. Bygrave and Andrew Zacharakis, Wiley; 2nd Edition (October 12, 2010). ISBN-10: 0470450371
4. Entrepreneurship: Theory, Process, and Practice by Donald F. Kuratko, South-Western College Pub; 8th Edition (November 14, 2008). ISBN-10: 0324590911
5. Entrepreneurship: Successfully Launching New Ventures by Bruce R. Barringer and Duane Ireland, Prentice Hall; 4th Edition (October 27, 2011)

SS-304 Foreign Language (French, German, Arabic, Chinese etc.)			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to :	**Domain**	**BT Level***
1- The course will develop students‘ functional skills of the offered language	C	2

* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:
1- Follow UOS‘s Relevant Department‘s Syllabus
Teaching Methodology:
Lecturing, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:

Contents of Information Technology Core Courses

ITCC-202 Information Technology Project Management			
Credit Hours:	3 (3,0)	**Prerequisites:**	Software Engineering

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	Domain	BT Level*
1. Plan and manage software development projects successfully	C	2
2. Maximizing the return from each stage of the software development life cycle.	C	2
3. Basic project management tools and their usage during SDLC	C	4
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Outline

1. Introduction: Software Project Versus Other Type of Projects Dimensions of a Software Project, Activities in SPM, Setting Goals & Objectives, Business Case, Signifi-cance of Processes, Project Vs. Program Management, [TB1: Ch. 1, Handouts]
2. Introduction of PM Tools, PMI‘s Knowledge Areas, Technical Fundamentals in SPM, Lifecycle Relationships, Classic Mistakes Product-Process-Peoples-Technology Mis-takes [TB2, Handouts]
3. PMI Framework, PMI Process Groups: Process Initiating Process Group, Planning Process Process Group, Executing Process, Process Monitoring and controlling, Clos-ing Process Group, Project Charter, Statement of Work.[TB2, Handouts]
4. Understanding Organizations, Organizational Structures, Functional -Project –Matrix, Organizational Impact on Projects, Identifying stakeholders: Define Responsibilities, Authority Relationships, Position Qualifications [TB2, Handouts]
5. Project Planning: Project Selection, Project Scope, Project Infrastructure, Analyze Project Characteristics, Identify Project & Product Activities, Work Break Down Structure [TB1:

Ch. 3]

6. Project Evaluation: Strategic Assessment, Technical Assessment, Economic Assess-ment, Project Portfolio Management, Cost-Benefit Analysis, Cash Flow Forecasting, Cost-Benefit Evaluation Techniques, Procurement Management, Procurement Tools &Techniques, Types of Contracts [TB1: Ch. 2]
7. Selection of an Appropriate Approach in Project: Choosing Technologies, Technical Plan, Waterfall Model, V-Model, Spiral Model, Software Prototyping, Incremental Delivery, Agile Process Model: Dynamic Systems Development Method, Extreme Programming, Selection of Most Appropriate Process Model [TB1: Ch. 4]
8. Software Effort Estimation: Work Breakdown Structure (WBS) and Its Types, Estima-tion Problems, Software Estimation Techniques: Expert Judgment, Estimating By Analogy, LOC, Function Point Estimation, and COCOMO [TB1: Ch. 5]
9. Activity Planning: Project and Activities, Sequencings and Scheduling Activities, Net-work Planning Models, Formulation of Network Model, Adding the Time Dimen-sions, The Forward Pass, The Backward Pass[TB1:Ch.6]
10. Identifying the Critical Path, Identify-ing the Critical Activities Project, AOA, GanttChart, (Installation & Configuration of Software Tools like MS-Project).[TB1: Ch. 6]
11. Risk Management: Categories of Risks, A Framework for Dealing with Risks, Evalu-ating the Risks to the Schedule: PERT, Importance of Risk, Types Of Risk, Risk Iden-tification Techniques, Project Risk and Change Management [TB1: Ch. 7]
12. Risk Control, RMMM, Configuration Management & Maintenance, Environment for Configuration Control, Configuration Control vs. Version Control [TB1: Ch. 7, OLM]
13. Resource Allocation: Nature of Resources, Identifying Resource Requirements, Schedul-ing Resources, Resource Scheduling Techniques[TB1: Ch. 8]
14. Monitoring & Control: Creating Framework, Collecting Data, Visualizing Progress, Cost Monitoring, Earned Value, Change Control [TB1: Ch. 9]
15. Review and Evaluation: DeTermining Satisfaction of Requirements, Reviewing And Evaluating Performance, Project Closure: Project Documentation, Cutover/Migration, Quality Standards, Project Closing. [TB2]
16. Challenges of Outsourcing in Project Management, Presentations

Teaching Methodology:

Lectures, Written Assignments, Semester Project.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Final Exam

Reference Materials:

1. Software Project Management by Bob Hughes and Mike Cotterell, McGraw-Hill Educa-tion; 5th Edition (2009). ISBN-10: 0077122798
2. A Guide to the Project Management Body of Knowledge, 3rd Edition (PMBOK Guides), ISBN-13: 978-1930699458
3. Applied Software Project Management by Andrew Stellman and Jennifer Greene, O'Reilly Media; 1st Edition (2005). ISBN-10: 0596009488
4. Software Project Survival Guide (Pro -- Best Practices) by Steve McConnell, Micro-soft Press; 1stEdition (1997), ISBN-10: 1572316217
5. Mastering Software Project Management: Best Practices, Tools and Techniques by Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing (2010). ISBN-10: 1604270349
6. Effective Project Management: Traditional, Agile, Extreme by Robert K. Wysocki, Wiley; 6th Edition (2011). ISBN-10: 111801619X
7. The Software Project Manager's Handbook - Principles that work at work by Dwayne Phil-

lips, 2nd Edition, IEEE Computer Society Press and Wiley Inter-science, 2004. ISBN 0-471-67420-6

ITCC-301 System and Network Administration			
Credit Hours:	4(3,1)	**Prerequisites:**	Operating Systems

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Describe the key terminologies and technologies of System and network administration.	C	2
2. Explain the services and functions provided by different data centers.	C	2
3. Identify various OS used to handle system and network administration routines.	C	3
4. Analyze the different services of Linux and windows.	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to System Administration, Systems, SA Components, Building a Site from Scratch, Growing a Small Site, Going Global, Replacing Services, Moving a Data Center, Handling a High Rate of Office Moves, Assessing a Site .[TB1:Ch. 1**]**
2. Server Environment (Microsoft and Linux): Known for Reliable Products, Understand the Cost of Server Hardware, Consider Maintenance Contracts and Spare Parts, maintaining Data Integrity, Put Servers in the Data Center, Client Server OS Configuration, and Provide Remote Console Access.). [TB1:Ch. 4**]**
3. Services and Comparative Analysis of most demanded OS: Important Attributes, Key Features, pros and Cons. [TB1:Ch. 5**]**
4. Linux Installation and verification. [TB2:Ch 1**]**
5. Configuring Local services and managing basic system issues. [TB2:Ch 8]
6. Administer users and groups. [TB2:Ch 5]
7. Software Management**.** [TB2:Ch 4]
8. Managing Network Services and Network monitoring tools**.** [TB2:Ch 11,12]
9. Boot Management and Process Management**.** [TB2:Ch 6]
10. IP Tables and filtering**.** [TB2:Ch 13]
11. Securing network traffic**.** [TB2:Ch 14,Ch 15]
12. Advance File systems and logs**.** [TB2:Ch 7]
13. Bash Shell Scripting and Command line**.** [TB2:Ch 3]
14. Configuring Servers (FTP, DNS, Apache) LAB**.** [TB2:Ch 16,17,18]
15. Configuring Servers Cont. (DHCP, Samba, NFS) LAB**.** [TB2:Ch 23,24]
16. Configuring Active Directory on Windows Server 2012 LAB [TB3:Ch 7]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1- Study guide for Practice of System and Network Administration by Thomas A. Limoncelli, Cram101; 2nd Edition (2011). ISBN-10: 1428851755. 2- Linux Administration: A Beginner's Guide, Seventh Edition 7th Edition by Wale Soyinka 3- Active Directory: Designing, Deploying, and Running Active Directory Fifth Edition by Barian Desmond

ITCC-302 Web Technologies			
Credit Hours:	3 (3,0)	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Learn basic WWW, its structure and working.	C	1
2. Describe the constraints that the web puts on developers.	C	2
3. Implement basic client side and server side languages.	C	4
4. Design and Implement a simple web application.	C	4
5. Review an existing web application against a current web standard.	C	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
1. Overview of WWW, Web Pages, Web Sites, Web Applications, TCP/IP, TCP/IP Application 2. Services, Web Servers, WAMP, LAMP,WAMP Configuration. 3. Introduction to HTTP, HTML & HTML5 Tags, and Dynamic Web Content.[Ch. 1] 4. CSS and CSS3 [Ch. 18,19] 5. Client Side Programming: Programing in JavaScript: Basics, Expressions and Control Flow[Ch. 13, 14, 15, 20] 6. Javascript Functions, Objects, and Arrays, Accessing CSS from JavaScript [Ch. 13, 14, 15, 20] 7. Form Handling [Ch. 11] 8. Server Side Programing: Programing in PHP, [Ch. 3, 4] 9. PHP functions and objects, PHP arrays [Ch. 5,6] 10. Introduction MySQL, MySQL Functions, Normalization, Relationships [Ch.9] 11. Accessing MySQL via PHP [Ch. 10] 12. Cookies, Sessions, and Authentication [Ch. 12] 13. Introduction to Ajax [Ch. 17] 14. Introduction to JQuery 15. Browsers and the DOM [W3 Schools Tutorial] 16. Designing a Social Networking Site [Ch. 21]
Teaching Methodology:
Lecturing, Written Assignments, Project, Report Writing
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Learning PHP, MySQL, JavaScript, and CSS, A Step-by-Step Guide to Creating Dy-namic Websites By Robin Nixon, O'Reilly Media; Second Edition edition (September 3, 2012). ISBN-10: 1449319262
2. Web Technologies: A Computer Science Perspective by Jeffrey C. Jackson, Prentice Hall; 1st Edition (August 27, 2006). ISBN-10: 0131856030
3. Web Technologies by Uttam Kumar Roy, Oxford University Press, USA (June 13, 2011). ISBN-10: 0198066228
4. Web Application Architecture: Principles, protocols and practices by Leon Shklar and Rich-ard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10: 047051860X

ITCC-403 Virtual Systems and Services			
Credit Hours:	4(3,1)	**Prerequisites:**	Programming Fundamentals, Com-puter Networks*

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1: How virtualization is changing today's IT consumption trends.	C	4
2: Implementation, Management and control of different Virtual environments	C	5
3: Windows and Linux based systems administration*	C	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Overview of virtualization technology and its application, Comparison of traditional and virtual systems
2. Overview of Intel x86 platform
3. Parallel and distributed systems
4. Types of virtualization, Virtualization at Software and Hardware level
5. Virtual Machines and configuration of VMs: Managing CPU, storage, networking etc for VMs
6. Key features of VMs, Hypervisors and Configuration of Vmware
7. Hyper-V and Xen hypervisors
8. Types of hypervisors: Type-1 and Type-2 hypervisor
9. Features and limitations of hypervisors
10. Para-virtualization and Para-virtualized software components
11. Vmware ESXi, Xen and Microsoft virtualization implementation in the context of datacenters (lab sessions)
12. Virtualization in Cloud Computing
13. Virtualization in IoT
14. Virtualization security: security at hypervisor level, VM security
15. Future of Virtualization
16. Semester project

Teaching Methodology:
Lectures, Labs, Labs Assignments, Semester Project, Presentations,
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Virtualization from Desktop to the Enterprise, Chris Wolf and Erick M. Halter, Latest Edition 2. The Definitive Guide to the Xen Hypervisor, David Chisnall, Latest Edition 3. Windows Server 2012 Hyper-V Installation and Configuration Guide, Aidan Finn, Michel Luescher, Patrick Lownds, 2013 4. Xen Hypervisor Case Study - Designing Embedded Virtualized Intel® Architecture Platforms 5. Handbook of Virtual Environments: Design, Implementation, and Applications (Human Factors and Ergonomics), Edited by Kay M Stanney, Lawrence Erlbaum Associates Virtual Reality Technology by GRIGORE

ITCC-407 Information Technology Infrastructure			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Information technology architectures including software systems, hardware, operating systems, databases, component technologies, networking, and architecture patterns.	C	2
2. IT Infrastructure Management.	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Outline:
1. Introduction and Definition of IT Infrastructure, IT building block, process building blocks, Application building block, Application Platform building block, Infrastructure building block [TB1: Ch.1,2] 2. Non-functional Attributes; introduction, non-functional requirements, Availability Concepts, Calculating availability, Sources of Unavailability, Availability Patterns. 3. Performance concepts: introduction, Perceived performance, Performance during Infrastructure Design, Performance of a running system, performance pattern, Sources of Performance Metrics, Performance Pattern. [TB1: Ch.5] 4. Security Concepts: Risk Management, Cryptography, Computer Crime, Security Patterns. [TB1: Ch.6] 5. Datacentres: Introduction & History, Building Blocks, Datacentre Availability, Datacentre Security. [TB1: Ch.7] 6. Networking: Building Blocks, Network virtualization [TB1: Ch.8] 7. Network Availability, Network Performance, Network Security [TB1: Ch.8]

8. Storage: Introduction and History, Building blocks, Availability, Performance, Security. [TB1: Ch.9]
9. Compute: Introduction, Building Blocks, Availability, Performance, Security [TB1: Ch.10]
10. Operating Systems: Introduction, Building Blocks, Implementing Various OSs, OS availability, OS Performance, OS Security. [TB1: Ch.11]
11. End User Devises: Introduction & History, Building Blocks, Desktop virtualization, Device Availability, Performance, Security [TB1: Ch.12]
12. Infrastructure life cycle [TB1:13]
13. Infrastructure deployment options: Introduction, Hosting options, Enterprise infrastructure deployment, Software defined data-centre, (Hyper) Converged Infrastructure, Cloud computing, infrastructure as a code [TB1:14]
14. Purchasing Infrastructure And Services [TB:15]
15. Deploying The Infrastructure [TB:16]
16. Maintaining The Infrastructure, Deploying applications, [TB:17,18]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. IT Infrastructure Architecture: Infrastructure building blocks and concepts by Sjaak-Laan, Lulu.com; 3rd edition (2017). ISBN-978-1-326-92569-7
2. IT Infrastructure and its Management by Prof Phalguni Gupta, Tata McGraw Hill Education Private Limited (October 6, 2009). ISBN-10: 0070699798
3. IT Architecture For Dummies byKalani Kirk Hausman and Susan Cook, For Dum-mies; 1st Edition (November 9, 2010). ISBN-10: 0470554231
4. Standards Policy for Information Infrastructure by Brian Kahin and, Janet Abbate, The MIT Press (August 14, 1995). ISBN-10: 026211206X
5. IT Architectures and Middleware: Strategies for Building Large, Integrated Systems by Chris Britton and Peter Bye, Addison-Wesley Professional; 2nd Edition (June 3, 2004). ISBN-10: 0321246942

ITCC-402 Cyber Security			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Describe the core information assurance (IA) principles.	C	3
2. Identify the key components of cyber security architecture.	C	3
3. Distinguish system and application security threats and vulnerabilities.	C	3
4. Define types of incidents including categories, responses and timelines for response	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1- Vulnerabilities in information system, measuring vulnerabilities. [TB1:Ch1]
2- Threat classification, cyber security starts at home and international awareness.[TB1:Ch1]
3- Vulnerabilities in the organization, access authorization and authentication, security services in wireless networks and cloud security.[TB1:Ch2]
4- Risk in information system infrastructure, hardware, software, and cyberspace. [TB1:Ch3].
5- Assets identification, resource access control and securing the assets communication. [TB1:Ch4]
6- Secure information system, information security management. .[TB1:Ch4]
7- Cyber security and the CIO, data backup and archiving , cyber trainings and cyber policy.[TB1:Ch5]
8- Building a secure organization, system access control and computer network management securely.[TB1:Ch6]
9- Personal, physical and environmental security and business continuity planning. [TB1:Ch6]
10- Cyberspace Intrusions, ID/PS configuration, ID/PS management and ID/PS classification. [TB1:Ch7]
11- ID/PS implementation and operation in organization. [TB1:Ch7]
12- Cyberspace defense, file protection application, PC performance applications. [TB1:Ch8]
13- Protection tools, security analyzer, password analyzer, firewalls and email protection. [TB1:Ch8]
14- Cyberspace and law, international law and cyber related laws. [TB1:Ch9]
15- Cybercrime, trends in cyber abuse, combating cybercrime. [TB1:Ch9]
16- Cyber warfare and homeland security and distributed defense. [TB1:Ch10]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Cyberspace and Cyber security 1st Edition by George Kostopoulos
2. Security+ Guide to Network Security Fundamentals, Fifth Edition Mark Ciampa
3. Essential Cyber Security Handbook Kindle Edition by Nam Nguyen

ITCC-406 Database Administration and Management			
Credit Hours:	3(3,1)	**Prerequisites:**	Database Systems

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fully understand the concepts and technical issues of Database Administration.	C	2
2. Have good understanding of internal functionality of Database Management System.	C	2
3. Administrator Huge Database implemented in a DBMS.	C	4

4. Database Administration tasks i.e. Backup and Recovery and Performance Tuning of Databases.	C	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course outline:

1. Installation; SQL* Plus; Oracle Enterprise Manager; DBA Tools. Oracle Architectural Components: Oracle Server; Oracle Instance.
2. Physical Structure; SGA; Shared Pool; Library Cache; Data Dictionary Cache; Large Pool; User Process; Server Process; Background Processes.
3. Managing an Oracle Instance: Parameter File; Creating SPFILE; Oracle Managed Files; Startup and Shutdown Database; Alert Log File; Background Trace File; User Trace File.
4. Creating Database and Data dictionary.
5. Managing Control Files and Redo Log Files.
6. Managing Tablespaces, Operations with Tablespaces.
7. Data File Management, Segments, Block.
8. Managing Undo Data, Undo Data Statistics: Managing Tables and Users:
9. Indexes Management, Maintaining Data Integrity, Constraints. Managing Privileges.
10. Basic Oracle Net Architecture: Types of Networks, Oracle Net Services, Oracle Shared Server, Connection Manager, Oracle Net Connections.
11. Server Side Configuration: The Listener Process; Configuring Listener, Sessions, Creating and Managing Listener.
12. Client Side Configuration: Host Naming Method, Local Naming Method, Net Assis-tant, Configurations. Usage and Configuration of Oracle Shared Server.
13. Backup and Recovery, Instance and Media Recovery, Configuration of Archive log mode, User Managed Complete Recovery
14. Loading Data into Database, Tuning Tools, Sizing Shared Pool, Sizing Buffer Cache, I/O Issues
15. Tuning Rollback Segments, Latches, Rollback Segment Tuning Shared Servers, Types of Locks, Block Efficiency, Storage hierarchy
16. Avoiding Dynamic allocation, Statistics, PCTFREE and PCTUSED, Monitoring Index Usage.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Oracle Database 11g DBA Handbook by Bob Bryla and Kevin Loney, McGraw-Hill Osborne Media; 1st Edition (December 6, 2007). ISBN-10: 0071496637
2. Oracle Database 12c DBA Handbook by Bob Bryla, McGraw-Hill; (2015),ISBN-978-0-07-179879-2
3. Database Administration: The Complete Guide to DBA Practices and Procedures by Craig S. Mullins, Addison-Wesley Professional; 2nd Edition (October 21, 2012). ISBN-10: 0321822943
4. Database Systems: A Practical Approach to Design, Implementation and Management by Thomas M. Connolly and Carolyn E. Begg, Addison-Wesley; 5th Edition (2009). ISBN-10: 0321523067
5. Oracle Database 11g The Complete Reference by Kevin Loney, McGraw-Hill Os-borne

Media; 1st Edition (2008). ISBN-10: 0071598758
6. Oracle Database 11g Release 2 Performance Tuning Tips & Techniques (Oracle Press) by Rich Niemiec, McGraw-Hill Osborne Media; 1st Edition (2012). ISBN-10: 0071780262
7. Online Material URL http://otn.oracle.com

Contents of Information Technology Supporting Courses

ITSC-201 Enterprise Systems			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Discover Demonstrate an understanding of the issues in systems use of an Enterprise Systems package (e.g. ERP) to support business operations and decision.	C	2
2. Understand the scope of common Enterprise Systems modules (e.g., MM, SCM, CRM, HRM, procurement).	C	3
3. Discuss the challenges associated with implementing enterprise systems and their impacts on organizations.	C	3
4. Develop models for selected business process in enterprise systems.	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1- Introduction to Enterprise system management.[TB: 1 Ch:1]
2- Business Process Management and system integration. [TB: 1 Ch: 2].
3- Architecture and Platform of Enterprise systems.[TB: 1 Ch:3]
4- Enterprise Systems and development lifecycle technology. [TB: 1 Ch:4]
5- Enterprise Systems and Business Process Reengineering, implementation and strategies. [TB: 1 Ch:5]
6- Software and vendor selection [TB: 1 Ch:6]
7- Operation and post-implementation. [TB: 1 Ch:7]
8- Program and project management. [TB: 1 Ch:8]
9- Global, Ethics and security management. [TB: 1 Ch:9]
10- Supply chain management. [TB: 1 Ch:10]
11- Customer Relationship management and its factor. [TB: 1 Ch:11]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Enterprise Systems for Management 2nd edition, Published by PEARSON: ISBN-13: 978-0-13-214576-3 Luvai F. Motiwalla and Jeff Thompson (2011).[TB] 2. Modern ERP: Select, Implement & Use Today's Advanced Business Systems by Marianne Bradford, lulu.com (October 19, 2009). ISBN-10: 0557012910. 3. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2nd Ed. 2012 4. Business Process Management Common Body Of Knowledge by Yvonne LedererAntonucci, et. al., CreateSpace Independent Publishing Platform, 2009

Course Learning Outcomes (CLOs):

ITSC-301 Operations Research			
Credit Hours:	3(3,0)	**Prerequisites:**	None

At the end of the course the students will be able to:	**Domain**	**BT Level***
1- Use quantities methods and techniques for effective decisions–making		1
2- Model formulation and applications that are used in solving business decision problems.		3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Model Building: An Introduction to Modeling. The Seven-Step Model-Building Process. Over view of Matrices and Vectors. Matrices and Systems of Linear Equations. The Gauss-Jordan Method for Solving Systems of Linear Equations. Linear Independence and Linear Dependence. The Inverse of a Matrix. Determinants. [TB1: Ch.1, 2]
2. Introduction to Linear Programming: The Graphical Solution of Two-Variable Linear Programming Problems. A Work-Scheduling Problem. A Capital Budgeting Problem. [TB1: Ch.3]
3. The Simplex Algorithm and Goal Programming: How to Convert an LP to Standard Form. The Simplex Algorithm. Using the Simplex Algorithm to Solve Minimization Problems. Solving LPs with Spreadsheets. [TB1: Ch.4]
4. Sensitivity Analysis: An Applied Approach: A Graphical Introduction to Sensitivity Analysis. The Computer and Sensitivity Analysis. Managerial Use of Shadow Prices. [TB1: Ch.5]
5. Sensitivity Analysis and Duality: A Graphical Introduction to Sensitivity Analysis. Some

Important Formulas. Sensitivity Analysis. Sensitivity Analysis When More Than One Parameter is Changed. Duality and Sensitivity Analysis. [TB1: Ch.6]

6. Transportation and Transshipment Problems: Formulating Transportation Problems. Finding Basic Feasible Solutions for Transportation Problems. The Transportation Simplex Method. Sensitivity Analysis for Transportation Problems. [TB1: Ch.7]
7. Network Models: Basic Definitions. Shortest Path Problems. Maximum Flow Problems. CPM and PERT. Minimum Cost Network Flow Problems. Minimum Spanning Tree Problems. The Network Simplex Method. [TB1: Ch.8]

Teaching Methodology:

Lectures, Written Assignments, Quizzes

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1- Operations Research: Applications and Algorithms by Wayne L. Winston. 4th Edition

ITSC-302 Object Oriented Analysis and Design			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Describe how to produce detailed object models and designs from system requirements.	C	2
2. Use the modeling concepts provided by UML	C	2
3. Analyze identify use cases and expand into full behavioral designs**.**	C	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1- Principles of Object Technology: Introduction to Object Technology, Principles of Modeling, and Principles of Object Orientation [TB: Ch. 1.1-5]

2- Introduction to UML, Unification, UML Diagrams, Unified Process & Rational Unified Process, RUP Disciplines, Case Study Analysis and Basics, Case Study, About Inception, Feasibility and Risk Analysis [TB: Ch. 1.6, 2.1-6, 3.1-2,4.1-3]

3- Understanding Requirements, Requirements Types, Use Case Modeling: Use Case Writing Styles, EBP Guidelines [TB: Ch. 5.1, 6.1-8]

4- System Use Case Diagram, Use Case Table, Activity Diagram, Supplementary Specifications, Vision Document, Glossary, Rational Rose Overview, Use Case & Activity Diagram Modeling in Rational Rose [TB: Ch. 6.9, 6.12-17, 7.2-4 & 7]

5- Elaboration Phase of RUP; Configuration Management; System Sequence Diagram, Domain Model : Identifying Business Classes, Associations, Attributes [TB: Ch.8.2-

5,9.2-4,10.1-4,11.1-7,12.1-4]
6- Implementation of System Sequence & Domain Model: Use Case Operational Contracts, Business Sequence, Analysis Sequence & Collaboration Diagrams [TB: Ch. 11.10, 12.9, 13.1-2, 13.9, 15.1-7]
7- Use Case Dependencies. Analysis Use Case Diagram, Implementation of Sequence, Collaboration, Analysis Use Case Diagram [TB: Ch. 25.1-5, 15.6-7]
8- State Chart Diagrams and Implementation [TB: Ch. 29.1-5, 29.8, Ch. 1-13, 25, 29]
9- Design Patterns: GRASP: Information Expert, Creator, Cohesion & Coupling, Controller [Ch. 16.1-10]
10- Use Case Realization Using GRASP Patterns, Design Model: DeTermining Visibility [TB: Ch. 17.1-9, 18.1-3]
11- Modeling Generalization, Creating Design Class Diagram, Mapping Data Model to Domain Model [TB: Ch. 26.1-7, 27.1-10, 19.1-6, 34.5-9]
12- Implementation of Design Class Diagram, Coding patterns, Mapping Design to Code [TB: Ch. 19.6, 20.1-11]
13- More Patterns for Assigning Responsibilities, Polymorphism, Pure Fabrication, Indirection, Protected Variation. GoF Design Patterns: Adapter, Factory [TB: Ch. 22.1-4, 23.1-2]
14- Gof: Singleton, Strategy, Composition, Façade and Discuss Remaining Patterns [TB: Ch. 23.4-8]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1- Applying UML and patterns: An introduction to Object-Oriented Analysis and Design and Iterative Development by Craig Larman, Prentice Hall; 3rd Edition (October 30,2004). ISBN-10: 0131489062
2- Fundamental of Object-Oriented Design in UML by Meiler Page-Jones, Addison Wesley, 2000. ISBN: 020169946X.
3- The Unified Modeling Language User Guide by G. Booch, J. Rambaugh and I. Jakob son, Addison-Wesley Professional; 2nd Edition (2005). ISBN-10: 0321267974

ITSC-303 Optimization Techniques			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1- The course provides students an exposure to solving non-linear optimi-zation problems by various techniques, with due emphasis on their mathematical rigor in terms of their derivation / justification.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1- Preliminaries: Review of the theory of maxima, minima (two variables); positive definite matrices, convexity of regions and functions; quadratic function and Hessian matrix; uniqueness of minimum. [TB2: Chapt. 9, Chapt. 11 : Sec.11.1 – 11.5]
2- Classical methods for functions of one variable and *n* variables, Newton's method [TB1: Chap. 1].

Unconstrained Optimization:

3- Search methods for functions of one variable: Single search techniques: Bracketing method; Quadratic and cubic interpolation; Fibonacci search; Golden-section. [TB1: Chap. 2]
4- Search methods for functions of *n* variables: method of Hooke and Jeeves, Nelder and Mead's Method. [TB1: Chap. 3]
5- Gradient methods: Davidon-Fletcher-Powell (DFP); Fletcher- Reeves, conjugate- gradient and direct- search methods, Newton's method, method of Steepest descent [TB1: Chap. 4].

Constrained Optimization:

6- Review of Lagrange multipliers technique with equality constraints; inequality constraints and slack variables; Kuhn-Tucker conditions [TB1: Chap. 5]
7- Search methods: modified Hooke and Jeeves, the Complex method [TB1: Chap. 6].
8- Penalty-function approach to constrained optimization; equality and inequality constraints, SUMT method of Fiacccco and McCormick. [TB1: Chap. 7]

Teaching Methodology:

Lectures, Class Exercises

Course Assessment:

Midterm Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1- Bunday, B. D., Basic Optimization Methods, Edward Arnold Ltd., 1984.
2- Chiang,Alpha.C., Fundamental Methods of Mathematical Economics, McGraw-Hill Education; 4th ed., 2004.

ITSC-102 Digital Logic Design			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1- Describe the key terminologies of digital circuit of large complexity.	C	2
2- Explain how such circuits could be built in a methodological way	C	2
3- Analyze from starting from Boolean logic and applying a set of rigorous techniques.	C	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1- Number Systems, Operations, and Codes: Decimal Numbers, Binary Numbers, Decimal-to-Binary Conversion, Binary Arithmetic, I's and 2's Complements of Binary, Numbers, Signed Numbers, Arithmetic Operations with Signed Numbers, Hexadecimal Numbers, Octal Numbers, Binary Coded Decimal (BCD), Digital Codes, Error Detection and Correction Codes. [Ch. 2]
2- Logic Gates: The Inverter, The AND Gate, The OR Gate, The NAND Gate, The NOR Gate, The Exclusive-OR and Exclusive-NOR Gates. [Ch. 3]
3- Boolean Algebra and logic Simplification: Boolean Operations and Expressions, Laws and Rules of Boolean Algebra, DeMorgan's Theorem, Boolean Analysis of Logic Circuits, Simplification Using Boolean Algebra, Standard Forms of Boolean Expressions, Boolean Expressions and Truth Tables, The Kamaugh Map, Karnaugh Map SOP Minimization, Karnaugh Map POS Minimization, Five-Variable Karnaugh Maps. [Ch. 4]
4- Combinational logic Analysis: Basic Combinational Logic Circuits, Implementing Combinational Logic, The Universal Property of NAND and NOR Gates, Combinational Logic Using NAND and NOR Gates. [Ch. 5]
5- Functions of Combinational logic: Basic Adders, Parallel Binary Adders, Ripple Carry versus Look-Ahead Carry Adders, Comparators, Decoders, Encoders. Code Conveners: Multiplexers (Data Selectors), Demultiplexers, Parity Generators/Checkers.[Ch. 6]
6- latches, Flip-Flops, and Timers: Latches, Edge-Triggered Flip-Flops, Flip-Flop Operating Characteristics, Flip-Flop Applications. [Ch. 7]
7- Counters: Asynchronous Counter Operation, Synchronous Counter Operation, Up/Down Synchronous Counters, Design of Synchronous Counters. [Ch. 8]
8- Shift Registers: Basic Shift Register Functions, Serial In/Serial Out Shift Registers, Serial In/Parallel Out Shift Registers, Parallel In/Serial Out Shift Registers, Parallel In/Parallel Out Shift Registers, Bidirectional Shift Registers, Shift Register Counters. [Ch. 9]
9- Memory and Storage: Basics of Semiconductor Memory, Random-Access Memories (RAMs), Read-Only Memories (ROMs), Programmable ROMs (PROMs and EPROMs), Flash Memories. [Ch. 10]
10- Programmable Logic: FPGA [Ch. 11]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1- Digital Fundamentals by Thomas L. Floyd, Prentice Hall; 9th edition (2007)
2- Digital Fundamentals: A Systems Approach by Thomas L. Floyd, Prentice Hall; 1 edition (July 13, 2012)

ITSC-305 Design and Analysis of Algorithms			
Credit Hours:	3(3,0)	**Prerequisites:**	Discrete Structure

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Student will be enable to design algorithms for problems	C	1
2. Understanding the core logic of problem solving	C	2
3. Time and Space Complexity of Algorithm	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Role of Algorithms in Computing, Analysing Algorithms, Designing Algorithms, Growth of Functions, Asymptotic Notation, Standard Notations and Common Functions. [TB: Ch1,2,3]
2. Divide-and-Conquer, Strassen's Algorithm for Matrix Multiplication, Recursion. [TB: Ch. 4]
3. Recurrences: Substitution Method for Solving Recurrences, Recursion-Tree Method for Solving Recurrences, Master Method for Solving Recurrences. [TB: Ch. 4]
4. Sorting and Order Statistics: Heapsort Algorithm, Priority Ques, Quicksort Algorithm, Analysis of Quicksort. [TB: Ch. 6, 7]
5. Sorting in Linear Time: Lower Bounds for Sorting, Counting Sort, Radix Sort, Bucket Sort. [TB: Ch. 8]
6. Medians and Order Statistics, Binary Search Trees, Querying a Binary Search Tree, Insertion and Deletion. [TB: Ch. 9, 12]
7. Red-Black Trees: Properties of Red-Black Trees, Rotations, Insertion, Deletion; Minimum Spanning Trees: Introduction, Growing a Minimum Spanning Tree. [TB: Ch. 12]
8. Dynamic Programming: Elements of Dynamic Programming, Longest Common Subsequence, Optimal Binary Search Trees [TB: Ch. 15]
9. Greedy Algorithms: Elements of The Greedy Strategy, Huffman Codes, Matroids and Greedy Methods, Task-Scheduling Problem. [TB: Ch. 16]
10. Elementary Graph Algorithms, Representations of Graphs, Breadth-First Search, Depth-First Search, Topological Sort. [TB: Ch. 22]
11. Single-Source Shortest Paths: The Bellman-Ford Algorithm, Single-Source Shortest Paths in Directed Acyclic Graphs, Dijkstra's Algorithm. [TB: Ch. 24]
12. All-Pairs Shortest Paths: Floyd-Warshall Algorithm, Johnson's Algorithm for Sparse Graphs. [TB: Ch. 25]
13. Maximum Flow: Flow Networks, Ford-Fulkerson Method, Push-Relabel Algorithms, Relabel-to-Front Algorithm. [TB: Ch. 26]
14. String Matching: Naive String-Matching Algorithm, Rabin-Karp Algorithm, String Matching with Finite Automata, Knuth-Morris-Pratt Algorithm. [TB: Ch. 32]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1- Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, The MIT Press; 3rdEdition (2009). ISBN-10: 0262033844
2- Introduction to the Design and Analysis of Algorithms by Anany Levitin, Addison Wesley; 2ndEdition (2006). ISBN-10: 0321358287
3- Algorithms in C++ by Robert Sedgewick (1999). ASIN: B006UR4BJS
4- Algorithms in Java by Robert Sedgewick, Addison-Wesley Professional; 3rdEdition(2002). ISBN-10: 0201361205

Contents of Information Technology Elective Courses

ITEC-303 Mobile Application Development			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Discuss different architectures & framework for Mobile Application development.	C	1
2. Develop mobile applications using current software development environments.	C	3
3. Compare the different performance tradeoffs in mobile application development.	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. A Little Background. What It Isn't. An Open Platform for Mobile Development. Native Android Applications. Android SDK Features. Introducing the Open Handset Alliance. What Does Android Run On? Why Develop for Android? Introducing the Development Framework. What Comes in the Box? [TB1: Ch 1 TB2: Ch 1].
2. Developing for Android. Developing for Mobile Devices. To-Do List Example. Android Development Tools. [TB1: Ch 2]
3. What Makes an Android Application? Introducing the Application Manifest. Using the Manifest Editor. The Android Application Life Cycle. Understanding Application Priority and Process States. Externalizing Resources. A Closer Look at Android Activities. [TB1: Ch 3]
4. Fundamental Android UI Design. Introducing Views. introducing Layouts. Creating New Views. Creating and Using Menus. [TB1: Ch 4].
5. Introducing Intents. Introducing Adapters. Using Internet Resources. Introducing Dialogs. Creating an Earthquake Viewer. [TB1: Ch 5].
6. Android Techniques for Saving Data. Saving Simple Application Data. Saving and Loading Files. Databases in Android. Introducing Content Providers. [TB1: Ch 6]

7. Saving and Loading User Preferences, Persisting Data to Files, Creating and Using Databases. [TB1: Ch 6].
8. Using Location-Based Services. Setting up the Emulator with Test Providers. Selecting a Location Provider. Finding Your Location. Using Proximity Alerts. Using the Geocoder. Creating Map-Based Activities. Mapping Earthquakes Example. [TB**1:** Ch **7**].
9. Introducing Services. Using Background Worker Threads. Let's Make a Toast. Introducing Notifications. Using Alarms. Using Alarms to Update Earthquakes. [TB1:Ch 8]
10. Peer-to-Peer Communication. Introducing Android Instant Messaging. Introducing SMS. [TB1:Ch 9 TB4:Ch 8].
11. Accessing Android Hardware. Using the Media APIs. Using the Camera. Introducing the Sensor Manager. Using the Accelerometer and Compass. [TB1:Ch 10].
12. Android Telephony. Using Bluetooth. Managing Network and Wi-Fi Connections. Controlling Device Vibration. [TB1:Ch 10].
13. Creating Your Own Services, Establishing Communication between a Service and an Activity, Binding Activities to Services, Understanding Threading. [TB1: Ch 11].
14. Consuming Web Services Using HTTP, Accessing Web Services Using the Get Method, Consuming JSON Services, Sockets Programming. [Tb4: Ch 10].
15. Creating Your Own Services, Establishing Communication between a Service and an Activity, Binding Activities to Services, Understanding Threading. [Tb4: Ch 11] .
16. Publishing Android Applications, App store [TB4: Ch12].

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2015.[TB]
2. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition, 2014.
3. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 2nd Edition, 2014
4. Beginning Android 4 Application Development by Wei-Menge Lee, John Wiley & Sons, 2012

ITEC-401 E-Commerce Application Development			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1: Understand the concepts and standards related to the discipline of E-Commerce.	C	2
2: Analyze complex real world problems found in E-Commerce	C	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective

domain

Course Content:

1. E-Commerce: An overview of e-Commerce, Brick 'N Mortar stores vs Service-based companies, e-Commerce Models, e-Commerce popular sites: iStockphoto, WooThemes, eBay, Amazon, Play.com. [TB: Ch.1]
2. Planning an e-Commerce Framework: Designing a framework, Patterns, ModelView-Controller, Registry, Singleton, Structure, Building a framework, Routing requests. [TB: Ch.2]
3. Products and Categories: Product information, Category information, Structuring Content, Versioning, Building products, categories, and content functionality, Routing products and categories. [TB: Ch.3]
4. Product Variations and User Uploads: Giving users choice, Giving users control, Shopping. [TB: Ch.4]
5. 5. Enhancing the User Experience: The importance of user experience, Search, Providing wish lists, Making Recommendations, Stock Checking, Customer‘s Feed Back, Processing reviews/comments. [TB: Ch.5]
6. 6. The Shopping Basket: Creating A Basket, Basket Contents, Managing the Basket, Cleaning the Basket. [TB: Ch.6]
7. The Checkout and Order Process: The Process, Authentication, Payment Method, Order Processed. [TB: Ch.7]
8. Shipping and Tax: Shipping Methods, Shipping Costs, Shipping Rules, Tracking, Tax Calculation. [TB: Ch.8]
9. Discounts, Vouchers, and Referrals: Discount codes, Purchasable Voucher Codes, Referrals. [TB: Ch.9]
10. Checkout: Checkout process consideration, Order process review, Authentication & Confirmation. [TB: Ch.10]
11. Taking Payment for Orders: Taking payment, Payment System, Payment gateway, Taking Payment Online, Taking payment offline. [TB: Ch.11]
12. User Account Features: User Account Area, Changing Details, Viewing & Managing Orders. [TB: Ch.12]
13. Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping, etc. [TB: Ch.3]
14. Deploying, Security, and Maintenance, SEO. [TB: Ch.14, 15]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. PHP 5 E-commerce Development by Michael Peacock, Packt Publishing (January 20, 2010). ISBN-10: 184719964X[TB]
2. E-Commerce, Kenneth Laudon and Carol Guercio Traver, 13th Edition, Pearson, 2017.
3. PHP 5 E-commerce Development, Michael Peacock, Packt Publishing, 2010.
4. Introduction to E-Commerce, Jeffrey F. Rayport, McGraw-Hill, 2nd Edition, 2007.
5. Electronic Commerce, Gary Schneider, Course Technology; 12th Edition 2016

ITEC-405 Mobile and Wireless Networks			
Credit Hours:	**3(3,0)**	**Prerequisites:**	**Computer Networks**

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	Domain	BT Level*
1. Introduction to mobile networking, with an emphasis on the mechanisms, protocols and standards	C	1
2. Understanding of the architecture and operating principles of mobile and wireless networks	C	2
3. Operations of wireless LANs, WANs and PANs	C	2
4. Solutions and effectiveness of routing schemes for mobile hosts and application-level features	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Basics of Wireless Local Area Networks: Networks Large and Small, WLANs from LANs, 802.11 WLANs, HiperLAN and HiperLAN 2, From LANs to PANs. [TB1: Ch2]
2. Radio Transmitters and Receivers, Multiple Access Methods: Overview of Radios, Radio Components, FDMA, TDMA, CDMA, Random Access, ALOHA, Slotted ALOHA, Reservation-based ALOHA. [TB1: Ch3]
3. Radio Propagation: Radio Propagation, Mechanisms of Radio Wave Propagation, Diffraction, Scattering, Path Loss, Multipath Phenomena. [TB1: Ch4]
4. Antennas and Transmission Lines: Introduction and Antenna Characteristics, Types of Antenna. [TB1: Ch5]
5. Communication Protocols and Modulation: Baseband Data Format and Protocol, Baseband Coding, RF Frequency and Bandwidth, Modulation, RFID. [TB1: Ch6]
6. High-Speed Wireless Data: System Types, Standards-Based and Proprietary Solutions: Fixed Networks, Nomadic Networks, Mobile Networks, Standards-Based Solutions and Proprietary Solutions, Overview of the IEEE 802.11 Standard, Overview of the IEEE 802.16 Standard, 10–66 GHz Technical Standards, 2–11 GHz Standards, Overview of the IEEE 802.20 Standard. [TB1: Ch7]
7. GSM/Cellular Networks: First-Generation Analog, Second-Generation TDMA, Second-Generation CDMA, Third-Generation Systems, 4G and Beyond, LTE. [TB2: Ch10] (William Stallings Ch. 5 and from GSM to LTE book)
8. Security in Wireless Local Area Networks: Introduction Key Establishment in 802.11, Anonymity in 802.11, Authentication in 802.11, Confidentiality in 802.11, Data Integrity in 802.11, Loopholes in 802.11 Security, WPA, WPA2 (802.11i). [TB1: Ch10]
9. Voice Over Wi-Fi and Other Wireless Technologies: Introduction and Ongoing 802.11 Standard Work, Wi-Fi and Cellular Networks, WiMax, VoWi-Fi and Bluetooth, VoWi-Fi

and DECT, VoWi-Fi and Other Ongoing 802.x Wireless Project. [TB1: Ch11]

10. Mobile Ad Hoc Networks: Mobile Ad Hoc Networks, Physical Layer and MAC, Routing in Ad Hoc Networks. [TB1: Ch12]
11. Wireless Sensor Networks: Application, Plant Network Layouts, Plant Network Architecture, Sensor Subnet Selection, Functional Requirements. [TB1: Ch13]
12. Reliable Wireless Networks for Industrial Applications: Benefits of Using Wireless, Issues in Deploying Wireless Systems, Wireless Formats, Wireless Mesh Networks,
13. Industrial Applications of Wireless Mesh Networks [TB1: Ch14]
14. Applications and Technologies: Wireless Local Area Networks (WLAN) and PAN: Bluetooth, Zigbee, Conflict and Compatibility, Ultra-wideband Technology. [TB1: Ch15]

Teaching Methodology:

Lectures, Written Assignments, Semester Project.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Final Exam

Reference Materials:

1. Wireless Networking: Know It All By Praphul Chandra, Daniel M. Dobkin, Dan Bensky, Ron Olexa, David Lide, Farid Dowla: Publisher: Newnes [TB]
2. Wireless Communications & Networks (2nd Edition) by William Stallings. ISBN: 0131918354. Revised in 2009.

3. Wireless Networks: Design and Integration for LTE, EVDO, HSPA and Wimax by Clint Smith 3rd edition (2014). ISBN-10: 0071819835

ITEC-302 Cloud Computing			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand about fundamental concepts of distributed computing, how these techniques work inside today's most widely-used cloud computing systems	C	1
2. Understanding the basic principles of cloud deployment and Service models	C	2
3. Deployment of service models of Cloud through simulator/Vmware/Openstack etc.	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Distributed systems, Characteristics, Design goals, Types of distributed systems [TB2:1]
2. What is Cloud Computing ? Different perspectives, Properties and characteristics, Benefits [TB1: Preface]
3. Service and deployment models of Cloud computing, Service models: IaaS, PaaS, SaaS[TB1:2]
4. From IaaS to PaaS, PaaS and SaaS properties, Issues, characteristics and Implementation[TB9]
5. Modern On-Demand Computing, Amazon's Elastic Cloud, Amazon EC2 Service, Characteristics, Amazon SimpleDB, Amazon Simple Queue Service (Amazon SQS), Amazon CloudFront, Amazon Elastic Block Store (EBS) [TB1: 2]
6. Virtualization, From emulation to virtualization, Goals of virtualization, Types of Virtualization Hosted and Hypervisor, Server Virtualization, CPU Virtualization [TB1:4, 5]
7. Memory Virtualization: Background, Virtualization Techniques: Emulated TLB, Shadow Page Tables, Hardware supported Memory Virtualization, Nested Page Tables [6]
8. Virtualization Practicum. [TB:Appendix A]
9. Cloud Federation: Characterization and Conceptual Model, Voluntary or independent model, Horizontal, Vertical, Hybrid model, Architectural models for cloud federation: Semantics based, Market-oriented, Reservoir, Market-oriented, Reservoir, Service oriented architecture, Conceptual Model, Segments in a Federation [TB1: 5, 7]
10. Presence in the Cloud, Presence Protocols, Leveraging Presence, Presence Enabled, The Future of Presence, The Interrelation of Identity, Presence, and Location in the Cloud, Federated Identity Management, Cloud and SaaS Identity Management, Federating Identity, Identity-as-a-Service (IaaS), Compliance-as-a-Service (CaaS), The Future of Identity in the Cloud [TB1: 5]
11. Presence Protocols: XMPP, SIMPLE, SIP [8]
12. Privacy and Its Relation to Cloud-Based Information Systems, Privacy Risks and the Cloud, Cloud Security Challenges, Software-as-a-Service Security, Security Management (People), Security Governance, Risk Management, Risk Assessment, Security Portfolio Management, Security Awareness.[TB1:6]
13. End-User Access to Cloud Computing, YouTube, YouTube API Overview, Widgets, YouTube Player APIs, The YouTube Custom Player, YouTube Data API, Zimbra, Zimbra Collaboration Suite (ZCS), Facebook, Facebook Development, Zoho, Zoho CloudSQL, DimDim Collaborations[TB1:8]
14. Mobile Internet Device and the Cloud, [TB1: 9]
15. Cloud, IOT and Fog Computing [3,4]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, LLC (2010). ISBN 978-1-4398-0680-7[TB]
2. Distributed Computing: Principles and Applications Book by Mei-Ling L. Liu. ISBN-13: 978-0201796445
3. Internet of Things: Principles and Paradigms,book by rajkumar buyya and Amir vahid

DastjerDi(Eds.), publisher: Morgan kaufmann, ISBN: 978-0-12-805395-9
4. https://arxiv.org/abs/1601.02752
5. https://www.vmware.com/pdf/virtualization.pdf
6. https://www.vmware.com/pdf/virtualization_considerations.pdf
7. https://www.researchgate.net/publication/270581440_Cloud_Federation_characterization_and_conceptual_model
8. https://xmpp.org/
9. Architecting the Cloud: Design Decision for Cloud Computing Service Models (SAAS, PAAS and IAAS) Publisher: Wiley India Private Limited; 2014 edition, ISBN-10: 8126550333

ITEC-404 Internet of Everything			
Credit Hours:	3(3,0)	**Prerequisites:**	CS-3134

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the structure of Internet of Things	C	1
2. Understand the basic principles of implementing IoT with Fog and Cloud	C	2
3. Familiarity with Programming frameworks and Big Data analytics in real IoT Applications	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Internet of Things: An Overview, IoT emergence, Internet of EveryThing. [TB1:Ch 1, 3]
2. IoT infrastructures: Open Source Semantic web architecture for managing IoT resources in Cloud. [TB1:Ch 2]
3. Device/Cloud Collaboration Framework for Intelligence Applications IoT. [TB1: Ch,3]
4. Communication Protocols for IoT, Network Layers, Transport and Application layer [TB1: Ch 1, 13]
5. Fog Computing: Principles, Architectures, and Applications.[TB1: Ch 4]
6. Programming Frameworks for Internet of Things, Embedded device Programming languages, IoT programming languages [TB1: Ch 5]
7. Virtualization on Embedded Boards as Enabling Technology for the Cloud of Things[TB1: Ch 6]
8. Micro Virtual Machines (MicroVMs) for Cloud-Assisted Cyber-Physical Systems [TB1: Ch 7]
9. Design and Implement Scalable, Flexible, and open IoT solutions using Web technologies [TB4: Ch 1]
10. IoT data management and Analytics: IoT and Cloud, Real time Analytics in IoT and Fog Computing, [TB1: Ch 8, TB2 : Ch 1]

11. A Framework for Distributed Data Analysis for IoT [TB1:Ch 9]
12. Security and Privacy in the Internet of Things, TinyTO: Two-Way Authentication for Constrained
    Devices in the Internet of Things [TB2 : Ch 12]
13. Internet of Things Applications, Monitoring and Actuating, Internet of Vehicles and Applications[Tb1 : Ch 15, 16]
14. Cloud-Based Smart-Facilities Management, IoT Services Life Cycle, Scheduling and Resource Management, Validating Applications and use cases [TB1:Ch 17]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

2. Internet of Things: Principles and Paradigms 1st Edition, ISBN-10: 012805395X [TB]
3. Big Data Analytics: Tools and Technology for Effective Planning, Published October 26, 2017, ISBN 9781138032392
4. https://pdfs.semanticscholar.org/2006/d0fca0546bdeb7c3f0527ffd299cff7c7ea7.pdf
5. Building the Web of Things, ISBN-10:9781617292682

ITEC-420 Data Warehousing			
Credit Hours:	3(3,0)	**Prerequisites:**	Database Systems

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the structure of modern data warehouse models	C	1
2. Understand the basic principles of designing the Data ware house	C	2
3. Familiarity with key algorithms for efficiency and efficacy	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Data Warehousing: Brief History, Characteristics, Architecture, Data Staging and ETL, Multidimensional Model, Meta-data, Accessing Data Warehouse, ROLAP, MOLAP, and HOLAP. [TB1: Ch. 1]
2. Data Warehouse System Lifecycle: Risk Factors, Top-Down vs Bottom-Up, Data Mart Design Phases, Methodological Framework – Data-Driven, Requirement-Driven; Testing Data Marts. [TB1: Ch. 2]
3. Analysis and Reconciliation of Data Sources: Inspecting and Normalization Schemata, Integration Problems, Integration Phases, Defining Mapping. [TB: Ch. 3]

4. User Requirement Analysis: Interviews, Glossary-based Requirement Analysis,
5. Additional Requirements. [TB: Ch. 4]
6. Conceptual Modeling: Dimensional Fact Model, Events and Aggregation, Temporal Aspects, Overlapping Fact Shcemata, Formalizing the Dimensional Fact Model. [TB: Ch. 6]
7. Conceptual Design: ER Schema-based Design, Relational Schema-based Design, XML Schema-based Design, Mixed-approach Design. Requirement-driven Approach Design. [TB: Ch. 6]
8. Workload and Data Volume [TB1: Ch. 7]
9. Logical Modeling: MOLAP and HOLAP Systems, ROLAP Systems, Views, Temporal Scenarios. [TB1: Ch. 8]
10. Logical Design: From Fact Schemata to Start Schemata, View Materialization, View Fragmentation. [TB1: Ch. 9]
11. Data-staging Design: Population Reconciled Databases, Cleansing Data, Populating Dimensional Tables, Populating Fact Tables, Populating Materialized View
    Indexes for the Data Warehouse: B*-Tree Indexes, Bitmap Indexes, Projection Index-es, Join & Star Indexes, Spatial Indexes, Join-Algorithm. [TB1: Ch. 11]
12. Physical Design: Optimizers, Index Selection, Splitting a Database into Tablespaces, Allocating Data Files, Disk Block Size. [TB1: Ch. 12]
13. Data Warehouse Project Documentation: Data Warehouse Levels, Data Mart Level, Fact Level
14. Case Studies, Tools for Data Warehousing: MS SQL and Teradata

Teaching Methodology:

Lectures, Semester Project, Assignments, Presentations

Course Assessment:

Sessional Exam, Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Data Warehouse Design: Modern Principles and Methodologies by Matteo Golfarelli and Stefano Rizzi, McGraw-Hill Osborne Media; 1st Edition (2009). ISBN-10: 0071610391
2. Building the Data Warehouse by William H. Inmon, Wiley; 4th Edition (2005). ISBN-10: 0764599445
3. The Data Warehouse Lifecycle Toolkit : Expert Methods for Designing, Developing, and Deploying Data Warehouses by Ralph Kimball, Laura Reeves, Margy Ross and Warren Thornthwaite, Wiley (August 13, 1998). ISBN-10: 0471255475
4. Data Warehousing Fundamentals for IT Professionals by Paulraj Ponniah, Wiley; 2nd Edition (2010). ISBN-10: 0470462078
5. • Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and Amit Asthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419

ITEC-406 Semantic Web			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
Having successfully completed this course, the student will be able to:	**Domain**	**BT Level***

1- Understand the concept structure of the Semantic Web technology and how this technology revolutionizes the World Wide Web and its uses.		3
2- Understand the concepts of metadata, semantics of knowledge and resource, ontology, and their descriptions in XML-based syntax and web ontology language (OWL).		3
3- Describe logic semantics and inference with OWL.		3
4- Understand Semantic Web query languages (SPARQL).		2
5- Use ontology engineering approaches in semantic applications.		3
6- Program semantic applications with Java and Jena API.		3

Course Content:

1- Semantic Web – Introduction and Vision , Structured Web Documents
2- XML, RDF, RDF-S, Web Ontology Language
3- WL, Ontology Engineering (Protégé) ,Discovering Information
4- Querying (SPARQL) Semantic Web Applications (E-learning, Web services)
5- Description Logic Reasoning (Fact++); Rules (SWRL) Building Semantic Web Applications (Apache Jena Framework)
6- Building Semantic Web Applications
7- State-of-the-art in Semantic Web community (Linked data and applications)

Teaching Methodology:

Lecturing, Written Assignments, Project,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1.A Semantic Web Primer third edition Grigoris Antoniou, Paul Groth, Frank van Harmelen, Rinke Hoekstra[TB] ISBN:0262018284 9780262018289

2. The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management by Michael C. Daconta Leo J. Obrst and Kevin T. Smith

3. Explorer's Guide to the Semantic Web by Thomas B. Passin

ITEC-407 Knowledge Management			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Appraise current thought on knowledge management in the light of	C	2

contemporary debates on knowledge productivity, strategic capability and organizational learning.		
2. Apply theories of knowledge management relevant to current workplace practice.	C	3
3. Apply the tools and techniques of knowledge management.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1- History and paradigms of knowledge management; Types of knowledge: Explicit Knowledge, Tacit Knowledge, Embedded Knowledge, Embroiled knowledge, Embodied knowledge, Encoded knowledge, Encultured knowledge; Organizational Internal & External Knowledge; Managers' Knowledge; Personal knowledge. Knowledge Economy: Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents; Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies. [TB1: Ch. 1, 2, 4]

2- KM Processes: Knowledge Discovery/ Detection, Knowledge Capture and Codification, Knowledge Organization, Knowledge Sharing, Explicit Knowledge Sharing, Knowledge transfer, Knowledge Acquisition, Knowledge Verification, Knowledge Utilization, Knowledge Creation, Knowledge Reuse; [TB1: Ch. 3]

3- KM Frameworks and Models: The SECI Model, Alen Frost's Model, Boisot's KM Model, Hedlund's KM Model, Earl's KM Model, Carayannis's KM Model, Wiig's KM Model, Edvinsson's Model of Intellectual Capital, Snowden's KM Model, Inkpen&Dinur's KM Model. [TB1: Ch. 4]

4- KM Frameworks and Models: Van Buren's Model of IC Management, Bukowitz& Williams's KM Model, Gamble & Blackwell's KM Model, Demerest's KM Model, Frid's KM Model, Stankosky&Baldanza's KM Framework, Kogut& Zander's KM Model, Botha et. al. KM Model, Integrated Knowledge Management Model. [TB1: Ch. 4]

5- Knowledge Capture and Codification: Tacit Knowledge Capture at the Individual, Group, and Organizational Levels, xplicit Knowledge Codification, Cognitive Maps, Decision Trees, Knowledge Taxonomies, The Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence; Strategic and Practical Implications of Knowledge Capture and Codification [TB2: Ch. 4]

6- Knowledge Sharing and Communities of Practice: Sociograms and Social Network Analysis, Knowledge-Sharing Communities, Types of Communities, Roles and Responsibilities in CoPs, Knowledge Sharing in Virtual CoPs, Obstacles to Knowledge Sharing, Strategic and Practical Implications of Knowledge Sharing. [TB2: Ch. 5]

7- Knowledge Application: Knowledge Application at the Individual Level, Characteristics of Individual Knowledge Workers, Bloom ' s Taxonomy of Learning Objectives, Task Analysis and Modeling, Knowledge Application at the Group and Organizational Levels, Knowledge Reuse, Knowledge Repositories, E-Learning and Knowledge Management Application, Strategic & Practical Implications of Knowledge Application. [TB3: Ch.6]

8- The Role of Organizational Culture: Different Types of Cultures, Organizational Culture Analysis, The Effects of Culture on Individuals, Organizational Maturity Models, KM Maturity Models, CoP Maturity Models, Transformation to a Knowledge-Sharing Culture, Impact of a Merger on Culture, Impact of Virtualization on Culture, Strategic and Practical Implications of Organizational Culture. [TB2: Ch.7]

9- Knowledge Management Tools: Knowledge Capture and Creation Tools, Content Creation Tools, Data Mining and Knowledge Discovery, Blogs, Mashups, Content Manage-

ment Tools, Folksonomies and Social Tagging/Bookmarking, Personal Knowledge Management (PKM), Knowledge Sharing and Dissemination Tools, Groupware and Collaboration Tools, Wikis, Social Networking, Web 2.0, and KM 2.0, Knowledge Acquisition and Application Tools, Intelligent Filtering Tools, Adaptive Technologies, Strategic and Practical Implications of KM Tools and Techniques. [TB2: Ch. 8]

10- Knowledge Management Strategy: Developing a Knowledge Management Strategy, Knowledge Audit, Gap Analysis, The KM Strategy Road Map, Balancing Innovation and Organizational Structure, Types of Knowledge Assets Produced. [TB2: Ch. 9]

11- The Value of Knowledge Management: KM Return on Investment (ROI) and Metrics, The Benchmarking Method, The Balanced Scorecard Method, The House of Quality Method, The Results-Based Assessment Framework, Measuring the Success of Communities of Practice. [TB2: Ch. 10]

12- Organizational Learning and Organizational Memory: How Do Organizations Learn and Remember? Frameworks to Assess Organizational Learning and Organizational Memory, The Management of Organizational Memory, Organizational Learning, The Lessons Learned Process, Organizational Learning and Organizational Memory Models, A Three-Tiered Approach to Knowledge Continuity. [TB2: Ch. 11]

13- The KM Team: Major Categories of KM Roles, Senior Management Roles, KM Roles and Responsibilities within Organizations, The KM Profession, The Ethics of KM. [TB2: Ch. 12]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Essentials of Knowledge Management: Concepts, Theories and Practices by M. A. Pasha & S. Pasha, Innovators Knowledge Services (2012). ISBN:978-969-9791-04-8
2. Knowledge Management In Theory And Practice by KimizDalkir, The MIT Press; 3nd Edition (March 4, 2011). ISBN-10: 0262015080
3. The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms by AmritTiwana, Prentice Hall; 2nd Edition (August 29, 2002). ISBN-10: 013009224X
4. Principles of Knowledge Management: Theory, Practice and Cases by ElieGeisler and NilminiWickramasinghe, M.E.Sharpe (January 15, 2009). ISBN-10: 0765613220
5. Knowledge Management: Concepts, Methodologies, Tools and Applications (6-volume set) by Murray E. Jennex, IGI Global; Reprint Edition (August 10, 2007). ISBN-10: 1599049333

ITEC-304 Network Design and Management			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
4. **Describe** the importance of network design top down approach.	C	2
5. **Explain** the matrices necessary to accomplish best network design.	C	2

6. **Identify** various internetworking devices and protocols, and their functions in a network.	C	3
7. **Analyze** working and performance of key technologies in network design.	C	3
8. **Build** Computer Network on the base of network design best practices	P	3

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Analyzing Business Goals and Constraints: Using a Top-Down Network Design Methodology, Analyzing Business Goals, Analyzing Business Constraints. Analyzing Technical Goals and Tradeoffs: Scalability, Availability, Network Performance, Security, Manageability, Usability, Adaptability, Affordability, Making Network Design Tradeoffs. [TB1: Ch. 1, 2]
2. Characterizing the Existing Internetwork: Characterizing the Network Infrastructure, Checking the Health of the Existing Internetwork. Characterizing Network Traffic: Characterizing Traffic Flow, Characterizing Traffic Load, Characterizing Traffic Behavior, Characterizing Quality of Service Requirements. [TB1: Ch. 3, 4]
3. Designing a Network Topology: Hierarchical Network Design, Redundant Network Design Topologies, Modular Network Design, Designing a Campus Network Design Topology, Virtual LANs, Wireless LANs, Redundancy and Load Sharing in Wired LANs, Server Redundancy, Workstation-to-Router Redundancy, Designing the Enterprise Edge Topology, Secure Network Design Topologies. [TB1: Ch. 5]
4. Designing Models for Addressing and Numbering: Guidelines for Assigning Network Layer Addresses, Designing a Model for Naming. [TB1: Ch. 6]
5. Selecting Switching and Routing Protocols: Making Decisions as Part of the Top Down Network Design Process, Selecting Switching Protocols, Selecting Routing Protocols, IP Routing. [TB1: Ch. 7]
6. Developing Network Security Strategies: Network Security Design, Security Mechanisms, Modularizing Security Design, [TB1: Ch. 8]
7. Developing Network Management Strategies: Network Management Design, Network Management Architectures, Selecting Network Management Tools and Protocols. [TB1: Ch. 9]
8. Physical Network Design: Selecting Technologies and Devices for Campus Networks: LAN Cabling Plant Design, LAN Technologies, Selecting Internetworking Devices for a Campus Network Design, Example of a Campus Network Design. [TB1: Ch. 10]
9. Selecting Technologies and Devices for Enterprise Networks: Remote-Access Technologies, Selecting Remote-Access Devices for an Enterprise, WAN Technologies, Example of a WAN Design. [TB1: Ch. 11]
10. Testing Network Design: Using Industry Tests, Building and Testing a Prototype Network System, Writing and Implementing a Test Plan for Network Design, Tools for Testing a Network Design. [TB1: Ch. 12]
11. Optimizing Network Design: Optimizing Bandwidth Usage with IP Multicast Technologies, Reducing Serialization Delay, Optimizing Network Performance to Meet Quality of Service Requirements, Cisco IOS Features for Optimizing Network Performance. Documenting Network Design: Responding to a Customer's Request for Proposal, Contents of a Network Design Document [TB1: Ch. 13, 14].

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Top-Down Network Design by Priscilla Oppenheimer, Cisco Press; 3rd Edition (September 3, 2010). ISBN-10: 1587202832 (TB1) 2. Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009). ISBN-10: 142009159X (TB2) 3. Networks: Design and Management by Steven Karris, Orchard Publications (August 2002). ISBN-10: 0970951140 4. Network Design: Management and Technical Perspectives by Teresa C. Piliourasand KornelTerplan, CRC Press (August 19, 1998). ISBN-10: 0849334047

ITEC-409 Business Intelligence and Analytics			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Enhance students' understanding regarding the evolution, need and benefits of business intelligence.	C	2
2. Students will also learn about various technical aspects of BI and understand the processes involving in planning, designing, building and maintaining BI environment.	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Business Intelligence - An Introduction, Value Drivers, Performance Metrics and Key Performance Indicators, Use Cases for BI. [TB: Ch. 1, 2]
2. BI Success Factors. Strategic Versus Tactical Planning, BI Strategy and Plan. [TB: Ch. 3,4]
3. BI Environment, BI and Analytics Platform and Strategy, Organizational BI Framework, Services & Systems Evaluation. [TB: Ch. 5]
4. Business Process and Information Flow: Information Need & Flow, Information Processing & Information Flow, Information Flow Model, Modeling Frameworks. [TB: Ch. 6]
5. Data Requirements Analysis: Business Uses of Information, Metrics: Facts, Qualifiers, and Models, Defining Business Rules, Data Requirement Analysis, Assessing Suitability. [TB: Ch. 7]
6. Data Warehouses and the Technical BI Architecture: Data Modeling and Analytics, Analytical Platforms, Operational Data Stores. Business Metadata: What is Metadata? Types of Metadata, Semantics Metadata Processes for Business Analytics. [TB: Ch. 8, 9]

7. Data Profiling: Data Sources, Data Profiling Activities, Data Model Inference, Attribute Analysis, Relationship Analysis, Management Issues. [TB: Ch. 10]
8. Business Rules: The Value of Proposition of Business Rules, The Business Rules Approach, Defining Business Rules, Business Rule Systems, Sources of Business Rules, Management Issues. [TB: Ch. 11]
9. Data Quality: Virtuous Cycle of Data Quality, Types of Data Flow, Business Impacts of Data Flow, Dimensions of Data Quality, Data Quality Assessment, Data Quality Rules, Data Quality Monitoring and Improvement, Data Quality for Business Analytics, Data Cleansing. [TB: Ch. 13]
10. Data Integration: Improving Data Accessibility, Extracting/ Transformation/Loading, Data Latency and Data Synchrony, Data Replication and Change Data Capture, Data Integration and Cloud Computing, Information protection, Merge/Purge and Record Consolidation. [TB: Ch. 13]
11. Deriving Insight from Data: Customer Profiles, Behavior, and Lifetime Value; Demographics, Psychographics, Geographic; Geographic Data, Behavior Analysis. [TB: Ch. 15, 16]
12. Knowledge Discovery & Delivery: Business Drivers, KD Virtuous Cycle, Direct Versus Unidirectional Knowledge Discovery, Data Mining Activities, Data Mining Techniques. [TB: Ch. 17]
13. BI User Types, Standards Reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, Dimensional Analysis, Alerts/ Notifications, Visualizations, Scorecards and Dashboards, Geographical Visualizations, Integrated Analysis. [TB: Ch. 18]
14. Installations, Configuring and Maintaining the BI Server, Creating Repositories from Relational Sources, Creating Repositories from OLAP Data Sources, Creating Reports Using Answers and Dashboards.

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Business Intelligence by David Loshi, Morgan Kaufmann; 2nd Edition (October 31, 2012). ISBN-10: 0123858895 [TB]
2. Oracle Business Intelligence 11g Developers Guide by Mark Rittman, McGraw-Hill Osborne Media; 1st Edition (September 18, 2012). ISBN-10: 0071798749
3. Delivering Business Intelligence with Microsoft SQL Server 2012 3/E by Brian Larson, McGraw-Hill Osborne Media; 3rd Edition (March 16, 2012). ISBN-10: 0071759387
4. Business Intelligence by Elizabeth Vitt, Michael Luckevich, and StaciaMisner, Microsoft Press (December 22, 2008). ISBN-10: 073562660X

ITEC-410 Data Mining			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the structure of modern data mining models	C	1
2. Understand the basic principles of implementing data mining models	C	2
3. Familiarity with key algorithms for efficiency and efficacy	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1- Data-Mining Concepts: Introduction, Data-Mining Process, Large Data Sets, Data Warehouses for Data Mining, Business Aspects Data Mining. [TB1: Ch. 1]
2- Preparing the Data: Raw Data- Representation, Characteristics, Transformation; Missing Data, Time-Dependent Data, Outlier Analysis. [TB1: Ch. 2]
3- Data Reduction: Dimensions of Large Data Sets, Feature Reduction, Relief Algorithm, Entropy Measure for Ranking Features, PCA, Value Reduction, Feature Discretization: Chi Merge Technique, Case Reduction. [TB1: Ch. 3]
4- Learning From Data: Learning Machine, SLT, Types of Learning Methods, Common Learning Tasks, SVMs, kNN: Nearest Neighbor Classifier, Model Selection versus Generalization, Model Estimation. [TB1: Ch. 4]
5- Statistical Methods: Statistical Inference, Assessing Differences in Data Sets, Bayesian Inference, Predictive Regression, ANOVA, Logistic Regression, Log-Linear Models, LDA. [TB1: Ch. 5]
6- Decision Trees and Decision Rules: Decision Trees, Generating & Pruning Decision Tree, CART Algorithm & Gini Index, Limitations of Decision Trees and Decision Rules. TB1: Ch. 6]
7- Artificial Neural Networks: Model of an Artificial Neuron, Architectures of ANNs, Learning Process, Learning Tasks Using ANNs, Multilayer Perceptron's, Competitive Networks and Competitive Learning, SOMs. [TB1: Ch.7]
8- Ensemble Learning: Ensemble-Learning Methodologies, Combination Schemes for Multiple Learners, Bagging and Boosting, Ada Boost. [TB: Ch. 8]
9- Cluster Analysis: Clustering, Similarity Measures, Agglomerative Hierarchical Clustering, Partitional Clustering, Incremental Clustering, DBSCAN Algorithm. BIRCH Algorithm, Agglomerative Hierarchal and Partition Clustering Algorithms, Clustering Validation. [TB: Ch. 9]
10- Association Rules: Market-Basket Analysis, Algorithm Apriori, From Frequent Item-sets to Association Rules, Improving the Efficiency of the Apriori Algorithm, FP Growth Method, Associative-Classification Method, Multidimensional Association–Rules Mining. [TB: Ch. 10]
11- Web Mining and Text Mining: Web Mining, Web Content, Structure, and Usage Mining, HITSC and LOGSOM Algorithms, Mining Path–Traversal Patterns, PageRank Algorithm, Text Mining, Latent Semantic Analysis. [TB: Ch. 11]
12- Genetic Algorithms: Fundamentals of GAs, Optimization Using GAs, Schemata, TSP, Machine Learning Using GAs, GAs for Clustering. [TB: Ch. 13]
13- Fuzzy Sets and Fuzzy Logic: Fuzzy Sets, Fuzzy-Set Operations, Extension Principle and Fuzzy Relations, Fuzzy Logic and Fuzzy Inference Systems, Multifactorial Evaluation, Extracting Fuzzy Models from Data, Data Mining and Fuzzy Sets
14- Visualization Methods: Perception and Visualization, Scientific Visualization and In-

formation Visualization, Parallel Coordinates, Radial Visualization, Visualization Using Self-Organizing Maps, Visualization Systems for Data Mining

15- Data Mining Tools: Weka, CBA and Yale, etc.

Teaching Methodology:

Lectures, Semester Project, Assignments, Presentations, Interactive sessions

Course Assessment:

Sessional Marks(Assignments, Quizzes, Project, Presentations), Mid Exam, Final Exam

Reference Materials:

1. Data Mining: Concepts, Models, Methods, and Algorithms by Mehmed Kantardzic, Wiley-IEEE Press; 2nd Edition (August 16, 2011). ISBN-10: 0470890452
   Reference Material:
2. Data Mining: Concepts and Techniques, Third Edition (The Morgan Kaufmann Series in Data Management Systems) by Jiawei Han, Micheline Kamber and Jian Pei, Morgan Kaufmann; 3rd Edition (2011). ISBN-10: 0123814790
3. Principles of Data Mining (Adaptive Computation and Machine Learning) by David J. Hand, Heikki Mannila and Padhraic Smyth, A Bradford Book (August 1, 2001). ISBN-10: 026208290X
4. Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and Amit Asthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419
5. Information-Statistical Data Mining: Warehouse Integration with Examples of Oracle Basics (The Springer International Series in Engineering and Computer Science) by Bon K. Sy and Arjun K., Springer; 1st Edition (2003). ISBN-10: 1402076509
6. Building the Data Warehouse by William H. Inmon, Wiley; 4th Edition (2005). ISBN-10: 0764599445**C**

ITEC-411 Enterprise Resource Planning			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Learn ERP technologies	C	2
2. How to implement ERP processes to business	C	2
3. Auditing ERP	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Enterprise Resource Planning Systems. [TB. Ch. 1]
2. ERP Technology. [TB. Ch. 2]
3. ERP and Business Process Reengineering. [TB. Ch. 3]

4. Systems Diagramming and the Process Map. [TB. Ch. 41]
5. ERP Life Cycle: Planning and Package Selection. [TB. Ch. 5]
6. ERP Life Cycle: Implementation and Operation and Maintenance. [TB. Ch. 6]
7. ERP Sales, CRM and Knowledge Management. [TB. Ch. 7]
8. ERP Financials. [TB. Ch. 8]
9. Human Capital Management, Self-Service and Outsourcing. [TB. Ch. 9]
10. Case studies

Teaching Methodology:

Lectures, Labs, Labs Assignments, Semester Project, Presentations,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Modern ERP: Select, Implement & Use Today's Advanced Business Systems by Marianne Bradford, lulu.com (October 19, 2009). ISBN-10: 0557012910.
2. Managerial Issues of Enterprise Resource Planning Systems by David Olson, McGraw-Hill/Irwin; 1st Edition (September 10, 2003). ISBN-10: 0072861126
3. Enterprise Resource Planning by Bret Wagner by Ellen Monk, Course Technology; 3rd Edition (February 4, 2008). ISBN-10: 1423901797
4. ERP Systems by AartiBatra, I K International Publishing House (February 15, 2010). ISBN-10: 9380578148

ITEC-412 Network Programming			
Credit Hours:	3(3,0)	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1: Identify and describe the purpose of each component of the TCP/IP protocol suite	C	4
2: Learn to develop large and complex client-server applications using TCP/IP	C	5
3**:** Learn socket programming in Linux and Windows environment developing client/server applications using C language	C	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction and TCP/IP: A Simple Daytime Client, Protocol Independence, Roadmap to Client/Server [CH.1]
2. BSD Networking, Unix standard, 64-bit Architectures. [Ch. 1]
3. Transport Layer details: UDP, TCP, SCTP, connections, port numbers, buffers etc [Ch. 2]
4. Sockets Introduction and Elementary TCP Sockets : Socket Address Structure, Argu-ments and Functions [Ch.3]

5. TCP/IP client server Application [Ch. 3]
6. I/O Multiplexing: The SELECT and POLL function with all aspects. [Ch. 6]
7. Socket Options: getsockopt and setsockopt functions, default [Ch. 7]
8. Socket states, generic, IPv4, IPv6, ICMPv6 socket options etc. [Ch. 7]
9. Elementary UDP Sockets: sendto and recvfrom functions, UDP echo server and client, summary of UDP. [Ch. 8]
10. Elementary Name and Address Conversions. [Ch. 9]
11. IPv4 and IPv6 Interoperability. [Ch. 10]
12. Daemon Processes and advanced I/O functions. [Ch. 12, 13]
13. Non-blocking I/O and ioctl operations. [Ch. 15,16]
14. Routing Sockets, Broadcasting, Multicasting. [Ch. 17,18, 19
15. Threads and Raw Sockets [Ch. 23, 25]
16. Data link Access & Streams [Ch. 26, 33]

Teaching Methodology:

Lectures, Labs, Labs Assignments, Semester Project, Presentations,

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1- UNIX Network Programming Volume I by Richard Steven, Prentice Hall; 2nd Edition (September 4, 1998).ISBN-10: 0130810819
2- Windows System Programming by Johnson M. Hart, Addison-Wesley Professional; 4th Edition (February 26, 2010). ISBN-10: 0321657748
3- The Linux Programming Interface: A Linux and UNIX System Programming Hand-book by Michael Kerrisk, No Starch Press; 1st Edition (October 28, 2010). ISBN-10: 1593272200
4- Linux Kernel Development by Robert Love, Addison-Wesley Professional; 3rd Edition (July 2, 2010). ISBN-10: 0672329468
5- System Software: An Introduction to Systems Programming by Leland L. Beck, Addison Wesley, (3rd Edition) (1996). ASIN: B0084YEEWO

ITEC-413 Information Systems and Audit			
Credit Hours:	3(3,0)	**Prerequisites:**	CMP-3450 (Database Systems)

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
CLO-1: Understand the concepts and standards related to the discipline of Information System Audit.	C	1
CLO-2: Analyze and Audit Information Systems	C	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Introduction to Auditing, Assurance and Internal Control: Different Types of Audit, Audit Risks, IT Audit, Role of Audit Committee, Internal Audit Control. [TB1:1]
2. IT Governance and Management: IT Governance Practices for Executives and Boards of Directors, IT Strategic Planning, Policies, Processes, Procedures, and Standards, Risk Man-

agement. IT Management Practices. [TB2: Ch. 2]

3. Organization Structure and Responsibilities, Business Continuity Planning, Auditing IT Governance. [TB2: Ch. 2]
4. The Audit Process: Audit Management, ISACA Auditing Standards, Risk Analysis, [TB2: Ch. 3]
5. Internal Controls, Performing an Audit, Control Self-Assessment, Implementation of Audit Recommendations [TB2: Ch. 3]
6. IT Life Cycle Management: Business Realization, Project Management, The Software Development Life Cycle (SDLC). [TB2: Ch. 4]
7. Infrastructure Development and Implementation, Maintaining Information Systems, Business Processes, Application Controls. [TB2: Ch. 4]
8. Auditing the Software Development Life Cycle, Auditing Business Controls, Auditing Application Controls. [TB2: Ch. 4]
9. IT Service Delivery and Infrastructure, Information Systems Operations, Information Systems Hardware, Information Systems Architecture and Software. [TB2: Ch. 5]
10. Disaster Recovery Planning, Auditing IS Infrastructure and Operations. [TB2: Ch. 5]
11. Information Asset Protection: Information Security Management, Logical Access Controls. [TB2: Ch. 6]
12. Network Security Controls, Environmental Controls, Physical Security Controls, Auditing Asset Protection [TB2: Ch. 6]
13. Over view of Popular Methodologies, Framework and Guidelines [TB2: Appendix B]
14. Overview of Computer-Assisted Audit Tools and Techniques: Application Controls, Testing Computer Application Controls, Computer- Aided Audit Tools and Techniques for Testing Controls. [TB1: Ch. 7]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Auditing Information Systems: Enhancing Performance of the Enterprise, Abraham Nyirongo, Trafford, 2015.
2. Information Systems Control and Audit, Ron Weber, Dorling Kindesley Pearson Education, 2014
3. CISA® Certified Information Systems Auditor All-in-One Exam Guide, Peter Gregory, 3rd Edition, McGraw-Hill Education, 2016
4. . Information Systems Auditing and Assurance by James A. Hall and Tommie Singleton, South-Western College Pub; 2nd Edition (July 27, 2004). ISBN-10: 0324191995
5. CISA® Certified Information Systems Auditor All-in-One Exam Guide By: Peter Gregory, McGraw-Hill Osborne Media; 2nd Edition (August 9, 2011). ISBN-10: 0071769102
6. Information Technology Control and Audit, Third Edition by Sandra Senft and Fre-derick Gallegos, Auerbach Publications; 3rd Edition (2008). ISBN-10: 1420065505
7. Managing the Audit Function: A Corporate Audit Department Procedures Guide by Michael P. Cangemi and Tommie W. Singleton, Wiley; 3rd Edition (2003). ISBN-10: 0471281190
8. COBIT 4.1 by IT Governance Institute, ISACA (2007). ISBN-10: 1933284722

ITEC-414 Routing And Switching			
Credit Hours:	3(3,0)	**Prerequisites:**	**Computer Network**

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	Domain	BT Level*
1. Understand the switching details and mechanism	C	1
2. Understanding of the architecture and operating principle of router	C	2
3. Operations of wireless LANs, WANs	C	2
4. Solutions and effectiveness of routing protocols and configurations	A	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Ethernet Basic: Ethernet Layer 1, Ethernet Layer 2, Switching and Bridging Logic, SPAN and RSPAN. [TB: Ch. 1]
2. Virtual LANs and VLAN Trunking: VLANs, VLAN Trunking Protocols, VLAN Trunking: ISL and 802.1Q, Configuring PPPoE. [TB: Ch. 2]
3. Spanning Tree Protocol: 802.1d Spanning Tree Protocol, Optimizing Spanning Tree, Protecting STP, Troubleshooting Complex Layer 2 Issues. [TB: Ch. 3]
4. IP Addressing: IP Addressing &Subnetting, CIDR, Private Addressing, and NAT. [TB: Ch. 4]
5. IP Services: ARP, Proxy ARP, Reverse ARP, BOOTP, and DGCP; HSRP, VRRP,and GLBP; Syslog, Web Cache Communication Protocol, Implementing and Using: IP-SLA, NetFlow, Router IP Traffic Export, FTP, Embedded Event Manager, Remote Monitoring, TFTP Server, Secure Copy Protocol, HTTP and HTTPs Access, Telnet Access, SSH Access. [TB: Ch. 5]
6. IP Forwarding (Routing): IP Forwarding, Muti-layer Switching, Policy Routing, Optimized Edge Routing and Performance Routing. [TB: Ch. 6]
7. EIGRP: Basic States, EIGRP Convergence, EIGRP Configuration, [TB: Ch. 7]
8. OSPF: OSPF Database Exchange, OSPF Design and LSAs, OSPF Configurations, Virtual Link Configuration, Configuring OSPF Authentication, OSPF Stub Router Configuration. [TB: Ch. 8]
9. IGP Routing: Routing Map, Prefix Lists, and Administrative Distance; Router Redistribution, Router Summarization, Default Routes, Troubleshooting Complex Layer 3 Is-sues. [TB: Ch. 9]
10. Fundamentals of BGP Operations: Building BGP Neighbor Relationships, Building the BGP Table, Building the IP Routing Table. [TB: Ch. 10]
11. BGP Routing Policies: Routing Filtering and Routers Summarization, BGP Path Attributes and the BGP Decision Processes, Configuring BGP Policies. [TB: Ch. 11]
12. Wide Area Network: Point-to-Point Protocol, Frame Relay Concepts, Frame Relay Configuration. [TB: Ch. 15]

13. IP Multicasting: Need of Multicasting, Multicasting IP Addresses, Managing Distribution of Multicast Traffic with IGMP, LAN Multicast Optimizations. [TB: Ch. 16]
14. IP Multicast Routing: Basic, Dense-Mode Routing Protocols, LAN- Specific Issues with PIM-DM and PIM-SM, Sparse-Mode Routing Protocols. [TB: Ch. 17]

Teaching Methodology:

Lectures, Written Assignments, Semester Project.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Final Exam

Reference Materials:

1. CCIE Routing and Switching Certification Guide (4th Edition) by Wendell Odom, Rus Healy and Denise Donohue, Cisco Press; 4th Edition
2. Packet Guide to Routing and Switching by Bruce Hartpence, O'Reilly Media (Sep-tember 3, 2011). ISBN-10: 1449306551
3. CCIE Routing and Switching v4.0 Quick Reference by Brad Ellis, Jacob Uecker and Steven Means, Cisco Press (October 4, 2010). ASIN: B00452V45O

ITEC-415 Business Process Management			
Credit Hours:	3(3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
4. Understand the key Terms and concepts in Business Process Management.	C	2
5. Learn about the major methodologies and techniques for implementing BPM.	C	2
6. Learn what a BPM management and process-centric organization is and how it works.	C	2
7. Understand the metrics and measurements critical to managing processes	C	3
8. Learn how to identify critical processes.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction: Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. [TB: Ch. 1]
2. Evolution of Enterprise Systems Architectures: Traditional Application Development, Enterprise Applications and their Integration, Enterprise Modeling and Process Orientation, Workflow Management, Enterprise Services Computing. [TB: Ch. 2]
3. Business Process Modeling: Foundation, Conceptual Model and Terminology, Abstraction Concepts, From Business Functions to Business Processes, Activity Models and Activity Instances, Process Models and Process Instances, Process Interactions, Modeling

Process Data, Modeling Organization, Modeling Operation, Business Process Flexibility, Architecture of Process Execution Environments. [TB: Ch. 3]

4. Process Orchestrations: Control Flow Patterns, Petri Nets, Event-driven Process Chains, Workflow Nets, Graph-Based Workflow Language, Business Process Model and Notation. [TB: Ch. 4]
5. Process Choreographies: Motivation and Terminology, Development Phases, Process Choreography Design, Process Choreography Implementation, Service Interaction Patterns, Choreography Modeling in BPMN. [TB: Ch. 5]
6. Properties of Business Processes: Data Dependencies, Object Lifecycle Conformance, Structural Soundness, Soundness, Relaxed Soundness, Weak Soundness, Lazy Soundness, Soundness Criteria Overview. [TB: Ch. 6]
7. Business Process Management Architectures: Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes: Case Handling. [TB: Ch. 7]
8. Business Process Management Methodology: Dependencies between Processes, Methodology Overview, Phases in Detail. [TB: Ch. 7]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2nd Edition (May 3, 2012). ISBN-10: 3642286151.[TB]
2. Business Process Management Common Body Of Knowledge by Yvonne LedererAntonucci, et. al., CreateSpace Independent Publishing Platform (March 8, 2009). ISBN-10: 1442105666
3. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Edition (January 21, 2011). ISBN-10: 3642151892
4. Business Process Management, Second Edition: Practical Guidelines to Successful Implementations by John Jeston and Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
5. Process Management: Practical Guidelines to Successful Implementation by T.S. Malik, Global India Publications Pvt Ltd; 1st Edition (December 31, 2009). ISBN-10: 9380228368
6. Business Process Management: Practical Guidelines to Successful Implementations by John Jeston& Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
7. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody-Cassidy Press (October 17, 2011). ISBN-10: 0982368119
8. Workflow Modeling: Tools for Process Improvement and Application Development by Alec Sharp and Patrick McDermott, Artech House; 2nd Edition (October 31, 2008). ISBN-10: 1596931922
9. Process Analysis and Improvement: Tools and Techniques by Seppanen, Marvic S., Kumar, Sameer & Chandra, Charu (2005). McGraw-Hill
10. Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals (The MK/OMG Press) by Paul Harmon and Business Process Trends, Morgan Kaufmann; 2nd Edition (July 27, 2007). ISBN-10: 0123741521

ITEC-416 Artificial Intelligence			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Knowledge of current progresses related to AI	C	1
2. Introduction of many advances subjects taught at MS and PhD level	C	2
3. Introduction of game theory	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction: What is AI, Foundations of AI, History of AI. Intelligent Agents: Agents and Environments, The Nature of Environments, The Structure of Agents [TB: Ch. 1, 2]
2. Problem Solving by Searching: Problem Solving Agents, Searching for Solutions, Uninformed Search Strategies.
3. Breadth-First Search, Depth-First Search, Depth-limited Search, Iterative Deepening, Depth-first Search, Comparison of Uninformed Search Strategies. [TB: Ch. 3]
4. Informed Search and Exploration: Informed (Heuristic) Search Strategies: Greedy Best-first Search, A* Search, Heuristic Functions, Local Search Algorithms and Optimization Problems. [TB: Ch. 4]
5. Constraint Satisfaction Problems: Backtracking Search for CSPs, Local Search for CSPs. Adversarial Search: Games, Minimax Algorithm, Alpha-Beta Pruning. [TB: Ch. 5, 6]
6. Reasoning and Knowledge Representation: Introductions to Reasoning and Knowledge Representation, Propositional Logic, First Order Logic: Syntax and Semantics of First-Order Logic, Knowledge Engineering in First-Order Logic, [TB: Ch. 7, 8]
7. Inference in First-Order Logic: Inference rules for quantifiers, A first-order inference rule, Unification, Forward Chaining, Backward Chaining, A backward chaining algorithm, Logic programming, The resolution inference rule [TB: Ch. 9]
8. Introduction to Prolog Programming
9. Reasoning Systems for Categories, Semantic Nets and Description logics, reasoning with Default Information: Open and closed worlds, Negation as failure and stable model semantic. Truth Maintenance Systems [TB: Ch. 10]
10. Reasoning with Uncertainty & Probabilistic Reasoning : Acting Under Uncertainty, Bayes' Rule and Its Use, [TB: Ch 13]
11. Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks. [TB: Ch. 14]
12. Learning from Observations: Forms of Learning , Inductive Learning,, Learning Decision Trees [TB: Ch. 18]
13. Knowledge in Learning, Explanation-Based Learning, Inductive Logic Programming. [TB: 19]
14. Statistical Learning, Neural Networks [TB: Ch. 20]

Teaching Methodology:
Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Artificial Intelligence: A Modern Approach, by Russell and Norvig, Prentice Hall. 2ndEdition. ISBN-10: 0137903952[TB] 2. Artificial Intelligence: A Systems Approach by M. Tim Jones, Jones and Bartlett Publishers, Inc; 1stEdition (December 26, 2008). ISBN-10: 0763773379 3. Artificial Intelligence in the 21st Century by Stephen Lucci , Danny Kopec, Mercury Learning and Information (May 18, 2012). ISBN-10: 1936420236

CMPC-402 Capstone II			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
1. Database Design 2. Interface Design 3. Initial Prototype 4. Implementation 5. Testing
Teaching Methodology:
Lectures, Semester Project, Assignments, Presentations, Interactive sessions
Course Assessment:
Sessional Marks(Assignments, Quizzes, Project, Presentations), Mid Exam, Final Exam
Reference Materials:

Revised Curriculum of BS Software Engineering for Main Campus, Sub Campuses and Affiliated Colleges



Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall 2019)

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Guidelines for Affiliated Colleges

- BSSE program shall be offered under Term System observing University of Sargodha's Affiliation Rules & Regulation.
- There shall be two terms in a calendar academic year.
- The affiliated college(s)/institutions shall follow the prescribed curriculum and course matrix. Necessary modification/changes shall be communicated to the affiliated Colleges/Institutions, if any.
- For domain elective courses, the affiliated institution(s)/college(s) shall follow "Regular Track". However, the administration of any affiliated institution must get prior permission from the competent authority to offer any specialization tracks which are being offered in the main campus. For this purpose, the institution's administration needs to show/demonstrate the availability of appropriate human resource along with necessary educational provisions before the start of the term in which specialization track shall be offered. The recommendations of the Convener BOS shall be solicited to make the recommendations for the Institution to offer the requested specialization track already approved by the BOS. The competent authority shall give the final approval.

Curriculum

for
BS (Software Engineering) Program

The Discipline of Software Engineering

Software Engineering is a bridge connecting the basic concepts and principles of Computer Science with the variety of users who can benefit from technologies based upon those principles. It includes the design and development of software systems which are effective, efficient, robust, maintainable, and maximally useful and usable. It also includes the design and development of techniques, processes and higher level tools by which these applications can be developed in a timely, cost effective and sustainable manner. At both levels it requires a systematic approach which deals with quantifiable measures of quality and effectiveness, as well as attention to the critical nature of the various products of the process.

Software engineering therefore requires familiarity with the basic needs and processes in the various application domains, with the principles of good engineering practice and with the underlying concepts and principles of computer science. It requires facility in problem analysis, solution design, program development and documentation. It also requires a basic understanding of the ways in which humans interact with technological systems.

A software engineering program should develop professionals who have a mastery of software development principles, theory, practice, and process.

Software Engineering and Computer Science differ in much the same way as do Electrical Engineering and Physics1. Generally, engineering should be concerned with applying what we already know to create products, while science is more theoretical. Therefore, the goal of Computer Science, according to Parnas2, is to learn and to extend the science. SE on the other hand aims to use the science and technology already available to create products and tools for use.

Software Engineering derives its essence from computer science as other engineering disciplines do from natural or life sciences, with an emphasis on issues of process, design, measurement, analysis and verification providing a strong foundation in engineering principles and practices as applied to software development.

Definition

[1] David Parnas, "Software Engineering Programmes are not Computer Science Programmes", *IEEE Software, Nov/Dec. 1999, pp. 19-30.*

[2] David Parnas, "Software Engineering Programmes are not Computer Science Programmes", *IEEE Software, Nov/Dec. 1999, pp. 19-30.*

Software Engineering is a discipline concerned with the development of software systems by applying engineering principles with the goal of developing cost-effective quality systems. There are many definitions in literature. Such as:

- "The establishment and use of sound engineering principles (methods) in order to obtain economically software that is reliable and works on real machines" [Bauer 1972].
- "Software engineering is that form of engineering that applies the principles of computer science and mathematics to achieving cost-effective solutions to software problems." [CMU/SEI-90-TR-003]
- "The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software" [IEEE 1990].

Software Engineering could also be defined as:

"The application of systematic, disciplined, quantifiable approach to design, development, deployment, and maintenance of reliable and economical software systems."

Vision of Software Engineering Education

Software engineering is the discipline of creating high-quality software systems in a systematic, controlled and efficient manner. It involves the application of engineering concepts, techniques, and methods to the design, development, deployment and maintenance of software systems. A software engineering program should develop professionals who have a mastery of principles, theory, practices, and processes necessary to produce quality software systems. The curriculum committee formalized the Vision Statement for SE education in Pakistan as follows:

> "The SE education in Pakistan will focus on imparting the knowledge and training which should enable students to harmonize theory with practice, concept with application, and problem with solution. It will prepare them to apply ably engineering principles, practices, and processes to design, develop, deploy, and maintain software systems. The program will lead to development of student's professional and interpersonal skills. It will help students to enhance their ability in oral and written communication, and their adaptability to team environments. The program will inculcate among students a strong sense of civic, professional and ethical responsibility. The program will also strive to develop a capacity for innovation and a passion for lifelong learning."

SE curricula thus developed would reflect the aim to satisfy professional demands of the industry and academia both in terms of immediate needs and the capacity for longer term development. The graduates thus produced will be adequately equipped to exploit the opportunities and answer the challenges offered by the modern world.

Knowledge Areas of SE Curriculum DevelopmentABET Engineering Criteria 2000 notes:

> "The curriculum must provide both breadth and depth across the range of engineering and computer science topics implied by the title and objective of the program. The program must demonstrate that graduates have: the ability to analyze, design, verify, validate, implement, apply, and maintain software systems; the ability to appropriately apply discrete mathematics, probability and statistics, and relevant topics in computer and management sciences to complex software systems."

SE curriculum has been developed systematically by identifying the major knowledge areas of SE education, in the spirit of engineering criteria above. It is noted that efforts carried out by ACM and IEEE-CS to develop international software curricula are very relevant and provide excellent guidelines on the issue. Outcome of these efforts is documented in *Software Engineering Body of Knowledge* (SWEBOK)[3], Software Engineering Education Knowledge (SEEK)[4], and Computing Curriculum 2008[5].

The following major areas of relevant pedagogy have been identified to be appropriate for design of the software engineering curriculum:

1. Computing Foundation (CS/SE/CE)
2. Software Engineering (SE Major)
3. Software Engineering Application Domain
4. Supporting Areas (Mathematics and Natural Sciences)
5. General Education (Management, Humanities, Social Sciences)

The revised curriculum focuses on building a solid foundation in the early stages of learning. It gradually introduces and strengthens the core professional competencies and desired skill-sets. Software engineering concepts have been taken up as early as the start of 2nd year. The main technical SE contentsare covered in the third and fourth years. Practical component should use medium to large scale projects to develop in students a systematic approach to problem solving and program development.

Software Engineering Programs' Rationale

The 21st century is loaded with a large number of challenges. These challenges include globalized business environment, keeping pace with innovative technologies, the availability of information with respect to time, speed, volume, mode, nature and management of this exponentially growing information, keeping control on international and inter-organizational business processes in real time, optimization of business processes across multiple sites, highly uncertain and chaotic business environments, a new level of national & international competition (hyper-competition), social & cultural diversity, rapidly changing products and processes, government regulations, increasing importance of skills, qualities, productivity and other stresses. To face these challenges and to bring a high level of agility, control and

[3]*Guide to Software Engineering Body of Knowledge*, 2004 Edition,.
[4]*Software Engineering – Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering, 2004August 23, 2004*
[5] Computing Curriculum 2008—Draft

transparency organizations now increasingly focus on maximizing their existing technology and human infrastructure through automating various processes that can free human resource to add value elsewhere within the organization. Accordingly, the software industry looks for graduates who are not only equipped with conventional computing skills but also have the capability to develop complex software that can provide verifiable insight into underlying business processes.

Software Engineering is the discipline of developing and maintaining software systems that behave reliably and efficiently, are affordable to develop and maintain, and satisfy all the requirements that customers have defined for them. Software engineering is different in character from other engineering disciplines due to both the intangible nature of software and the related operations. It seeks to integrate the principles of mathematics and computer science with the engineering practices developed for tangible, physical artifacts. Software engineering students learn more about software reliability and maintenance and focus more on developing and maintaining software techniques while Computer Science students just acquire abstract knowledge of these aspects.

Software Engineering is a bridge connecting the basic concepts and principles of Computer Science with a variety of users who can benefit from technologies based upon those principles. It includes the design and development of software systems which are effective, efficient, robust, maintainable, and maximally useful and usable. It also includes the design and development of techniques, processes and higher level tools by which these applications can be developed in a timely, cost effective and sustainable manner. At both levels, it requires a systematic approach which deals with quantifiable measures of quality and effectiveness, as well as attention to the critical nature of various products of the process. Software Engineering, therefore, requires familiarity with the basic needs and processes in the various application domains, with the principles of good engineering practices and with the underlying concepts and principles of computer science. It requires facility in problem analysis, solution design, program development and documentation. It also requires a basic understanding of ways in which humans interact with technological systems and necessary skills to create high-quality software systems in a systematic, controlled and efficient manner. It involves the application of engineering concepts, techniques, and methods to the design, development, deployment and maintenance of software systems.

The key rationale behind BS Software Engineering program is to produce graduates who have masteryinthe above discussed aspects. The program intends to impart knowledge and training which enable students to harmonize a theory with practice, a concept with an application, and a problem with a solution. It will prepare them to apply ably engineering principles, practices, and processes to design, develop, deploy, and maintain software systems. The program will lead to development of students' professional and interpersonal skills. It will help them to enhance their ability in oral and written communication, and their adaptability to team environments. The program will inculcate among students a strong sense of civic, professional and ethical responsibility. The program will also strive to develop a capacity for innovation and a passion for lifelong learning.

Software Engineering Programs' Curriculum Underlying Principles



Curriculum plays an important role within education as it outlines the planned and structured learning experiences that an academic program provides. For an effective academic program the curriculum must meet the needs of the stakeholders and face the emerging challenges. The Department of CS & IT (UOS) realizes the rapidly changing needs of today's knowledge intensive technology driven complex work places and the changing patterns of 21st century universities' education which have removed the identity of place, the identity of time, the identity of the scholarly community, and the identity of the student community. To meet these challenges, the Department has revised the existing curriculum. The revised curriculum is based on following underlying principles:

i. The curriculum should be a broad based and provides students with the flexibility to work across many disciplines & professions.
ii. The curriculum should prepare graduates to succeed in a rapidly changing field.
iii. The curriculum should provide guidance for the expected level of mastery of topics by graduates.
iv. Should provide realistic, adoptable recommendations that provide guidance and flexibility, allowing curricular designs that are innovative and track recent developments in the field.
v. The curriculum contents should be relevant and compatible with a variety of institutions.
vi. The size of the essential knowledge must be managed.
vii. The curriculum should identify the fundamental skills and knowledge that all graduates should possess.
viii. The curriculum should provide the greatest flexibility in organizing topics into courses and curricula.

In the light of these principles, the curriculum of the program has adopted a balanced and multidisciplinary approach and presents a blend of study areas which spread across the boundaries of fundamental knowledge of traditional disciplines to advanced knowledge of the emerging disciplines. Body of knowledge (BOK) of the program covers knowledge areas which are required for the program's accreditation from the Accreditation Council and knowledge area which are required for professional certification and professional development.

It is universally accepted that each profession needs both a specific skill set and an appropriate mindset. Developing an appropriate mindset of the prospective computing graduates requires a body of knowledge which enriches students' experiences, thoughts, beliefs, assumptions, and attitudes about the special characteristics of that specific domain. Therefore, the course contents and related practical experiences are designed to meet the professional requirements of the respective domain. For this purpose, the curriculum has focused on following six (6) key areas:

i. Knowledge: Theoretical learning of concepts and principles regarding a particular subject(s).
ii. Skills: Capability of using learnt knowledge and applying it according to the context

iii. Competencies: The ability to do things satisfactory- not necessarily outstandingly or even well, but rather to a minimum level of acceptable performance.
iv. Expertise: Level of proficiency and innovative ways of applying learnt knowledge. (Competitive edge)
v. Dispositions: Habits of mind or tendencies to respond to certain situations in certain ways. The role of dispositions in computing education is very important. For example, having the disposition to be a programmer is much better that just having programming skills.
vi. Values: Moral, ethical and professional practices.

To make curriculum more effective, specialization tracks have also been integrated within the curriculum. These specialization tracks are designed according to what the industry is looking for in an employee and the learning interests of students. Furthermore, life skills including desired dispositions, soft skills, public speaking, critical thinking & reasoning, 21st Century literacies, personal attributes, entrepreneurship, attitude towards lifelong learning, professional practices and other social skills have not considered discrete items, rather threaded into the entire fabric of the curriculum.

BS Software Engineering Program's Aims & Objectives

BSSE Program aims to create, expand, disseminate and teach the Software Engineering body of knowledge through academics, applications and research which positively impact society locally, nationally, and internationally.

The objective of the program is to prepare students for professional careers and graduate studies with a balance between computing theory and practical application of software engineering concepts, methodologies, tools and technologies in the modern software development environments. The curriculum is designed to ensure breadth across allied disciplines and supporting subjects; and depth in most areas of the software engineering body of knowledge. Various components have been included in the curriculum to ensure that the graduates will:

- Understand and be able to apply mathematics, physical science, computer science and related disciplines.
- Understand and be able to apply the principles of software engineering practices and processes, subject to realistic constraints.
- Be able to model, analyze, document and track system requirements, both functional and non-functional.
- Be able to design, implement, deploy and maintain quality oriented software systems.
- Be able to verify and validate quality oriented software systems.
- Have an awareness of current industry standards and practices.
- Be able to work in one or more application domains.
- Understand and apply the principles of software quality assurance.
- Be able to understand and apply software project management skills: measurement, estimation, costing, planning, documenting, deployment and tracking of resources.
- Have strong communication, team management and interpersonal skills.
- Be capable of independent learning.
- Understand professional responsibility and application of ethical principles.

- Have knowledge of economics, humanities and social sciences.

BSSE Program's Outcome

The program will produce entrepreneurs of great character, competence, vision and drive equipped with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in computer science domain or proceed to further or higher education or training.

BSSE Program's Structure

The structure of a BS program in Software Engineering meets the needs of students with formal computing experience and with established relevant skills. The students are expected to learn theoretical and practical understanding of the entire field of Software Engineering. The program structure provides basis for various options including Breadth-Based, Depth-Based, and Integrated Breadth & Depth-Based specializations. Student may choose a particular option, which is the most appropriate to their planned future career. Followings are the program's details:

Degree Requirement

To become eligible for award of BS degree, a student must satisfy the following requirements:

a) Must have studied and passed the prescribed courses, totaling at least 130 credit hours.
b) Must have earned CGPA (Cumulative Grade Point Average) of at least 2.0 on a scale of 4.0.

Duration

The **minimum duration** for completion of BS degree is four years. The HEC allows a **maximum period of seven years** to complete BS degree requirements.

Eligibility Criteria

The minimum requirements for admission in a Bachelor degree program in Computer Science/ Information Technology/ Software Engineering, is **at least 50% marks in Intermediate (HSSC) examination with Mathematics or equivalent qualification with Mathematics certified by IBCC**..

Assessment & Evaluation

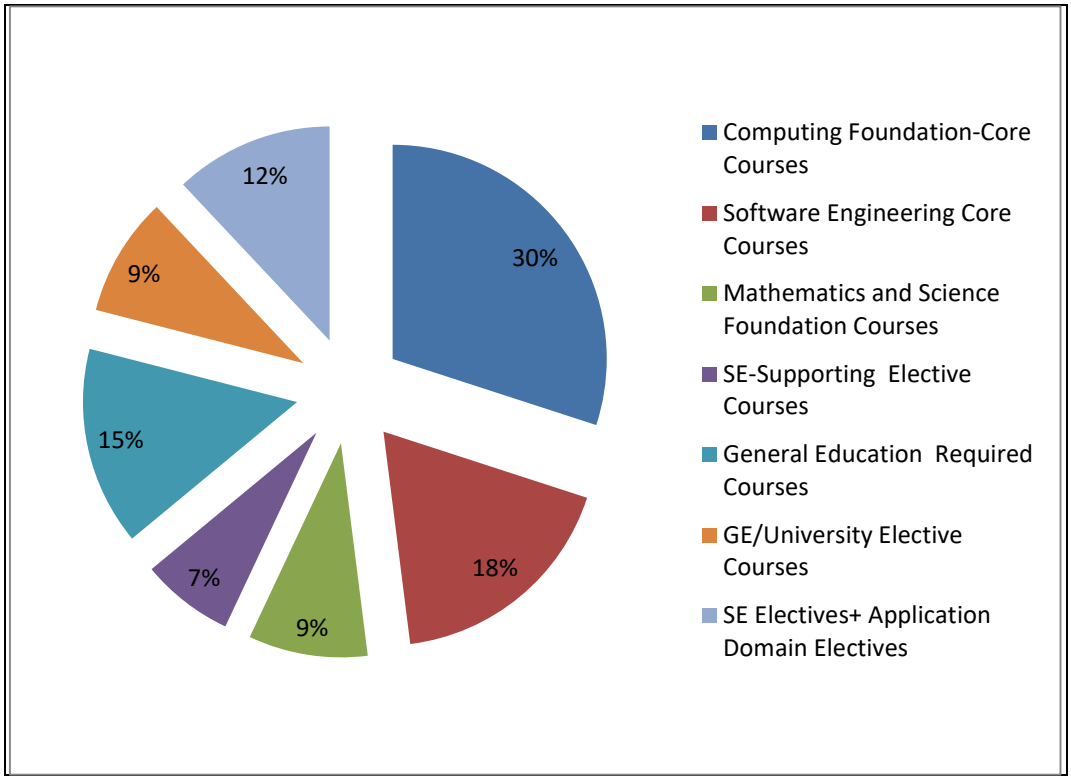
University's Semester and Examination Rules &Regulations shall be followed for assessment & evaluation.

Distribution of Courses

Followings are the distribution of total credit hours:

Major Areas	Cr. Hrs.	%
Computing Foundation-Core Courses	39	30%
Software Engineering Core Courses	24	18%
Mathematics and Science Foundation Courses	12	9%

SE-Supporting Elective Courses	9	7%
General Education Required Courses	19	15%
GE/University Elective Courses	12	9%
SE Electives+ Application Domain Electives	15	12%
Total	**130**	**100%**



Proposed Curriculum for BS-SE

Computing Core Courses – 39 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
1	CMPC-101	-	Programming Fundamentals	4 (3+1)
2	CMPC-102	CMPC-101	Object Oriented Programming	4 (3+1)
3	CMPC-106	-	Discrete Structures	3 (3+0)
4	CMPC-104	-	Software Engineering	3 (3+0)
5	CMPC-201	CMPC-102	Data Structure and Algorithms	4 (3+1)
6	CMPC-202	-	Operating Systems	4 (3+1)
7	CMPC-204	-	Database Systems	4 (3+1)
8	CMPC-301	-	Computer Communication and Networks	4 (3+1)
9	CMPC-302	-	Information Security	3 (3+0)
10	CMPC-401	-	Capstone Project	6 (0+6)

Software Engineering Core Courses – 24 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
11	SECC-201	CMPC-106	Software Requirement Engineering	3(3+0)
12	SECC-205	-	Human Computer Interaction	3(3+0)
13	SECC-202	-	Software Design & Architecture	3(2+1)
14	SECC-301	-	Software Construction & Development	3(2+1)
15	SECC-302	CMPC-106	Software Quality Engineering	3(3+0)
16	SECC-304	-	Web Engineering	3(3+0)
17	SECC-401	-	Software Project Management	3(3+0)
18	SECC-403	-	Software Re-Engineering	3(3+0)

General Education Courses – 19 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
19	ENGL-101	-	English Composition & Comprehension	3(3+0)
20	ENGL-102	-	Communication Skills	3(3+0)
21	ENGL-301	-	Technical and Report Writing	3(3+0)
22	PKST-101	-	Pakistan Studies	2(2+0)
23	ISLS-102	-	Islamic Studies	2(2+0)
24	ICTC-101	-	Introduction to Information & Communication Technologies	3 (2+1)
25	SESC-306	-	Professional Practices	3 (3+0)

SE -Supporting (Math/Science) Required Elective Courses - 12 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
26	MATH-101	-	Calculus and Analytical Geometry	3(3+0)
27	MATH-201	-	Linear Algebra	3(3+0)
28	STAT-202	-	Probability and Statistics	3(3+0)
29	PHYS-101	-	Applied Physics	3(3+0)

Supporting Elective Courses - 9 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
30	SESC-301	-	Business Process Engineering	3(3+0)
31	SESC-305	-	Formal Methods in Software Engineering	3(3+0)
32	SESC-304	-	Cyber Security	3(3+0)

GE/University Elective Courses - 12 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**

33	BUSB-102	-	Principles of Management	3(3+0)
34	BUSB-201	-	Human Resource Management	3(3+0)
35	BUSB-401	-	Organizational Behavior	3(3+0)
36	BUSB-202	-	Business Economics	3(3+0)
37	BUSB-402	-	Entrepreneurship	3(3+0)

Software Engineering Elective Courses - 15 Credit Hours

Regular Track Elective Courses - 15 Credit Hours (Any 5 Courses)
for
Main Campus, Mianwali, Bhakkar Campus

39	SEEC-401	-	Model-Driven Software Development	3(3+0)
40	SEEC-402	-	Software Engineering Economics	3(3+0)
41	SEEC-403	-	Big Data Analytics	3(3+0)
42	SEEC-404	-	Software CASE Tools & Applications	3(3+0)
43	SEEC-405	-	E-Commerce Applications Development	3(3+0)
44	SEEC-406	-	Enterprise Resource Planning Systems	3(3+0)
45	SEEC-407	-	Mobile Application Development	3(3+0)
46	SEEC-408	-	Enterprise Application Development	3(3+0)
47	SEEC-301	-	Artificial Intelligence	3(3+0)
48	SEEC-409	-	Cloud Computing	3(3+0)
49	SEEC-410	-	Systems Programming	3(3+0)
50	SEEC-311	-	Management Information Systems	3(3+0)
51	SEEC-411	-	Game Application Development	3(3+0)
52	SEEC-426	-	Software Metrics	3(3+0)
53	SEEC-314	-	Multimedia Systems and Design	3(3+0)
54	SEEC-414	-	Virtual Reality	3(3+0)
55	SEEC-415	-	IOT	3(3+0)
56	SEEC-416	-	Semantic Web Techniques	3(3+0)
57	SEEC-417	-	Mobile Computing	3(3+0)
58	SEEC-418	-	Data Warehousing	3(3+0)
59	SEEC-419	-	Data Mining	3(3+0)
60	SEEC-420	-	Business Intelligence and Analytics	3(3+0)
61	SEEC-302	-	Database Administration & Management	3(3+0)
62	SEEC-423	-	Advance Database Management	3(3+0)
63	SEEC-423	-	Business Process Management	3(3+0)
64	SEEC-424	-	Knowledge Management	3(3+0)

Regular Track Elective Courses - 15 Credit Hours (Any 5 Courses)
for
PPP-Sub Campus and Affiliated Colleges

42	SEEC-401	-	Model-Driven Software Development	3(3+0)
43	SEEC-402	-	Software Engineering Economics	3(3+0)
44	SEEC-404	-	Software CASE Tools & Applications	3(3+0)
45	SEEC-301	-	Artificial Intelligence	3(3+0)
46	SEEC-409	-	Cloud Computing	3(3+0)
47	SEEC-426	-	Software Metrics	3(3+0)
48	SEEC-314	-	Multimedia Systems and Design	3(3+0)

Course Coding Scheme

Scheme for Course Code		
Discipline Code	Course Level	Course Number
4	1 Digit	2 Digits
XXXX	1-4	0-9

Course Level	
Level	**Course Type**
1	Foundation, Core Level 1 Courses
2	Foundation, Core Level 1 Courses
3	Core Level 2 + Specialization Level 1
4	Specialization Level 2

Discipline Code	
CMPC	Computing
SECC	Software Engineering Core
SESC	Software Engineering Supporting
SEEC	Software Engineering Elective
PKST	Social Studies
MATH	Mathematics
ENGL	English
BUSB	Management
PHYS	Physics
ICTC	Information & Communication Technologies

Scheme of Studies for BS Software Engineering Program Main Campus and Mianwali and Bhakkar Campus

(130 Credit Hours)

(For Regular Track)

Semester - I

Code	Course Title	Credit Hours
ICTC-101	Introduction to Information and Communication Technologies	3(2-1)
CMPC-101	Programming Fundamentals	4(3-1)
ENGL-101	English Composition & Comprehension	3(3-0)
MATH-101	Calculus & Analytical Geometry	3(3-0)
PKST-101	Pakistan Studies	2(2-0)
PHYS-101	Applied Physics	3(3-0)
	Total	18

Semester - II

Code	Course Title	Credit Hours
CMPC-102	Object Oriented Programming	4(3-1)
ENGL-102	Communication & Presentation Skills	3(3-0)
CMPC-106	Discrete Structures	3(3-0)
CMPC-104	Software Engineering	3(3-0)
ISLS-102	Islamic Studies	2(2-0)
xxxx-2xx	University Elective - I	3(3-0)
	Total	18

Semester - III

Code	Course Title	Credit Hours
CMPC-201	Data Structures & Algorithms	4(3-1)
SECC-201	Software Requirement Engineering	3(3-0)
SECC-205	Human Computer Interaction	3(3-0)
MATH-201	Linear Algebra	3(3-0)
xxxx-2xx	University Elective-II	3(3-0)
	Total	16

Semester - IV

Code	Course Title	Credit Hours
CMPC-202	Operating Systems	4(3-1)
CMPC-204	Database Systems	4(3-1)
SECC-202	Software Design and Architecture	3(2-1)
STAT-202	Probability and Statistics	3(3-0)
xxxx-2xx	University Elective – III	3(3-0)
	Total	17

Semester - V

Code	Course Title	Credit Hours
SECC-301	Software Construction and Development	3(2-1)
CMPC-301	Computer Networks	4(3-1)
ENGL-301	Technical and Business Writing	3(3-0)
SESC-3xx	SE Supporting –I	3(3-0)
SESC-3xx	SE Supporting - II	3(3-0)
	Total	16

Semester - VI

Code	Course Title	Credit Hours
SECC-302	Software Quality Engineering	3-0
CMPC-302	Information Security	3-0
SESC-306	Professional Practice	3-0
SECC-304	Web Engineering	3-0
SEEC-3xx	SE Elective – I	3-0
SESC-3xx	SE Supporting - III	3-0
	Total	18-0

Semester - VII

Code	Course Title	Credit Hours
SECC-401	Software Project Management	3-0
SECC-403	Software Re-Engineering	3-0
SEEC-4xx	SE Elective -II	3-0
SEEC-4xx	SE Elective - III	3-0
CMPC-401	Final Year Project - I	0-3
	Total	12-3

Semester - VIII

Code	Course Title	Credit Hours
SEEC-4xx	SE Elective - IV	3-0
SEEC-4xx	SE Elective - V	3-0
CMPC-402	Final Year Project - II	0-3
xxxx-4xx	University Elective - IV	3-0
	Total	9-3

Scheme of Studies for BS Software Engineering Program Affiliated Colleges and PPP- Sub Campuses

(130 Credit Hours)

(For Regular Track)

Semester - I

Code	Course Title	Credit Hours
ICTC-101	Introduction to Information and Communication Technologies	3(2-1)
CMPC-101	Programming Fundamentals	4(3-1)
ENGL-101	English Composition & Comprehension	3(3-0)
MATH-101	Calculus & Analytical Geometry	3(3-0)
PKST-101	Pakistan Studies	2(2-0)
PHYS-101	Applied Physics	3(3-0)
	Total	18

Semester - II

Code	Course Title	Credit Hours
CMPC-102	Object Oriented Programming	4(3-1)
ENGL-102	Communication & Presentation Skills	3(3-0)
CMPC-106	Discrete Structures	3(3-0)
CMPC-104	Software Engineering	3(3-0)
ISLS-102	Islamic Studies	2(2-0)
BUSB-102	Principles of Management	3(3-0)
	Total	18

Semester - III

Code	Course Title	Credit Hours
CMPC-201	Data Structures & Algorithms	4(3-1)
SECC-201	Software Requirement Engineering	3(3-0)
SECC-205	Human Computer Interaction	3(3-0)
MATH-201	Linear Algebra	3(3-0)
BUSB-201	Human Resource Management	3(3-0)
	Total	16

Semester - IV

Code	Course Title	Credit Hours
CMPC-202	Operating Systems	4(3-1)
CMPC-204	Database Systems	4(3-1)
SECC-202	Software Design and Architecture	3(2-1)
STAT-202	Probability and Statistics	3(3-0)
BUSB-202	Business Economics	3(3-0)
	Total	17

Semester - V

Code	Course Title	Credit Hours
SECC-301	Software Construction and Development	3(2-1)
CMPC-301	Computer Networks	4(3-1)
ENGL-301	Technical and Business Writing	3(3-0)
SESC-301	Business Process Engineering	3(3-0)
SESC-305	Formal Methods in Software Engineering	3(3-0)
	Total	16

Semester - VI

Code	Course Title	Credit Hours
SECC-302	Software Quality Engineering	3-0
CMPC-302	Information Security	3-0
SESC-306	Professional Practice	3-0
SECC-304	Web Engineering	3-0
SEEC-314	Multimedia Systems and Design	3-0
SESC-304	Cyber Security	3-0
	Total	18-0

Semester - VII

Code	Course Title	Credit Hours
SECC-401	Software Project Management	3-0
SECC-403	Software Re-Engineering	3-0
SEEC-401	Model Driven Software Development	3-0
SEEC-409	Cloud Computing	3-0
CMPC-401	Final Year Project - I	0-3
	Total	12-3

Semester - VIII

Code	Course Title	Credit Hours
SEEC-426	Software Metrics	3-0
SEEC-402	Software Engineering Economics	3-0
CMPC-402	Final Year Project - II	0-3
BUSB-402	Entrepreneurship	3-0
	Total	9-3

Course Contents for BS Software Engineering

Contents of Computing Core Courses

CMPC-101 Programming Fundamentals			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Problem solving skills.	C	1
2. Coding skills.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction, Introduction to Computer Programming: Machine Languages, Assembly Languages and High-Level Languages. History of C, C Standard Library, Typical C Program Development Environment, Memory Concepts, white spaces, comments. [TB 1: Ch. 1]
2. Principles of Structured and Modular Programming: Algorithms, Pseudo code, flowchart representation. Basic Data Types (variables, constants). [TB 1: Ch. 2]
3. Unary (increment/decrement) and Binary (arithmetic, relational, arithmetic assignment) operators. Arithmetic (Expression) in C. C Programming Basics: Programming Practices [TB 1: Ch. 1, 2, 3]
4. Decision Statements: if statement, if-else statement, Multi if-else-if statement. Decision Statements: Nested if-else statements, Switch Statement. [TB 1: Ch. 3]
5. Decision Statements: Conditional operator, Logical Operators, Programming Practices, and Summary. Program Control: Repetition Essentials, Counter-Controlled Repetition. for loop. [TB 1: Ch. 3]
6. Loops: while loop, do while loop [TB 1: Ch. 4]
7. Nested loop structures. Other Control Statements, break and continue Statements, Logical Operators, Confusing Equality (==) and Assignment (=) Operators. Programming Practices, Summary. [TB 1: Ch. 4]
8. Arrays: Defining Arrays, Array Examples (finding max, min value from the array). Searching techniques (linear search, Binary search). Sorting Arrays: selection sort, bubble sort. Case Study: Computing Mean, Median and Mode Using Arrays. [TB 1: Ch. 6]
9. Strings: String Library Functions Characters and Strings: Fundamentals of Strings and Characters. Strings: Character-Handling Library, Programming Practices, Summary. [TB 1: Ch. 8]
10. Functions: Function declaration, definition, Passing Arguments to functions, Returning values from functions. Functions: Arguments pass by reference and pass by copy. [TB 1: Ch. 8]
11. Functions: Passing arrays and strings to functions. Functions: Inline functions, Default arguments, Local and global variables, Summary. [TB 1: Ch. 8]
12. Pointers: Pointers and their purpose. Pointer expressions. Pointers: Pointers and arrays, Pointers in functions. [TB 1: Ch. 8]
13. Pointers: Static and dynamic memory allocation, Memory Management using Pointers. Problems with pointers, program practice, Summary. [TB 1: Ch. 8]
14. Structures: Purpose, Defining structures, Initializing Structures, Accessing Structure Members. Example (complex number or Time). Structures: Passing Structures to functions, Structures using pointers. [TB 1: Ch.10]
15. File Processing: Data Hierarchy, Files and Streams, Creating a Sequential-Access File,

Reading Data from a Sequential-Access File. File Processing: Random-Access Files, Creating a Random-Access File, Writing Data Randomly to a Random-Access File, Reading Data from a Random-Access File. [TB 1: Ch.10]
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. C How to Program by Paul Deitel and Harvey Deitel, Prentice Hall; 7th Edition (March 4, 2012) 2. Programming in C by Stephen G. Kochan, Addison-Wesley Professional; 4th Edition (September 25, 2013). ISBN-10: 0321776410

CMPC-102 Object Oriented Programming			
Credit Hours:	3+1	**Prerequisites:**	CMPC-101

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand principles of object oriented paradigm.	C	2
2. Identify the objects & their relationships to build object oriented solution	C	3
3. Model a solution for a given problem using object oriented principles	C	3
4. Examine an object oriented solution.	C	4
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to Classes, Objects and Strings: Defining a Class with a Member Function, Defining a Member Function with a Parameter, Data Members, set Member Functions and get Member Functions, Initializing Objects with Constructors, Placing a Class in a Separate File for Reusability, Separating Interface from Implementation, Validating Data with set Functions [TB 1: Ch. 3]
2. Class Templates array and vector; Catching Exceptions: Introduction, Arrays, Declaring arrays, Examples Using arrays, Range-Based for Statement, Sorting and Searching arrays, Multidimensional arrays. [TB 1: Ch. 7]
3. Classes - Throwing Exceptions: Class Scope and Accessing Class Members, Access Functions and Utility Functions, Constructors with Default Arguments, Destructors, When Constructors and Destructors Are Called, Default Memberwise Assignment, const Objects and const Member Functions, Composition: Objects as Members of Classes, friend Functions and friend Classes, Using the this Pointer, static Class Members. [TB 1: Ch. 9]
4. Operator Overloading; Class string: Introduction, Using the Overloaded Operators of Standard Library Class string, Fundamentals of Operator Overloading, Overloading Binary Operators, Overloading the Binary Stream Insertion and Stream Extraction Operators, Overloading Unary Operators, Overloading the Unary Prefix and Postfix ++

and – Operators, Dynamic Memory Management, Operators as Member vs. Non-Member Functions, Converting Between Types, explicit Constructors and Conversion Operators, Overloading the Function Call Operator () [TB 1: Ch. 10].

5. Inheritance: Introduction, Base Classes and Derived Classes, Relationship between Base and Derived Classes, Constructors and Destructors in Derived Classes, public, protected and private Inheritance, Software Engineering with Inheritance. [TB 1: Ch. 11]]
6. Polymorphism: Introduction, Relationships Among Objects in an Inheritance Hierarchy, Type Fields and switch Statements, Abstract Classes and Pure virtual Functions, Polymorphism, Virtual Functions and Dynamic Binding ―Under the Hood‖. [TB 1: Ch. 12]
7. Stream Input/Output: Introduction, Streams, Stream Output, Stream Input, Unformatted I/O Using read, write and gcount, Introduction to Stream Manipulators, Stream Format States and Stream Manipulators, Stream Error States, Tying an Output Stream to an Input Prentice Hall File Processing: Introduction, Files and Streams, Creating a Sequential File, Reading Data from a Sequential File, Updating Sequential Files, Random-Access Files, Creating a Random-Access File, Writing Data Randomly to a Random-Access File, Reading from a Random-Access File Sequentially [TB 1: Ch. 14]
8. Standard Library Containers and Iterators: Introduction to Containers, Introduction to Iterators, Introduction to Algorithms, Sequence Containers, Associative Containers, Container Adapters, Class bitset. [TB 1: Ch. 15]
9. Exception Handling: Introduction, Rethrowing an Exception, Stack Unwinding, When to Use Exception Handling, Constructors, Destructors and Exception Handling, Exceptions and Inheritance, Processing new Failures, Class unique_ptr and Dynamic Memory Allocation, Standard Library Exception Hierarchy. [TB 1: Ch. 17]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. C++ How to Program, 10th Edition, Deitel & Deitel.
2. Object Oriented Programming in C++, 3rd Edition by Robert Lafore
3. Starting Out with C++ from Control Structures to Objects, 9th Edition, Tony Gaddis
4. Java: How to Program, 9th Edition by Paul Deitel
5. Beginning Java 2, 7th Edition by Ivor Horton
6. An Introduction to Object Oriented Programming with Java, 5th Edition by C. Thomas Wu

CMPC-106 Discrete Structures			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. The course provides a solid theoretical foundation of discrete	C	1

structures as they apply to computer science problems and structures. The students will learn how to use mathematical notation and solve problems using mathematical tools.		

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Logic: Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Methods of Proof. [TB 1: Ch. 1]
2. Sets & Functions, Sequences and Summations. [TB 1: Ch. 2]
3. Algorithms: the Growth of Functions, Complexity of Algorithms, the Integers and Division, Matrices. [TB 1: Ch. 3]
4. Number Theory and Cryptography. [TB 1: Ch. 4]
5. Advanced Counting Techniques: Recurrence Relations, Solving Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion-Exclusion & its Application. [TB 1: Ch. 8]
6. Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings. [TB 1: Ch. 9]
7. Graph: Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. [TB 1: Ch. 10]
8. Trees: Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees. [TB 1: Ch. 11]

Teaching Methodology:

Lectures, Class Exercises

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. K. H. Rosen, Discrete Mathematics and Its Applications, McGraw-Hill Science/Engineering/Math, 7th Ed. 2011. ISBN-10: 0073383090
2. R. Johnsonbaugh, Discrete Mathematics, Pearson; 7th Ed., 2008. ISBN-10: 0131593188
3. S. B. Maurer and A. Ralston, Discrete Algorithmic Mathematics, A K Peters/CRC Press; 3rd Ed., 2004. ISBN-10: 1568811667
4. B. Kolman, R. Busby and S. C. Ross, Discrete Mathematical Structures, Pearson, 6th Ed. 2008. ISBN-10: 0132297515

CMPC-104 Software Engineering			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain how various software development models and software	C	4

development life cycles are applied.		
2. Presents the fundamentals concepts of project management.	C	3
3. Important Requirements modeling, fact-finding techniques.	C	3
4. Have knowledge of software configuration management.	C	4
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. The Nature of Software, Unique Nature of WebApps, Software Engineering, The Software Process, Software Engineering Practice, Software Myths. [TB1: Ch. 1]
2. Generic Process Models: Framework Activity, Task Set, Process Patterns, Process Improvement, CMM, Prescriptive Process Models: Waterfall Model, Incremental Process Model, Evolutionary Process Model. [TB1: Ch. 2]
3. Specialized Process Models: Component Based Development, The Formal Methods Models, Agile Development. [TB1: Ch. 2-3]
4. Introduction to Systems Analysis and Design, Business Information Systems, Information System Components, Types of Information Systems, Evaluating Software, Make or Buy Decision. [TB1: Ch. 1]
5. Introduction to SDLC, SDLC Phases, System Planning, Preliminary Investigation, SWOT Analysis. [TB1: Ch. 2]
6. The Importance of Strategic Planning, Information Systems Projects, Evaluation of Systems Requests, Preliminary Investigation, Systems Analysis, Requirements Modeling, Fact-Finding Techniques. [TB1: Ch. 2-3]
7. Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Requirements Model. [TB1: Ch. 5]
8. Requirements Modelling Strategies, Difference between Structured Analysis and Object Oriented Analysis; Difference between FDD Diagrams & UML Diagrams. [TB2:Ch. 3]
9. Data & Process Modelling, Diagrams: Data Flow, Context, Conventions, Detailed Level DFD's Diagram 0, Levelling, Balancing, Logical Versus Physical Models. [TB2: Ch. 4]
10. Design Within the Context of Software Engineering, The Design Process, Design Concepts, Design Models: Data Design Elements. [TB1: Ch. 8]
11. Architecture Design Elements, Interface Design Elements, Component-Level Design Elements, Deployments Design Elements. [TB 1: Ch. 8]
12. System Architecture, Architectural Styles, User Interface Design: The Golden Rules, User Interface Analysis and Design, WebApps Interface Design. [TB1: Ch. 9-11]
13. Software Quality Assurance: Background Issues, Elements of Software Quality Assurance, Software Testing Strategies, Strategic Issues, Test Strategies for Conventional Software. [TB1: Ch.16-17]
14. Validation Testing, System Testing, Internal and External View of Testing: White Box Testing and Black Box Testing Techniques. [TB1: Ch. 17-18)]
15. Introduction to Project Management, Project Scheduling: Gantt Chart, Risk Management: Proactive versus Reactive Risk Strategies, Software Risks, Maintenance and Reengineering: Software Maintenance, Software Reengineering. [TB1: Ch. 28-29]

Teaching Methodology:

Lecturing, Written Assignments, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Software Engineering: A Practitioner's Approach by Roger S. Pressman, McGraw-Hill Science/Engineering/Math; 7th Edition (2009). ISBN-10: 0073375977 2. Software Engineering 8E by Ian Sommerville, Addison Wesley; 8th Edition (2006). ISBN-10: 0321313798 3. Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225 4. Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225

CMPC-201 Data Structures and Algorithms			
Credit Hours:	3+1	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Acquire the basic knowledge of data structures & algorithms and understand the concepts of various data structures and use them in different applications.	C	1,2
2. Solve, analyze and evaluate the problems using different data structures and algorithms.	C	3
3. Demonstrate& apply independently the various forms of data structures and algorithms	P	3,4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Course, Basic Object Orientation concepts, Properties of Algorithm, Introduction to Algorithm's Performance Analysis and Measurement (Big Oh Notation)
2. ADT, Basic Operations, Reading, Writing, Insertion, Deletion, Merging, Binary Search.
3. Introduction to Sorting types and Techniques, Logical and Algorithmic Implementation of Bubble, Selection Sort, Insertion, Quick Sort, Merge Sort.
4. The Stack ADT, Expressions, Postfix Notation, Infix to postfix, postfix evaluation, Applications of stack
5. Introduction to Recursion, Examples of Recursion, Writing Recursive Programs
6. The Queue ADT and Its Applications, Variation of Queue ADT i.e. Circular and Double Ended Queue
7. Priority Queues, Introduction to Pointers, Linear single Link
8. Linked Stacks and Queues, Linear Doubly Linked list
9. Circular Lists: Implementation of queues and stacks, Doubly Link List
10. Introduction to Trees, Tree Terminology, Logical construction and Representation

of Trees, Introduction to Binary Tree ADT, Mathematical properties, Linked Implementation of Binary Trees (Insertion, Traversing, Searching and deletion in Binary Trees)
11. Binary Search Tree, Implementation and Applications of BSTs
12. Heaps and Heaps as Priority Queues, Introduction to Balanced and AVL Trees, Heap Sort.
13. Hashing, Overflow Handling, Open Addressing, Chaining
14. Introduction to graph and related terminology, Adjacency Matrix representation of graph and Adjacency list
15. Elementary Graph Operations, DFS, BFS, Spanning Trees
16. Shortest path algorithms: Dijkstra Algorithm, Minimum Cost Spanning Trees.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Data Structures and Algorithms in C++ by Michael T. Goodrich, Roberto Tamassia, and David Mount (2nd Edition) : ISBN-13: 978-0470383278
2. Data Structures and Algorithms in C++ 4th Edition by Adam Drozdek : ISBN-13: 978-1133608424
3. Data Structures and Algorithm Analysis in Java (3rd Edition) 3rd Edition by Mark A. Weiss : ISBN-13: 978-0132576277
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms", 2nd Ed, MIT Press, 2001, ISBN 0-07-013151-1
5. Data Structures and Abstractions with Java (5th Edition) (What's New in Computer Science) 5th Edition by Frank M. Carrano (Author), Timothy M. Henry (Author) : ISBN-13: 978-0134831695
6. Data Structures & Algorithm Analysis in C++ 4th Edition by Mark A. Weiss : ISBN-13: 978-0132847377

CMPC-202 Operating Systems			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	C	2
2. Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions.	C	5
3. Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction: Over view of: Operating Systems, Operating-System Structure, Operating-System Operations, Process management, Memory Management, Storage Management, Protection and Security, Protection and Security, Distributed Systems, Special-Purpose Systems, Computing Environments. [TB 1: Ch1] 2. Operating-System Structures: Operating-System Services, Operating-System Structure, User Operating-System Interface, Virtual Machines, System Calls, Operating-System Generation, Types of System Calls, System Boot, System Programs. [TB 1: Ch2]. 3. Processes: Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication, Communication in Client- Server Systems. Threads: Multithreading Models, Thread Libraries, Threading Issues. [TB 1: Ch. 3, 4] 4. CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling, Algorithm Evaluation. [TB 1: Ch. 5] 5. Process Synchronization: Background, Monitors, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classic Problems of Synchronization. [TB 1: Ch. 6] 6. Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock. [TB 1: Ch. 7] 7. Main Memory: Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Example: The Intel Pentium. [TB 1: Ch.8] 8. Virtual Memory: Allocating Kernel Memory, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing. [TB 1: Ch. 9] 9. File-System Implementation: File-System Structure, Log-Structured File Systems, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery. [TB 1: Ch. 11] 10. Security: The Security Problem, Computer-Security, Program Threats, Classifications, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks. [TB 1: Ch. 15]
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Operating Systems Concepts, 9th edition by Abraham Silberschatz [Text Book] 2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum 3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

CMPC-204 Database Systems			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain fundamental database concepts.	C	2

2. Design conceptual, logical and physical database schemas using different data models.	C	3
3. Identify functional dependencies and resolve database anomalies by normalizing database tables.	C	3
4. Use Structured Query Language (SQL) for database definition and manipulation in any DBMS.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Databases Overview: Basic Concepts and Definitions, Traditional File Processing & Database Approach [TB1: Ch 1]
2. Data Models, Advantages of Database Approach, Costs and Risks of Database Approach, Components of the Database Environment, The Database Development Process [TB1: Ch 1]
3. E-R Model, Modelling Rules of the Organisation, Modelling Entities and Attributes, Modelling Relationships [TB1: Ch 2]
4. Enhanced E-R Model, Representing Supertypes and Subtypes, Specifying Constraints in Supertype/Subtype Relationships [TB1: Ch 3]
5. Relational Data Model, Integrity Constraints, Transforming EER Diagrams into Relations [TB1: Ch 4]
6. Introduction to Normalization, First Normal Form, Second Normal Form, Third Normal Form, Functional Dependencies and Keys [TB1: Ch 4]
7. The Physical Database Design Process, Designing Fields: Choosing Data Types, Coding Techniques, Handling Missing Data [TB1: Ch 5]
8. Denormalizing and Partitioning Data, File Organizations (Heap, Sequential, Indexed, Hashed), Creating a Unique/Nonunique Key Index, When to Use Indexes [TB1: Ch 5]
9. Introduction to SQL, The SQL Environment, Defining a Database in SQL [TB1: Ch 6]
10. Basic SQL Commands for Processing Single Tables [TB1: Ch 6]
11. SQL Commands for Processing Multiple Tables using Joins and Subqueries [TB1: Ch 7]
12. Client/Server Architectures, Databases in a Two-Tier Architecture, Three-Tier Architectures [TB1: Ch 8]
13. Web Application Components, Databases in Three-Tier Applications [TB1: Ch 8]
14. The Roles of Data and Database Administrators, Database Backup and Recovery, Types of Database Failure, Disaster Recovery [TB1: Ch 12]
15. Controlling Concurrent Access, Serializability, Locking Mechanisms, Data Dictionaries and Repositories [TB1: Ch 12]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Modern Database Management by Jeffrey A. Hoffer, V. Ramesh, and Heikki Topi. Pearson; 12th Edition (2015). ISBN-10: 1292101857
2. Fundamentals of Database Systems by R. Elmasri and S. Navathe. Pearson; 7th Edition (2015). ISBN-10: 0133970779
3. Database System Concepts by Abraham Silberschatz, Henry F. Korth and S. Sudarshan. McGraw-Hill Education; 6th Edition (2010). ISBN-10: 0073523321

4. Oracle 12c: SQL by Joan E. Casteel. Cengage Learning; 3rd Edition (2015). ISBN-10: 1305251032

CMPC-301 Computer Networks			
Credit Hours:	3+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Describe the key terminologies and technologies of computer networks.	C	2
2. Explain the services and functions provided by each layer in the Internet protocol stack.	C	2
3. Identify various internetworking devices and protocols, and their functions in a network.	C	4
4. Analyze working and performance of key technologies, algorithms and protocols.	C	4
5. Build Computer Network on various Topologies.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to networks and protocols architecture [TB1: Ch. 1].
2. Basic concepts of networking, network topologies and the Internet [TB1: Ch. 1].
3. Layered architecture and the OSI model [TB1: Ch. 2].
4. Physical layer functionality, data link layer functionality and the TCP/IP protocol architecture [TB1: Ch. 2].
5. Multiple access techniques, WAN Technologies and protocols , circuit switching and packet switching.[TB1: Ch. 9]
6. Wireless networks, Cellular Network Generations and LTE-Advanced [TB1: Ch. 10]
7. LAN technologies, LAN protocol architecture and virtual LANs [TB1: Ch. 11]
8. MAC addressing. [TB1: Ch. 11]
9. Networking devices , bridges, hubs and switches [TB1: Ch. 11]
10. Network layer protocols, Principles of Internetworking, IPv4 and IPv6. [TB1: Ch. 14]
11. IP addressing, Internet Protocol Operation, virtual private networks and IP Security and Subletting, CIDR. [TB1: Ch. 14].
12. Transport layer protocols, ports and sockets and connection-oriented transport protocol mechanisms [TB1: Ch. 15]
13. Routing protocols OSPF, EIGRP, RIP and routing in packet-switching networks [TB1: Ch. 19]
14. Connection establishment, flow and congestion control, effects of congestion, TCP congestion control and datagram congestion control protocol [TB1: Ch. 20]
15. Application layer protocols, electronic mail (SMTP and MIME), Web Access: HTTP and DNS [TB1: Ch. 24]
16. Latest trends in computer networks , real-time traffic and voice over IP [TB1: Ch. 25]

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Data and Computer Communications, 10th Edition by William Stallings. 2. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross. 3. Computer Networks, 5th Edition by Andrew S. Tanenbaum. 4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan.

CMPC-302 Information Security			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain key concepts of information security such as design principles, cryptography, risk management, and ethics.	C	2
2. Discuss legal, ethical, and professional issues in information security.	C	2
3. Apply various security and risk management tools for achieving information security and privacy.	C	3
4. Identify appropriate techniques to tackle and solve problems in the discipline of information security.	C	4
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Information security foundations, security design principles; security mechanisms [TB 1: Ch 1] 2. Vulnerabilities and protections: Malwares [TB 1: Ch 6] 3. Hash functions [TB 1: Ch 2, 21] 4. Digital signatures [TB 1: Ch 2] 5. Key management [TB 1: Ch 2,20] 6. Authentication: Access control [TB 1: Ch 3,4] 7. Symmetric cryptography: Symmetric Encryption Principles, Data Encryption Standard, 8. Advanced Encryption Standard, Cipher Block Modes of Operation [TB 1: Ch 20] 8. Asymmetric cryptography: HMAC, The RSA Public-Key Encryption Algorithm, Diffie-Hellman and Other Asymmetric Algorithms [TB 1: Ch 21] 9. Software security [TB 1: Ch 11] 10. Database security: The Need for Database Security, Database Management Systems 1. Relational Databases, SQL Injection Attacks, Database Access Control, Inference, Database Encryption [TB 1: Ch 5] 11. Network security: Secure E-Mail and S/MIME, Domain Keys Identified Mail, Secure Sockets Layer (SSL) and Transport Layer Security (TLS), HTTPS, IPv4 and IPv6 Security, Wireless Security, Mobile Device Security [TB 1: Ch 22, 24] 12. Firewalls: The Need for Firewalls, Firewall Characteristics and Access Policy, Types of

Firewalls, Firewall Basing [TB 1: Ch 9] 13. Intrusion detection: Intruders, Intrusion Detection, Analysis Approaches, Types of IDS [TB 1: Ch 8] 14. Security policies, policy formation and enforcement, risk assessment [TB 1: Ch 14,15] 15. Cybercrime, law and ethics in information security, privacy and anonymity of data [TB 1: Ch 19]
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Computer Security: Principles and Practice, 3rd edition by William Stallings[TB1] 2. Principles of Information Security, 6th edition by M. Whitman and H. Mattord 3. Computer Security, 3rd edition by Dieter Gollmann 4. Computer Security Fundamentals, 3rd edition by William Easttom 5. Official (ISC)2 Guide to the CISSP CBK, 3rd edition

CMPC-401 Capstone Project			
Credit Hours:	6+0	**Prerequisites:**	None

Course Content:
1. Project Proposal 2. Introduction 3. Software Requirements Specification 4. Software Function Specification

CMPC-402 Capstone II			
Credit Hours:	3	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Database Design 2. Interface Design 3. Initial Prototype 4. Implementation 5. Testing
Teaching Methodology:
Lectures, Semester Project, Assignments, Presentations, Interactive sessions
Course Assessment:
Sessional Marks(Assignments, Quizzes, Project, Presentations), Mid Exam, Final Exam
Reference Materials:

Contents of Software Engineering Core Courses

SECC-201 Software Requirements Engineering			
Credit Hours:	3+0	**Prerequisites:**	CMPC-106

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. To understand Issues in Requirements Engineering, to understand and apply Requirements Engineering Process,	C	2
2. To understand and use Requirements Elicitation and Specification,	C	2
3. To understand and use Formal Techniques,	C	2
4. To understand modeling and analysis of Non-Functional Requirements.	C	2
5. Manage and control changes in Requirement	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Requirements Engineering (RE): Essential Software Requirement, Bad Requirements, Characteristics and Benefits Requirement Engineering, Requirements from the Customer's Perspective. 2. RE Processes: Requirements Elicitation, Requirements Analysis, Requirements Specification, Requirements Validation, Requirements Management, and Requirements Development Process.

3. The Requirements Analyst Role, Tasks, Essential Skills & Knowledge, Defining the Vision through Business Requirements, Vision and Scope Document.
4. Dealing with Customers: Elicitation Techniques, Interviews, Surveys, Workshops, Classifying Customer Input, Incomplete Requirements (Finding Missing Requirements).
5. Prototype Categories (Throwaway, evolutionary, paper and electronic), evaluation, Risks, Validating the Requirements: Requirements Review and Inspection, Requirements Review Challenges, Acceptance Criteria.
6. Documenting the Requirements: The Software Requirements Specification, Labelling, Dealing with Incompleteness, User Interfaces and the SRS, A Software Requirements Specification Template, The Data Dictionary.
7. Non Functional Requirements: Software Quality Attributes: Defining, Performance Requirements, Defining Non-functional Requirements Using Planguage, Attribute Tradeoffs, Implementing Non-functional Requirements.
8. Setting Requirements Priorities: Why Prioritize Requirements? Play with Priorities, A Prioritization Scale, Prioritizing Based on Value, Cost, and Risk.
9. Special Requirements Challenges: Requirements for Maintenance Projects, Begin Capturing Information, New Requirements Techniques, Follow the Traceability Chain, Consider Business Rules, Requirements for Outsourced Projects, Requirements for Emergent Projects.
10. Requirements Development Plans, Estimation, Scheduling, From Requirements to Designs, Code, Tests and Success.
11. Requirements Management Principles and Practices, Baseline, Procedures, Requirements Version Control, Tracking Requirements Status.
12. Requirements Creeping, Managing Scope Creep, The Change Control Process, The Change Control Board, Change-Control Tools, Measuring Change Activity, Impact Analysis.
13. Tracing Requirements introduction, The Requirements Traceability Matrix, Tools for Requirements Traceability, Requirements Traceability Procedure, Is Requirements Traceability Feasible?
14. Tools for Requirements Management: Benefits and Capabilities of tool for Requirements Management, Requirements Management Automation, selecting a Tool, Changing the Culture.
15. Software Requirements Risk Management: Fundamentals, Elements, Documenting Project Risks, Planning for Risk Management, Requirements-Related Risks

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Software Requirements 2 by Karl Wiegers, 2nd Edition (2003). Microsoft Press; ISBN-10: 0735618798
2. Requirements Engineering: Processes and Techniques, Kotonya and Sommerville, John Wiley Sons, 1998. ISBN-10: 0471972088
3. Software Requirements Engineering, 2nd Edition by Richard H. Thayer and Merlin Dorfman, Wiley-IEEE Computer Society Pr; 2nd Edition (1997). ISBN-10: 0818677384
4. Requirements Engineering: From System Goals to UML Models to Software Specifications by A. van Lamsweerde, Wiley; 1st Edition (2009). ISBN-10:

0470012706.
5. Requirements Engineering: Fundamentals, Principles, and Techniques by Klaus Pohl, Springer; 1st Edition (July 23, 2010). ISBN-10: 3642125778
6. Requirements Engineering by Hull, Jackson, and Dick, Springer; 3rd Edition (October 11, 2010). ISBN-10: 1849964041

SECC-205 Human Computer Interaction			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain context of HCI and different measures for evaluation.	C	2
2. Apply the principles of good design for people from the perspective of age and disabilities.	C	3
3. Analyze techniques for user centered design for a medium sized software.	C	4
4. Evaluate the usability of a medium size software user interface.	C	5

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. The human: Input–output channels, Human memory, Thinking, Emotion, Individual differences, Psychology and the design of interactive systems. [TB 1: Ch. 1]
2. The computer: Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning, Memory, Processing and networks. [TB 1: Ch. 2]
3. The interaction: Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, Interactivity, The context of the interaction, Experience, engagement and fun. [TB 1: Ch. 3]
4. Interaction design basics: What is design? The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping. [TB 1: Ch. 5]
5. HCI in the software process: The software life cycle, Usability engineering, Iterative design and prototyping, Design rationale. [TB 1: Ch. 6]
6. Design rules: Principles to support usability, Standards, Guidelines, Golden rules and heuristics, HCI patterns. [TB 1: Ch. 7]
7. Implementation support: Elements of windowing systems, Programming the application, Using toolkits, User interface management systems. [TB 1: Ch. 8]
8. Evaluation techniques: What is evaluation? Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. [TB 1: Ch. 9]
9. Universal design: Universal design principles, Multi-modal interaction, Designing for diversity. [TB 1: Ch. 10]
10. User support: Requirements of user support, Approaches to user support, Adaptive help systems, Designing user support systems. [TB 1: Ch. 11]
11. Task analysis: Differences between task analysis and other techniques, Task

decomposition, Knowledge-based analysis, Entity–relationship-based techniques, Sources of information and data collection, Uses of task analysis [TB 1: Ch. 15]
12. Dialog notations and design: What is dialog? Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design. [TB 1: Ch. 16]
13. Models of the system: Standard formalisms, Interaction models, Continuous behaviour. [TB 1: Ch. 17]
14. Modeling rich interaction: Introduction, Status–event analysis, Rich contexts, Low intention and sensor-based interaction. [TB 1: Ch. 18]
15. Groupware: Groupware systems, Computer-mediated communication, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware, Implementing synchronous groupware. [TB 1: Ch. 19]
16. Ubiquitous computing and augmented realities: Ubiquitous computing applications research, Virtual and augmented reality, Information and data visualization. [TB 1: Ch. 20]
17. Hypertext, multimedia and the World Wide Web: Understanding hypertext, Finding things, Web technology and issues, Static web content, Dynamic web content. [TB 1: Ch. 21]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Human-Computer Interaction by Alan Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, Prentice Hall; 3rd Edition (December 20, 2003). ISBN-10: 0130461091
2. Designing the User Interface: Strategies for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, 6th Ed, Pearson Inc, 2016.
3. Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design, Benyon, D. 3rd Ed., Pearson. 2013
4. About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, 4th Ed, Wiley, 2014

SECC-202 Software Design & Architecture			
Credit Hours:	2+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the role of design and its major activities within the OO software development process, with focus on the Unified process.	C	2
2. Comprehend the advantages of consistent and reliable software design.	C	3
3. Design OOD models and refine them to reflect implementation details	C	3
4. Apply and use UML to visualize and document the design of software systems.	C	3
5. Implement the design model using an object-oriented programming language.	C	5
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Software Architecture (SA): SA in Context, SA as a Design Plan, Abstraction, SA Terminology, 4+1 Views Model: Coupling Between Views, Uses and Notation of Four Views. IS2000: The Advanced Imaging Solution, Chapter 1 [TB 1:Ch. 1, Ch. 2]
2. Characteristics of SA, Importance of SA, SA Business Cycle and Software Processes, SA History, "Good" Architecture, Architectural Patterns, Reference Models, and Reference Architectures, Architectural Structures and Views [TB 2: Ch.1, Ch.2]
3. SA Case Study: A-7E Avionics System - Architecture, Business Cycle, Requirements and Qualities [TB 2: Ch. 3]
4. Creating Architecture: Understanding Quality Attributes, Functionality and Architecture, Architecture and Quality Attributes, System Quality Attributes, Quality Attribute Scenarios in Practice, Other System Quality Attributes, Business Qualities, Architecture Qualities [TB 2: Ch. 4]
5. Achieving Qualities: Introducing Tactics, Availability Tactics, Modifiability Tactics, Performance Tactics, Security Tactics, Testability Tactics, Usability Tactics, Relationship of Tactics to Architectural Patterns, Architectural Patterns and Styles [TB 2: Ch. 5]
6. Global Analysis: Overview of Global Analysis Activities, Analyze Factors, Develop Strategies., Analyze Organizational Factors, Begin Developing Strategies, Analyze Technological Factors, Continue Developing Strategies, Analyze Product Factors, Continue Developing Strategies [TB 1: Ch. 3]
7. Conceptual Architecture View: Design Activities for the Conceptual Architecture View, Global Analysis, Central Design Tasks: Components, Connectors, and Configuration, Final Design Task: Resource Budgeting, Traceability, Uses for the Conceptual Architecture View [TB 1: Ch. 4]
8. Module Architecture View: Design Activities for the Module Architecture View, Global Analysis, Central Design Tasks: Modularization and Layering, Final Design Task: Interface Design, Traceability, Uses for the Module Architecture View [TB 1: Ch. 5]
9. Execution Architecture View: Design Activities for the Execution Architecture View, Global Analysis, Central Design Tasks: Runtime Entities, Communication Paths, and Configuration, Final Design Task: Resource Allocation, Traceability, Uses for the Execution Architecture View [TB 1: Ch. 6]
10. Code Architecture View: Design Activities for the Code Architecture View, Global

Analysis, Central Design Tasks, Final Design Tasks, Traceability, Uses for the Code Architecture View [TB 1: Ch. 7] 11. Designing & Documenting the Architecture: Architecture in the Life Cycle, Designing the Architecture, Forming Team, Creating a Skeletal System. Documenting Software Architectures, Uses of Architectural Documentation, Views, Choosing the Relevant Views, Documenting a View, Documentation across Views, Unified Modelling Language [TB 2: Ch. 7, Ch. 9] 12. Analyzing Architectures: The ATAM - A Comprehensive Method for Architecture Evaluation, Participants in the ATAM, Outputs of the ATAM, Phases of the ATAM, The Nightingale System: A Case Study in Applying the ATAM [TB 2: Ch. 11] 13. The CBAM: A Quantitative Approach to Architecture Design Decision Making, Decision-Making Context, The Basis for the CBAM, Implementing the CBAM, Case Study: The NASA ECS Project, Results of the CBAM Exercise [TB 2: Ch. 12] 14. Reconstructing Software Architectures: Introduction, Information Extraction, Database Construction, View Fusion, Reconstruction [TB 2: Ch. 10]
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Applied Software Architecture by Christine Hofmeister, Robert Nord and DilipSoni, Addison-Wesley Professional (1999). ISBN-10: 0201325713. 2. Software Architecture in Practice by Len Bass, Paul Clements and Rick Kazman, Addison-Wesley Professional; 2ndEdition (April 19, 2003). ISBN-10: 0321154959 3. Software Architecture in Practice by Len Bass, Paul Clements and Rick Kazman, Addison-Wesley Professional; 3rdEdition (2012). ISBN-10: 0321815734 4. Software Architecture and Design Illuminated by Kai Qian, Xiang Fu, Lixin Tao and Chong-weiXu, Jones & Bartlett Publishers; 1stEdition (2009). ISBN-10: 076375420X 5. Software Architecture: Foundations, Theory, and Practice by R. N. Taylor, N. Medvidovic and E. M. Dashofy, Wiley; 1stEdition (2009). ISBN-10: 0470167742.

SECC-301 Software Construction & Development			
Credit Hours:	2+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. To apply a wide variety of software construction techniques and tools, including state-based and table-driven approaches to low-level design of software.	C	2
2. Able to state-based and table-driven approaches to low-level design of software.	C	2
3. To understand and apply collaborative construction	C	2
4. To understand Refactoring & its strategies	C	2
5. To understand layout and styling of developing software	C	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Software Construction: What Is Software Construction? Why Is Software Construction Important? Metaphors for Software Development, The Importance of Metaphors, how to Use Software Metaphors, Common Software Metaphors. [TB1: Ch. 1, 2]
2. Prerequisites: Importance of Prerequisites, Type of Target Software, Problem-Definition Prerequisite, Requirements Prerequisite, Architecture Prerequisite, Time Constraints. [TB1: Ch. 3]
3. Key Construction Decisions: Choice of Programming Language, Programming Conventions, Localization Aspects of Technology, Selection of Construction Practices. [TB1: Ch. 4]
4. Design in Software Construction: Design Challenges, Key Design Concepts, Design Building Blocks: Heuristics, Design Practices, Popular Methodologies. [TB1: Ch. 5]
5. Defensive Programming: Protecting Your Program from Invalid Inputs, Assertions, Error Handling Techniques, Exceptions, Barricade Your Program to Contain the Damage Caused by Errors, Debugging Aids, Determining How Much Defensive Programming to Leave in Production Code, Being Defensive About Defensive Programming, The Pseudocode. [TB1: Ch. 8]
6. The Software-Quality Landscape: Characteristics of Software Quality, Techniques for Improving Software Quality, Relative Effectiveness of Quality Techniques, when to Do Quality Assurance, Principle of Software Quality. [TB1: Ch. 20]
7. Collaborative Construction: Overview of Collaborative Development Practices, Pair Programming, Formal Inspections, Other Kinds of Collaborative Development Practices. [TB1: Ch. 21]
8. Refactoring: Kinds of Software Evolution, Introduction to Refactoring, Reasons to Refactor, Specific Refactoring, Refactoring Safely, Refactoring Strategies. [TB1: Ch. 24]
9. Program Size & Software Construction: Communication and Size, Range of Project Sizes, Effect of Project Size on Errors, Effect of Project Size on Productivity, Effect of Project Size on Development Activities. [TB1: Ch. 27]
10. Managing Construction: Encouraging Good Coding, Configuration Management, estimating a Construction Schedule, Measurement, Treating Programmers as People, 8.6 Managing Your Manager. [TB1: Ch. 28]
11. Integration: Importance of the Integration Approach, Integration Frequency—Phased or Incremental? Incremental Integration Strategies, Daily Build and Smoke Test. [TB1: Ch. 29]
12. Programming Tools: Design Tools: Source-Code Tools, Executable-Code Tools, Tool-Oriented Environments, Building Your Own Programming Tools, Tool Fantasyland. [TB1: Ch. 30]
13. Layout and Style: Layout Fundamentals, Layout Techniques, Layout Styles, Laying Out Control Structures, Laying Out Individual Statements, Laying Out Comments, Laying Out Routines, Laying Out Classes. [TB1: Ch. 31]
14. Self-Documenting Code: External Documentation, Programming Style as Documentation, To Comment or Not to Comment, Keys to Effective Comments, Commenting Techniques. [TB1: Ch. 32]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Code Complete: A Practical Handbook of Software Construction by Steve McConnell, Microsoft Press; 2nd Edition (July 7, 2004). ISBN-10: 0735619670 2. Compiler Construction (International Computer Science Series) by Niklaus Wirth, Addison-Wesley Pub (Sd); (1996). ISBN-10: 0201403536. 3. Object-Oriented Software Construction (Book/CD-ROM) (2nd Edition) by Bertrand Meyer, Prentice Hall; 2nd Edition (2000). ISBN-10: 0136291554. 4. The Design of Well-Structured and Correct Programs, S. Alagic& M.A. Arbib, Springer-Verlag (1978), ISBN 0-387-90299-6. 5. Object-Oriented Software Construction, by Bertrand Meyer, Second Edition, Published by, Prentice Hall in 1997. Prentice Hall; 2nd Edition (March 21, 2000). ISBN-10: 0136291554

SECC-302 Software Quality Engineering			
Credit Hours:	3+0	**Prerequisites:**	CMPC-106

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
5. Outline software testing and software quality assurance principles.	C	1
6. Prepare test case and test suites for completely testing all aspects of a system under test (SUT)	C	3
7. Analyze which of the software testing techniques are relevant for a particular case and know software reliability analysis tools and techniques.	C	4
8. Compile findings of a quality assurance cycle.	C	5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:
1. A Quality Principles, Benefits of Quality, Organization and Process Benchmarking [TB 1: Ch. No.1]
2. Ethical and Legal Compliance: ASQ Code of Ethics, Legal and Regularity Issues [TB 1: Ch. No.2]
3. Standards and Models: ISO 9000 Standards, IEEE Software Engineering Standards, SEI Compatibility Maturity Model Integration (CMMI).[TB 1: Ch. No.3]
4. Leadership Skills: Organizational Leadership, Facilitation Skills, Communication Skills [TB 1: Ch. No.4]
5. Team Skills, Team Management, Team Tools [TB 1: Ch. No.5]
6. Quality Management System: Quality Goals and Objectives, Customers and Other Stakeholders, Planning, Outsourcing [TB 1: Ch. No.6]
7. Methodologies for Quality Management: Cost of Quality, Process Improvement Models, Corrective Action Procedures, Defect Prevention [TB 1: Ch. No.7]
8. Audit Types, Audit Roles and Responsibilities, Audit Process [TB 1: Ch. No.8]
9. Project Tracking and Control, Tracking Methods, Project Reviews and Program

Reviews [TB 1: Ch. No.16]

10. Software Verification and Validation Method, Software Product Evaluation [TB 1: Ch. No.21]
11. Testing Planning and Design: Test Strategies, Test Plans, Test Design, Test Coverage Specifications, Code Coverage Techniques, Test Environments, Test Tools [TB 1: Ch. No.22]
12. Reviews and Inspection: Peer Reviews, Formal Versus Informal Reviews, Types of Peer Reviews, Walk-Throughs, Inspections, Technical Reviews [TB 1: Ch. No.23]
13. Test Execution Documentation: Test Execution, Test Case, Test Procedure, Test Log, Problem Report, Test Result Data and Metrics, Test Report [TB 1: Ch. No.24]
14. Customer Deliverables: Peer Reviews, Development Testing, Development Audits, Pilots, Installation Testing, Customer/User Testing [TB 1: Ch. No.25]
15. Configuration Control and Status Accounting: Item, Baseline, Version Control, CCB, Concurrent Development, and Status Accounting, Configuration Audit [TB 1: Ch. No.28-29]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. The Certified Software Quality Engineer by Linda Westfall, Quality Press; (September 28, 2009), ISBN-10: 0873897307
2. Software Quality Assurance: Principles and Practice by Nina S. Godbole, published by Alpha Science (2004). ISBN-10: 1842651765.
3. Software Testing: Fundamental Principles and Essential Knowledge by James D. McCaffrey, BookSurge Publishing (2009). ISBN-10: 1439229074.
4. Perfect Software: And other illusions about testing by Gerald M. Weinberg, published Dorest House (2008). ISBN-10: 0932633692.
5. Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement by Jeff Tian, published by John Wiley & sons, (2005). ISBN-10: 0471713457
6. Mastering Software Quality Assurance: Best Practices, Tools and Techniques for Software Developers by Murali Chemuturi, J. Ross Publishing (2010). ISBN-10: 1604270322.

SECC-304 Web Engineering			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Discuss how web standards impact software development.	C	1
2. Describe the constraints that the web puts on developers.	C	2
3. Design and Implement a simple web application.	C	4
4. Review an existing web application against a current web	C	4

standard.		

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. An Introduction to Web Engineering: Categories of Web Applications, Characteristics of Web Applications.
2. Requirements Engineering for Web Applications: Fundamentals of RE, RE Specifics in Web Engineering, Principles for RE of Web Applications, Adapting RE Methods to Web Application Development. [TB 1: Ch. 2]
3. Web Applications Modeling: Fundamentals of WAM, Modeling Specifics in Web Engineering, Modeling Requirements, Content Modeling, Hypertext Modeling, Presentation Modeling, Customization Modeling, Methods and Tools. [TB 1: Ch. 3]
4. Web Application Architectures: Fundamentals of WAA, Specifics of WAA, Components of a Generic AA, Layered Architecture, Data-aspect Architectures. [TB 1: Ch. 4]
5. Technology-away Web Application Design: Web Design from an Evolutionary Perspective, Presentation Design, Interaction Design, Functional Design, Outlook. [TB 1: Ch. 5]
6. Technologies for Web Applications: Fundamentals, Client/Server Communication on the Web, Client-side Technologies, Document-specific Technologies, Server-side Technologies. [TB 1: Ch. 6]
7. Testing Web Applications: Test Web Applications: Fundamentals, Test Specifics in Web Engineering, Test Approaches, Test Scheme, Test Methods and Techniques, Test Automation. [TB 1: Ch. 7]
8. Operation and Maintenance of Web Application: Introduction, Challenges Following the Launch of a Web Application, Promoting a Web Application, Content Management, Usage Analysis. [TB 1: Ch. 8]
9. Web Project Management: Project Management to Web Project Management, Challenges in WPM, Managing Web Team, Managing the Development Process. [TB 1: Ch. 9]
10. Web Application Development Process: Fundamentals, Requirements for a Web Ap plication Development Process, Analysis of the Rational Unified Development Process, Analysis of Extreme Programming. [TB 1: Ch. 10]
11. Usability of Web Applications: What is Usability, Characteristics of Web Application Usability, Design Guidelines, Web Usability Engineering Methods, Web Usability standards, Web Usability Engineering Trends. [TB 1: Ch. 11]
12. Performance of Web Applications: What is Performance, Characteristics of Web Applications Performance, System Definition and Indicators, Characterizing the Workload, Analytical Techniques, Representing and Interpreting Results, Performance Optimization Methods. [TB 1: Ch. 12]
13. Security for Web Applications: Introduction, Aspects of Security, Encryption, Digital Signatures and Certificates, Secure Clients/Server-Interaction, Client Security Issue, Service Provider Security Issues. [TB 1 : Ch. 13]
14. The Semantic Web: Fundamentals, Technological Concepts, Specifics of Semantics Web Applications, Tools. [TB 1: Ch. 14]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Web Engineering: The Discipline of Systematic Development of Web Applications by Gerti Kappel, Birgit Pr ¨ oll, Siegfried Reich, Werner Retschitzegger, Springer; Softcover reprint of hardcover 1st Edition. 2008 Edition (December 10, 2010). ISBN-10:184996677X 2. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016 3. Web Engineering, Emilia Mendes and Nile Mosley, Springer Verlag, 2010. 4. Web Engineering: A Practitioners' Approach, Roger S. Pressman, McGraw Hill, 2008. 5. Dynamic HTML: The Definitive Reference: A Comprehensive Resource for XHTML, CSS, DOM, JavaScript 3rd Edition, O'Reilly Media 2007. 6. JavaScript: The Definitive Guide, 8th Edition, David Flanagan. O'Reilly Media. 2014.

SECC-401 Software Project Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explain principles of the project lifecycle and how to identify opportunities to work with learners on relevant and appropriate project scenarios to share this understanding.	C	2
2. Critically evaluate and discuss the issues around project management and its application in the real world with course participants and learners	C	3
3. Choose project management techniques for IT projects to initiate, plan, execute and evaluate a project and work in teams to create a project plan for a project scenario that includes key tasks, critical path, dependencies and a realistic timeline.	C	3
4. Present strategies for gaining confidence in managing projects through simple project planning examples.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction: Software Project Versus Other Type of Projects Dimensions of a Software Project, Activities in SPM, Setting Goals & Objectives, Business Case, Significance of Processes, Project Vs. Program Management, [TB1: Ch. 1, Handouts] 2. Introduction of PM Tools, PMI's Knowledge Areas, Technical Fundamentals in SPM, Lifecycle Relationships, Classic Mistakes Product-Process-Peoples-Technology Mistakes [TB2, Handouts] 3. PMI Framework, PMI Process Groups: Process Initiating Process Group, Planning Process Group, Executing Process, Process Monitoring and controlling, Closing Process Group, Project Charter, Statement of Work.[TB2, Handouts] 4. Understanding Organizations, Organizational Structures, Functional -Project –Matrix,

Organizational Impact on Projects, Identifying stakeholders: Define Responsibilities, Authority Relationships, Position Qualifications [TB2, Handouts]

5. Project Planning: Project Selection, Project Scope, Project Infrastructure, Analyze Project Characteristics, Identify Project & Product Activities, Work Break Down Structure [TB1: Ch. 3]
6. Project Evaluation: Strategic Assessment, Technical Assessment, Economic Assessment, Project Portfolio Management, Cost-Benefit Analysis, Cash Flow Forecasting, Cost-Benefit Evaluation Techniques, Procurement Management, Procurement Tools &Techniques, Types of Contracts [TB1: Ch. 2]
7. Selection of an Appropriate Approach in Project: Choosing Technologies, Technical Plan, Waterfall Model, V-Model, Spiral Model, Software Prototyping, Incremental Delivery, Agile Process Model: Dynamic Systems Development Method, Extreme Programming, Selection of Most Appropriate Process Model [TB1: Ch. 4]
8. Software Effort Estimation: Work Breakdown Structure (WBS) and Its Types, Estimation Problems, Software Estimation Techniques: Expert Judgment, Estimating By Analogy, LOC, Function Point Estimation, and COCOMO [TB1: Ch. 5]
9. Activity Planning: Project and Activities, Sequencings and Scheduling Activities, Network Planning Models, Formulation of Network Model, Adding the Time Dimensions, The Forward Pass, The Backward Pass, Identifying the Critical Path, Identifying the Critical Activities Project, AOA, GanttChart, (Installation & Configuration of Software Tools like MS-Project).[TB1: Ch. 6]
10. Risk Management: Categories of Risks, A Framework for Dealing with Risks, Evaluating the Risks to the Schedule: PERT, Importance of Risk, Types Of Risk, Risk Identification Techniques, Project Risk and Change Management [TB1: Ch. 7]
11. Risk Control, RMMM, Configuration Management & Maintenance, Environment for Configuration Control, Configuration Control vs. Version Control [TB1: Ch. 7, OLM]
12. Resource Allocation: Nature of Resources, Identifying Resource Requirements, Scheduling Resources, Resource Scheduling Techniques[TB1: Ch. 8]
13. Monitoring & Control: Creating Framework, Collecting Data, Visualizing Progress, Cost Monitoring, Earned Value, Change Control [TB1: Ch. 9]
14. Review and Evaluation: Determining Satisfaction of Requirements, Reviewing And Evaluating Performance, Project Closure: Project Documentation, Cutover/Migration, Quality Standards, Project Closing. [TB2]
15. Challenges of Outsourcing in Project Management, Presentations

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Software Project Management by Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009). ISBN-10: 0077122798
2. A Guide to the Project Management Body of Knowledge, 3rdEdition (PMBOK Guides), ISBN-13: 978-1930699458
3. Applied Software Project Management by Andrew Stellman and Jennifer Greene, O'Reilly Media; 1st Edition (2005). ISBN-10: 0596009488
4. Software Project Survival Guide (Pro -- Best Practices) by Steve McConnell, Microsoft Press; 1stEdition (1997), ISBN-10: 1572316217
5. Mastering Software Project Management: Best Practices, Tools and Techniques by Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing (2010). ISBN-10: 1604270349
6. Effective Project Management: Traditional, Agile, Extreme by Robert K. Wysocki, Wiley; 6th Edition (2011). ISBN-10: 111801619X
7. The Software Project Manager's Handbook - Principles that work at work by Dwayne Phillips, 2ndEdition, IEEE Computer Society Press and Wiley Inter-science, 2004. ISBN 0-471-67420-6

SECC-403 Software Re- Engineering			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand basic of software maintenance terminologies	C	2
2. Understand concept of maintenance effort using COCOMO model, analyzing the software scale drivers and software cost drivers	C	2
3. Explain legacy systems, legacy system components and the concept of software reuse in supporting software maintainability,	C	2
4. List the concept of architectural evolution concept.	C	2
5. Understand Reusability techniques and software metrics	C	2

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Software Maintenance: The nature of Software maintenance, Software Maintenance types, Characteristics of maintainable software.
2. Software Maintenance Process Models: The Software Maintenance Process Lifecycle, Evolution Process, Change Request and Change Requests Management.
3. Software Maintenance Process Models: Impact Analysis, System Release Planning, Change Implementation, Regression Testing and System Testing, Acceptance Testing, Quality Assurance, System Release, Version and Release management issues
4. Software Maintenance Process Models; The software maintenance process Models: Quick-and-Fix Model, Bohem's Model
5. Software Maintenance Process Models: Osborne Model, Iterative Model, SW Maintenance difficulties

6. Legacy Systems: Software Types: S-Type, P-Type, Lehman's laws, Legacy Systems Structure and definitions.
7. Legacy Systems: Legacy System Design, Legacy replacement strategies., Legacy System Assessment
8. Software Cost Modeling: Maintenance Cost issues using COCOMO II model, Bohem's Maintenance Cost Model.
9. Software Cost Computing: Application Scenario, Software Scale Drivers, Software Cost Drivers, Function Points.
10. System Evolution; Program evolution dynamics, Architectural evolution (n-tire), Architectural evolution (VMC, SC, Web services).
11. Software Re- engineering in Maintenance; The Re- Engineering Process Definition, Advantages, Re-engineering Process: Source code translation, Reverse engineering, Reverse Engineering v/s Forward Engineering
12. Software Re- engineering in Maintenance: Reverse Engineering Process, Program structure improvement, Program modularization.
13. Data re-engineering in Maintenance; Data re-engineering Process, Data Migration, Data Restructuring
14. Software Reuse and Reuse Landscape; Software Reusability Definition, Problems. Benefits, Approaches to Reuse, Software Reuse and Maintainability Issues Design Patterns, Frameworks, Program Generators, COTS, Reuse, Aspect-Oriented Development, Product Lines, Web-Services.
15. Software Metrics; Software Quality Measures, Types of measures: Size –Oriented Metrics, Metrics for Source Code, Metrics for Testing, Metrics For Maintenance, Metrics For Design, Metrics For Specification

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. P.i Tripathy & K. Naik, Software Evolution and Maintenance: A Practitioner's Approach, Wiley, 2015.
2. I. Sommerville Software Engineering, 10th Edition, Addison Wesley, 2016.
3. Software Engineering A practitioner's Approach, Roger Pressman, 7th edition, 2010
4. Penny Grubb & Armstrong A Takang Software Maintenance: Concepts and Practice, (2nd Edition), World Scientific Publishing Co. Pte. Ltd , 2003
5. Software Engineering A practitioner's Approach, Roger Pressman, 7th edition, 2010
6. Software Engineering, Ian Sommerville, 8th Edition, Addison Wesley, 2007.

Contents of General Education Courses

ENGL-101 English Composition & Comprehension			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT**

		Level*
1. Can articulate clearly, take and pass on messages, deal with customers effectively, read, understand and follow a wide range of documents and write fluently and accurately, using accepted business conventions of format, spelling, grammar and punctuation.	C	2
2. This course is developed to strengthen students these skills which enable them to deal with the practical problems and challenges of life – at home, in education and at work.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Punctuation: Periods, Question Marks, Exclamation Marks, Semicolons, Colons, Commas, Apostrophes, Quotation Marks.
2. Writing Mechanics: Capitals, Abbreviations; Vocabulary: Frequently Confused Words, Frequently Misused Words,
3. Vocabulary: Phrases, Synonyms, Antonyms, Idioms, General Vocabulary
4. Use Of Articles And One, A Little/ A Few, This, That, Care, Like, Love, Hate, Prefer, Wish, All, Each, Every, Both, Neither, Either, Some, Any, No, None; Interrogatives: Wh-? Words And How?
5. Kinds of Nouns; Kinds of Adjectives; Adverbs: Kinds, Form, Position and Use
6. Prepositions; Possessive, Personal and Reflexive Pronouns; Relative Pronouns and Clauses
7. Classes of Verbs: Ordinary Verbs, Auxiliary Verbs (Be, Have, Do); May and Can for Permission and Possibility; Can and Be Able for Ability; Ought, Should, Must, Have To, Need for Obligation; Must, Have, Will and Should for Deduction and Assumption; The Auxiliaries Dare and Used
8. The Present Tenses
9. The Past and Perfect Tenses
10. The Future; The Infinitive
11. The Gerund & The Participles; Commands, Requests, Invitations, Advice, Suggestions; The Subjunctive
12. The Passive Voice; Indirect Speech
13. Conjunctions, Purpose
14. Clauses: Noun Clauses; Clauses of Reason, Result, Concession, Comparison, Time
15. Numerals, Dates, and Weights And Measures; Spelling Rules;
16. Phrasal Verbs, List Of Irregular Verbs

Teaching Methodology:

Lecturing, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. A Practical English Grammar by A. J. Thomson and A. V. Martinet,4th Edition Oxford University Press (1986).
2. Basic English Usage by Michael Swan, Oxford UnivPr (Sd) (January 1986). ISBN-10: 0194311872
3. Functional English In Aglobal Society: Vocabulary Building and Communicative

Grammar by Nicanor L. Guintomary Ann R. Sibal Brian D. Villaverde Dept. of Languages, Literature and Humanities College of Arts and Sciences Southern Luzon State University (2012).
4. AQA Functional English Student Book: Pass Level 2 by Mr David Stone, Heinemann; 1st Edition (28 Jun 2010). ISBN-10: 0435151401
5. English Composition and Grammar: Complete Course by John E. Warriner, Harcourt Brace Jovanovich; Complete Course Benchmark Edition (January 1988). ISBN-10: 0153117362
6. Companion to English: Vocabulary (Learners Companion) by George Davidson, Prim-Ed Publishing (March 1, 2003). ISBN-10: 9814070904
7. Word Power Made Easy by Norman and Lewis, Goyal Publishers (September 1, 2009). ISBN-10: 8183071007
8. 1000 Most Important Words by Norman W. Schur, Ballantine Books (July 12, 1982). ISBN-10: 0345298632
9. High School English Grammar and Composition by P.C Wren, Chand & Co (July 13, 2008). ISBN-10: 812192197X

ENGL-102 Communication Skills (English-II)			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. To sensitize students to their communicative behavior	C	2
2. To enable them to reflect and improve on their communicative behavior/performance.	C	2
3. To build capacities for self-criticism and facilitate growth.	C	2
4. To lead students to effective performances in communication.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Communication Skills: What Is Communication, The Importance of Communication, What Are Communication Skills? The Communication Process : Source, Message, Encoding, Channel , Decoding , Receiver, Feedback, Context . Perspectives in Communication: Introduction, Visual Perception, Language, Other Factors Affecting Communication Perspective, Past Experiences, Prejudices, Feelings, Mood, Relationship, Environment.
2. Internal Representation: Introduction, Internal Representation of Our World, Language as a Representational System, Verbal Clues, Visual Representation System, Auditory Representational System, Kinaesthetic Representational System, Auditory Digital Representational System, Eye Movements as an Indication, Visual Recall, Visual Con-struct, Auditory Recall, Auditory Construct, Kinaesthetic, Internal Auditory, Phrases for Use in Response to Each Representational System.
3. Elements of Communication: Introduction, Face to Face Communication, Tone of Voice, Body Language, Verbal Communication, Physical Communication. Communication Styles: Introduction, The Communication Styles Matrix, Direct Communication Style,

Spirited Communication Style, Systematic Communication Style, Considerate Communication Style, Examples of Communication for Each Style, Direct Style, Spirited Style, Systematic Style Considerate Style.

4. Listening: Real Vs. Introduction, Self-Awareness, Pseudo Listening, Active Listening, Blocks to Listening, Assessing Your Listening, Four Steps to Effective Listening, Total Listing, Becoming an Active Listener.
5. Expressing: The Four Kinds of Expression, Whole Message, Contaminated Messages, Preparing Your Message, Practicing Whole Message, Rules of Effective Expression. Body Language: Body Movement, Spatial Relationships. Paralanguage and Meta-messages: The Element of Paralanguage, Changing Your Paralanguage, Meta-message, Coping with Meta-message. Hidden Agendas: The Eight Agendas, Purpose of the Agenda.
6. Clarifying Language: Understanding a Model, Challenging the Limits of a Model, Challenging Distortion in a Model. Assertiveness: Your Legitimate Right, Three Communication Styles, Identifying Communication Style, Your Assertive Goals, Assertive Expression and Listening, Combining Assertive Expression and Listening, Responding to Criticism, Special Assertive Strategies.
7. Making Contact: Fear of Stranger, Guidelines for Making Contact, The Art of Conversation, Putting It All Together. Negotiations: Four Stages of Negotiation, Dealing with Conflicts, Rules of Principles Negotiation, When The Going Get Tough.
8. Prejudgment: Prejudgment Traps, Stereotypes, Approval and Disapproval in Prejudgment, Parataxic Distortion, Perpetuating Illusion, Clarifying First Impression. Validation Strategies: What is validation, Why Does Validation Work? What Validation Is Not? Components of Validation, Successful Validation Strategies, The Power of Validation.
9. Influencing Others: What is Persuasion? Persuading Audience, Ineffective Strategies for Influencing Change, Effective Strategies, for Influencing Others, Your Plan for Influencing Change, Lisa‘s Plan for Influencing Change Art of Persuasion.
10. Public Speaking: Defining Your Purpose, Outlining The Subject, Presentation, Organization, Audience Analysis, Style, Supporting Materials, The Outline, Delivery, Deal-ing with Stage Fright.
11. Preparing A Formal Oral Presentation: Presentation Design: Introduction, Consistency, Aspects of Consistency Language, Color, Fonts, Images, Contrast, Alignment, Simplicity, White Spaces, Charts, Graphics & Tables, How to Choose Which Type of Graph to Use? Graph Types, Multimedia Presentations, Adding Quotations.
12. Delivering Presentation: Introduction, Delivery, Managing Voice, Passion, Language, Movement, Facial Expressions, Body Language, Some Useful Tips: Active Listening, Inventing Stories, Feedback, Preliminary Preparations Proximity, Tension & Nerves, Questions, Tips to Handle Questions, Habits, Handling Tough Situations, Common Mistakes & Their Remedies, Dealing with Unexpected Disasters, Presentation for International Audience, Dealing People with Disabilities, Things to Remembers, Last Minute Tips.
13. Interviewing: Clarifying What You Want, If You are the Interviewer, If You Are the Interviewee.
14. Effective Written Communication: Introduction, When and When Not to Use Written Communication, Complexity of the Topic, Amount of ‗Discussion‘ Required, Shades of Meaning Formal Communication, Writing Effectively, Subject Lines, Put the Main Point First, Know Your Audience, Organization of the Message.
15. Building Rapport: Introduction, Six Steps to Building Rapport, Match the Person‘s Sensory Modality, Mirror the Person‘s Physiology, Match the Person‘s Voice, Match the Person‘s Breathing, Match the Way the Person Deals with Information, Match Common

Experiences, Calibration, Perceptual Positions.
Teaching Methodology:
Lecturing, Written Assignments, Report Writing, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:

1. Effective Communication Skills, MTD Training & Ventus Publishing ApS.(2010) ISBN 978-87-7681-598-1 (TB1)
2. Messages: The Communication Skills Book by Matthew McKay PhD , Martha Davis PhD, and Patrick Fanning, New Harbinger Publications; Third Edition (March 3, 2009). ISBN-10: 1572245921
3. Secrets of Successful Presenters: A Guide for Successful Presenters by Dr. M. A. Pasha & Dr. S. Pasha, Lambert Academic Publishing (2012). ISBN-10:3659217557
4. Communication Skills in English by Prof P N Kharu, Dr.Varinder Gandhi Publisher: Laxmi. EAN: 9788131806920
5. Essential Communication Skills: Teacher Edition with Talking Points by Patty Ann, Patty Ann; 1st Edition (July 5, 2012). ASIN: B008HYUDWQ
6. Communication Skills Magic: Improve Your Relationships & Productivity through Better Understanding Your Personality Style and the Personality Styles of Those Around You by E.G. Sebastian, CreateSpace Independent Publishing Platform (Janu-ary 5, 2010). ISBN-10: 1450513344
7. People Skills: How to Assert Yourself, Listen to Others, and Resolve Conflicts by Robert Bolton,Touchstone (June 6, 1986). ISBN-10: 067162248X
8. The Handbook of Communication Skills by Owen Hargie, Routledge; 4th Edition, Taylor & Francis, (12-Oct-2012). Web Engineering: A Practitioners' Approach, Roger S. Pressman, McGraw Hill, 2008.
9. Dynamic HTML: The Definitive Reference: A Comprehensive Resource for XHTML, CSS, DOM, JavaScript 3rd Edition, O'Reilly Media 2007.
10. JavaScript: The Definitive Guide, 8th Edition, David Flanagan. O'Reilly Media. 2014.

ENGL-301 Technical and Report Writing (English-III)			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Effectively plan and structure technical reports and to recognize the various stages in writing a technical report.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Writing for Readers: Academic, Public, and Work Communities; Analyzing Electronic Communities; Myths and Realities about Writing.

2. Discovering and Planning: Discovering Topics; Generating Ideas; Organizing Information; Planning in Digital Environments.
3. Purpose, Thesis, and Audience: Identifying Your Focus and Purpose; Creating a The-sis; Understanding Your Readers.
4. Drafting: Moving from Planning to Drafting, Drafting Collaboratively, Drafting in Digital Environments.
5. Revising, Editing, and Proofreading: Making Major Revisions; Making Minor Revisions; Revising Collaboratively; Revising in Digital Environments; Editing; Editing Collaboratively; Proofreading.
6. Paragraphs: Unfocused Paragraphs; Revising for Focus; Incoherent Paragraphs; Re-vising for Coherence; Poorly Developed Paragraphs; Revising for Development; Using Special-Purpose Paragraphs.
7. Clear and Emphatic Sentences: Unclear Sentences; Revising for Clear Sentences; Re-vising for Variety and Emphasis.
8. Reasoning Critically: Recognizing Critical Reasoning, Building a Chain of Reasoning, Representing Your Reasoning.
9. Reading Critically: Reading to Understand; Reading to Respond and Evaluate; Using Journals to Turn Reading into Writing.
10. Arguing Persuasively: Recognizing an Issue, Developing Your Stance, Creating an Argumentative Thesis, Developing Reasons and Evidence, Acknowledging Other Perspectives, Arguing Logically, Writing a Position Paper.
11. Designing Documents: Goals of Document Design, Format Choice, Layout, Type Choice, Visuals, Sample Documents. Creating a Visual Argument: Presenting an Is-sue, Providing Evidence.
12. Writing in Online Communities: Online Expectations, E-mail Conventions, Online Communities, Web Pages, Avoiding Plagiarism and Behaving Ethically Online.
13. Speaking Effectively: Oral Presentations, Preparing an Oral Presentation, Managing Speech Anxiety, Fielding Questions.
14. Academic Writing: Social and Natural Sciences: Goals of Writing in the Social and Natural Sciences, Audiences in the Social and Natural Sciences, Writing Tasks in the Social and Natural Sciences, Types of Writing in the Social and Natural Sciences,
15. Abstract, Informative Report, Lab Report, Research Report,
16. Public Writing: Goals of Public Writing, Public Audiences, Public Writing Tasks, Types of Public Writing, Public Flyer, Letter to the Editor, Oral Presentation.
17. 16. Researching and Writing: Beginning Your Research, Types of Research Writing, Developing a Research Question, Developing a Preliminary Thesis, Creating a Re-search File and a Timeline, Reading and Notetaking, Summarizing, Paraphrasing, and Synthesizing.

Teaching Methodology:

Lecturing, Written Assignments, Report Writing, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Writer's Companion – The Longman by Chris M. Anson, Robert A. Schwegler and Marcia F. Muth, Pearson Longman, 4th Edition (2007) . ISBN10: 0-20556-252-3
2. Technical English: Writing, Reading, and Speaking by Pickett and Laster. 8th Edition.
3. The Technical Writer‘s Companion byAlred, Gerald, Charles T. Brusaw and Walter E. Oliu, 3rd Edition. ISBN 0-312-25978-6.

PKST-101 Pakistan Studies			
Credit Hours:	2+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.	C	2
2. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. [TB 1: Ch 1] 2.
Teaching Methodology:
Lecturing, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1.

ISLS-102 Islamic Studies			
Credit Hours:	2+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Enhance understanding of the students regarding Islamic Civilization.	C	2
2. Improve Students skill to perform prayers and other worships.	C	2
3. Enhance the skill of the students for understanding of issues related to faith and religious life.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. [TB 1: Ch 1] 2.
Teaching Methodology:
Lectures, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1.

ICTC-101 Introduction to Information & Communication Technologies			
Credit Hours:	2+1	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Get basic understanding of computer software, hardware, and associated technologies.	C	2
2. Learn how computers are used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to Computers: Data and Information, Information Processing Cycle, the Components of a Computer, Advantages and Disadvantages of Using Computers. Networks and the Internet. Computer Software, Categories of Computers, Elements of an Information System, Examples of Computer Usage, Computer Applications in Society [TB 1: Ch. 1].
2. The Internet and World Wide Web: Key Concepts of the Internet, Evolution of the Internet, The World Wide Web, E-Commerce, Other Internet Services, Netiquette [TB 1: Ch. 2].
3. Application Software: Business Software, Graphics and Multimedia Software, Soft-ware for Home, Personal, and Educational Use, Web Applications, Application Soft-ware for Communications. [TB 1: Ch. 3]
4. The System Unit: Processor, Data Representation, Memory, Expansion Slots and Adapter Cards, Ports and Connectors, Buses, Bays, Power Supply. [TB 1: Ch. 4]
5. Input Devices: What Is Input? What Are Input Devices? The Keyboard, Pointing De-vices, Mouse, Other Pointing Devices, Touch Screens And Touch-Sensitive Pads, Pen Input, Other Input For Smart Phones, Game Controllers, Digital Cameras, Voice In-put, Video Input, Scanners And Reading Devices, Biometric Input, Terminals, Putting It All Together, Input Devices For Physically Challenged Users. [TB 1: Ch. 5]
6. Output Devices: What is Output? Display Devices, Printers, Speakers, Headphones, and Ear buds, Other Output Devices. [TB 1: Ch. 6]
7. Storage: Hard Disks, Flash Memory Storage, Cloud Storage, Optical Discs, Other Types of Storage. [TB 1: Ch. 7]
8. System Software: Operating Systems, Operating System Functions, Types Of Operating Systems, Stand-Alone Operating Systems, Server Operating Systems, Embedded Operating Systems, Utility Programs [TB 1: Ch. 8]
9. Communications: Uses of Computer Communications, Networks, Network Communications Standards, Communications Software, Communications over the Telephone Network, Communications Devices, Home Networks, Communications Channel, Physical Transmission Media, Wireless Transmission Media. [TB 1: Ch. 9]
10. Databases: Data, and Information, The Hierarchy of Data, Maintaining Data, File Processing Versus Databases, Database Management Systems, Relational, Object-

Oriented, and Multidimensional Databases, Web Databases, Database Administration 11. Computer Security and Safety, Ethics, and Privacy: Computer Security Risks, Internet And Network Attacks, Unauthorized Access And Use, Hardware Theft And Vandal-ism, Software Theft, Information Theft, System Failure, Backing Up, Wireless Security, Health Concerns Of Computer Use, Ethics And Society
Teaching Methodology:
Lecturing, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Discovering Computers by Gary B. Shelly & Misty E. Vermaat, Course Technology; 1st Edition (January 25, 2011). 2. Computing Essentials 2012 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 22nd Revised Edition (February 1, 2011). 3. Computers: Understanding Technology by Fuller, Floyd; Larson, Brian, Fourth Edition, ISBN: 978-0-76383-927-7 (OR Latest Edition.) 4. The Concepts of Information Technology by Imran Saeed, Afsan Raza, Tariq Mahmood and Zafar Hussain, 6th Edition, IT Series Publications. 5. The Essential Guide to Computing: The Story of Information Technology by by E Garrison Walters, Prentice Hall PTR (August 11, 2000). ISBN-10: 0130194697 6. Computer Applications by Tasleem Mustafa, Tariq Mahmood, Imran Saeed and Zahid Javed, IT Publication Series

SESC-306 Professional Practices			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand responsibilities with respect to the society	C	2
2. Understand historical, social, economic, ethical, and professional issues related to the discipline of Computing	C	2
3. It identifies key sources for information and opinion about professionalism and ethics.	C	2
4. Analyze, evaluate, and assess ethical and professional computing case studies.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. The Engineering Profession [TB 1: Ch. 1] 2. The Structure of Organizations [TB 1: Ch. 2] 3. Finance and Accounting [TB 1: Ch. 3] 4. Anatomy of a Software House [TB 1: Ch. 4] 5. Computer Contracts [TB 1: Ch. 5] 6. Intellectual Property Rights [TB 1: Ch. 6]

7. The Framework of Employee Relations Law and Changing Management Practices [TB 1: Ch. 7] 8. Human Resource Management and Software Engineering [TB 1: Ch. 8] 9. Health and Safety at Work [TB 1: Ch. 9] 10. Software Liability: Liability and Practice [TB 1 : Ch. 10] 11. Computer Misuse and the Criminal Law [TB 1: Ch. 11] 12. Regulation and Control of Personal Information: Data Protection, Defamation and Related Issues [TB 1: Ch. 12] 13. The British Computer Society Code of Conduct [Online] 14. IEEE Code of Ethics [Online] 15. ACM Code of Ethics and Professional Conduct [Online] 16. 16. ACM/IEEE Software Engineering Code of Ethics and Professional Practice [Online]
Teaching Methodology:
Lectures, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513 2. Online Resources 3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488 4. Applied Professional Ethics by Gregory R. Beabout, University Press Of America (1993). ISBN-10: 0819193747. 5. The Dark Side of Software Engineering: Evil on Computing Projects by Johann Rost and Robert L. Glass, Wiley-IEEE Computer Society Pr; 1st Edition (2011). ISBN-10: 0470597178 6. Software Engineering Best Practices: Lessons from Successful Projects in the Top Companies by Capers Jones, McGraw-Hill Osborne Media; 1st Edition (2009). ISBN-10: 007162161X

Contents of SE Supporting (Math/Science) Required Elective Courses

MATH-101 Calculus and Analytical Geometry			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

1. Understand the foundation and basic ground for calculus and analytical geometry background.	C	2

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Real Numbers and the Real Line, Coordinates, Lines, and Increments, Functions, Shifting Graphs, Trigonometric Functions. [TB 1: Preliminaries]
2. Limits and Continuity: Rates of Change and Limits, Rules for Finding Limits, Target Values and Formal Definitions of Limits, Extensions of the Limit Concept, Continuity, Tangent Lines. [TB 1: Ch. 1]
3. Derivatives: The Derivative of a Function, Differentiation Rules, Rates of Change, Derivatives of Trigonometric Functions, The Chain Rule, Implicit Differentiation and Rational Exponents. [TB 1: Ch. 2]
4. Applications of Derivatives: Extreme Values of Functions, The Mean Value Theorem, The First Derivative Test for Local Extreme Values, Graphing with y‘ and y‘‘. [TB 1: Ch. 3]
5. Integration: Indefinite Integrals, Integration by Substitution—Running the Chain Rule Backward, Estimating with Finite Sums, Riemann Sums and Definite Integrals, Prop-erties, Area, and the Mean Value Theorem. Substitution in Definite Integrals. Numeri-cal Integration. [TB 1: Ch. 4]
6. Applications of Integrals: Areas between Curves, Finding Volumes by Slicing, Vol-umes of Solids of Revolution—Disks and Washers. Cylindrical Shells. Lengths of Plan Curves, Areas of Surfaces of Revolution, Moments and Centers of Mass. [TB 1: Ch. 5]
7. Transcendental Functions: Inverse Functions and Their Derivatives, Natural Loga-rithms, The Exponential Function, ax and logax, Growth and Decay, L'Hôpital's Rule, Relative Rates of Growth, Inverse Trigonometric Functions, Derivatives of Inverse Trigonometric Functions; Integrals. Hyperbolic Functions. [TB 1: Ch. 6]
8. Conic Sections, Parameterized Curves, and Polar Coordinates: Conic Sections and Quadratic Equations. Classifying Conic Sections by Eccentricity. Quadratic Equations and Rotations. Parameterizations of Plan Curves. Calculus with Parameterized Curves. Polar Coordinates. Graphing in Polar Coordinates. Polar Equations for Conic Sections. Integration in Polar Coordinates. [TB 1: Ch. 7, 9]
9. Vectors and Analytic Geometry in Space, Vectors in the Plane Dot Products, Vector-Valued Function Cartesian (Rectangular) Coordinates and Vectors in Space. Dot Products. Cross Products. Lines and Planes in Space. Cylinders and Quadric Surfaces. Cylindrical and Spherical Coordinates. [TB 1: Ch. 9, 10]

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Calculus and Analytic Geometry by George B. Thomas and Ross L. Finney, Addison Wesley; 10th Edition (1995) ISBN-10: 0201531747
2. Calculus and Analytical Geometry by Swokowski, Olinick and Pence, 6th Edition, (1994), Brooks/Cole Publishers.
3. Calculus by Howard Anton, Irl C. Bivens, Stephen Davis, Wiley; 10th Edition (2012), ISBN-10: 0470647728
4. Calculus with Analytic Geometry: Student Solution Manual by Howard Anton, Wiley; 5th Edition (1995). ISBN-10: 0471105899

MATH-201 Linear Algebra			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to Vectors: Vectors and Linear Combinations, Lengths and Dot Products, Matrices. [TB1: Ch. 1]
2. Solving Linear Equations: Vectors and Linear Equations, the Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices. [TB1: Ch. 2]
3. Elimination = Factorization; A = LU, Transposes and Permutations
4. Vector Spaces and Subspaces: Spaces of Vectors, The Null space of A: Solving Ax = 0, The Rank and the Row Reduced Form, the Complete Solution to Ax = B, Independence, Basis and Dimension, Dimensions of the Four Subspaces. [TB1: Ch. 3]
5. Orthogonally: Orthogonally of the Four Subspaces, Projections, Least Squares Approximations, Orthogonal Bases and Gram-Schmidt. [TB1: Ch. 4]
6. Determinants: The Properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes. [TB1: Ch. 5]
7. Eigenvalues and Eigenvectors: Introduction to Eigenvalues, Diagonalizing a Matrix, Applications to Differential Equations, Symmetric Matrices, Positive Definite Matrices, Similar Matrices, Singular Value Decomposition (SVD). [TB1: Ch. 6]
8. Applications: Matrices in Engineering, Graphs and Networks, Markov Matrices, Population, and Economics; Linear Programming, Fourier series: Linear Algebra for Functions, Linear Algebra for Statistics and Probability, Computer Graphics.
9. Numerical Linear Algebra: Gaussian Elimination in Practice, Norms and Condition Numbers, Iterative Methods for Linear Algebra. [TB1: Ch. 9]
10. Complex Vectors and Matrices: Complex Numbers, Hermitian and Unitary Matrices, Matrix Factorizations. [TB1: Ch. 10]

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Introduction to Linear Algebra by Gilbert Strang, Wellesley Cambridge Press; 4th Edition (February 10, 2009). ISBN-10: 0980232716
2. Elementary Linear Algebra with Applications by Bernard Kolman, David Hill, 9th Edition, Prentice Hall PTR, 2007. ISBN-10: 0132296543
3. Strang's Linear Algebra And Its Applications by Gilbert Strang, Strang, Brett Coonley, Andy Bulman-Fleming, Andrew Bulman-Fleming, 4th Edition, Brooks/Cole, 2005

4. Elementary Linear Algebra: Applications Version by Howard Anton, Chris Rorres, 9th Edition, Wiley, 2005.
5. Linear Algebra and Its Applications by David C. Lay, 2nd Edition, Addison-Wesley, 2000.
6. Linear Algebra by Harold M. Edwards, Birkhäuser; 1st Edition (2004). ISBN-10: 0817643702
7. Linear Algebra: A Modern Introduction by David Poole by Brooks Cole; 3rd Edition (May 25, 2010).ISBN-10: 0538735457

STAT-202 Probability and Statistics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the concepts of data analysis, presentation, counting techniques, probability and decision making.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to Statistics and Data Analysis: Statistical Inference, Samples, Populations, and the Role of Probability, Sampling Procedures; Collection of Data, Measures of Location: The Sample Mean and Median, Measures of Variability, Discrete and Continuous Data, Statistical Modeling, Scientific Inspection, and Graphical, General Types of Statistical Studies: Designed Experiment, Observational Study, and Retrospective Study. [TB 1: Ch. 1]
2. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. [TB 1: Ch. 2]
3. Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Joint Probability Distributions. [TB 1: Ch. 3]
4. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. [TB 1: Ch. 4]
5. Discrete Probability Distributions: Binomial and Multinomial Distributions, Hyper-geometric Distribution, Negative Binomial and Geometric Distributions, Poisson Distribution and the Poisson Process. [TB 1: Ch. 5]
6. Continuous Probability Distributions: Continuous Uniform Distribution, Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Gamma and Exponential Distributions, Chi-Squared Distribution, Beta Distribution. [TB 1: Ch. 6]
7. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. [TB 1: Ch. 8]
8. One- and Two-Sample Estimation Problems: Introduction, Statistical Inference, Classical

Methods of Single Sample: Estimating the Mean, Standard Error of a Point, Pre-diction Intervals, Tolerance Limits, Estimating the Difference between Two Means. [TB 1: Ch. 9]

9. Single Sample: Estimating a Proportion, Estimating the Difference between Two Pro-portions, Single Sample: Estimating the Variance, Estimating the Ratio of Two Variances. [TB 1: Ch. 9]
10. One- and Two-Sample Tests of Hypotheses: Statistical Hypotheses: General Concepts, Testing a Statistical Hypothesis, The Use of P-Values for Decision Making in Testing Hypotheses. [TB 1: Ch. 10]
11. Single Sample: Tests Concerning a Single Mean, Two Samples: Tests on Two Means, Choice of Sample Size for Testing Means, Graphical Methods for Comparing Means, One Sample: Test on a Single Proportion, Two Samples: Tests on Two Proportions. [TB 1: Ch. 10]
12. One- and Two-Sample Tests Concerning Variances, Goodness-of-Fit Test, Test for Independence (Categorical Data), Test for Homogeneity [TB 1: Ch. 10]
13. Simple Linear Regression and Correlation: Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators. [TB 1: Ch. 11]
14. 14. Multiple Linear Regression and Certain: Nonlinear Regression Models, Introduction, Estimating the Coefficients, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators. [TB 1: Ch. 12]

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson; 9th Edition (January 6, 2011). ISBN-10: 0321629116
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 3rd Edition (February 3, 2006), ISBN-10: 0495107573
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. AluSrinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10: 0071544259
4. Probability: A Very Short Introduction by John Haigh, Oxford University Press (2012). ISBN-10: 0199588481

PHYS-101 Applied Physics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the basic laws of physics, circuiting and basics of transistors.	C	2

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Zero Reference Level, Chassis Ground, Ohm‘s Law, Formula Variations of Ohm‘s Law, Graphical Representation of Ohm‘s Law, Linear Resistor, Non Linear Resistor, Cells in Series and Parallel.[TB 1: Ch 1]
2. Resistive Circuits. [TB 1: Ch 2]
3. Resistors(5.1-15), Inductors(5.19-21) Capacitors(5.35-48) .[TB 1: Ch 5]
4. Energy Sources. [TB 1: Ch 6]
5. Magnetism and electromagnetism [TB 1: Ch 7].
6. Solid State. Atomic structure, Electron distribution of different atoms, Energy bands in solids, Bonds in solids, Conduction in solids, Conductors, Semiconductors and types of semiconductors, Insulators, Majority and Minority charge carriers, Mobile charge carriers and immobile ions, Drift current in good conductors.[TB 1: Ch 12]
7. P-N Junction. Formation of depletion layer, Junction or barrier voltage, Forward biased P-N Junction, Forward V/I Characteristics, Reverse biased P-N Junction, Re-verse Saturation Current, Reverse V/I Characteristics, Junction breakdown, Junction Capacitance. [TB 1: Ch 13]
8. Optoelectronics Devices. Spectral response of human eye, Light Emitting Diode (LED), Photoemissive Devices, Photomultiplier Tube, Photovoltaic Devices, Bulk type Photoconductive cells, Photodiodes, P-N junction Photodiode, PIN Photodiode, and Avalanche Photodiode. [TB 1: Ch 16]
9. DC Power Supplies. Unregulated and Regulated Power Supply, Steady and Pulsating DC Voltages, Rectifiers (17.5-17.8), Filters (17.9-17.2), Voltage Multipliers (17.24-17.30), Silicon Controlled Rectifier SCR(17.33-17.37)[TB 1: Ch 17]
10. The Basic Transistor. Transistor Biasing, Transistor Circuit Configuration. [TB 1: Ch 18]
11. Modulation and Demodulation. Carrier Waves, Modulation, Demodulation or Detection, Comparison between Amplitude Modulation (AM) and Frequency Modulation (FM). [TB 1: Ch 30]
12. Integrated Circuits. Advantages of ICs and Drawbacks of ICs, Scale of Integration, Classification of ICs by function, Linear and Digital Integrated Circuits, IC Terminology, Fabrication of IC Components, Popular Application of ICs, Operational Amplifier. [TB 1: Ch 31]
13. Fiber Optics. Structure of Optical Fibres, Classification of Optical Fibres, Fibre Characteristics, Choice of Wavelength, Optical Fibre cable, Application of Fibre Optic Communication. [TB 1: Ch 38]

Teaching Methodology:

Lecturing, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. A Practical English Grammar by A. J. Thomson and A. V. Martinet,4th Edition Oxford University Press (1986).
2. Basic English Usage by Michael Swan, Oxford UnivPr (Sd) (January 1986). ISBN-10: 0194311872
3. Functional English In Aglobal Society: Vocabulary Building and Communicative Grammar by Nicanor L. Guintomary Ann R. Sibal Brian D. Villaverde Dept. of Languages, Literature and Humanities College of Arts and Sciences Southern Luzon State University (2012).
4. AQA Functional English Student Book: Pass Level 2 by Mr David Stone, Heinemann; 1st Edition (28 Jun 2010). ISBN-10: 0435151401
5. English Composition and Grammar: Complete Course by John E. Warriner, Harcourt Brace Jovanovich; Complete Course Benchmark Edition (January 1988). ISBN-10:

0153117362
6. Companion to English: Vocabulary (Learners Companion) by George Davidson, Prim-Ed Publishing (March 1, 2003). ISBN-10: 9814070904
7. Word Power Made Easy by Norman and Lewis, Goyal Publishers (September 1, 2009). ISBN-10: 8183071007
8. 1000 Most Important Words by Norman W. Schur, Ballantine Books (July 12, 1982). ISBN-10: 0345298632
9. High School English Grammar and Composition by P.C Wren, Chand & Co (July 13, 2008). ISBN-10: 812192197X

Contents of SE Supporting Elective Courses

SESC-301 Business Process Engineering			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Discover the various technologies that support Business Process Engineering	C	2
2. Analyze the performance of existing processes and identify process improvement.	C	3
3. Propose business solutions in written and verbal forms for process innovation and redesign projects.	C	3
4. Create a BPM implementation strategy and implementation plan for an organization.	C	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. Introduction to Business Process Engineering, Motivation and Definitions, Business Process Lifecycle [TB1, Ch1]
2. Classification of Business Processes, Goals, Structure, and Organization [TB1, Ch2]
3. Business Reengineering for Information Technology [TB1, Ch4]
4. Evolution of Enterprise Systems Architectures. [TB1, Ch5]
5. Market-and Product-Oriented Design of Business Processes [TB1, Ch6]
6. BPR Methodologies: Methods and Tools [TB1, Ch8]
7. Knowledge-Based Reengineering of Business Processes [TB1, Ch9]
8. Defense Enterprise Planning and Management [TB1, Ch11]
9. Supporting Business Process Reengineering in Industry Week1 [TB1, Ch12]
10. Supporting Business Process Reengineering in Industry Week2 [TB1, Ch12]
11. Dynamic Simulation in Business Process Redesign Week1 [TB1, Ch12]

12. Dynamic Simulation in Business Process Redesign Week2 [TB1, Ch12]
13. Various Approaches to Engineering [TB1, Ch14]
14. Networking as an Enabler of Business Process Reengineering [TB1, Ch15]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Business Process Engineering: Advancing the State of the Art, D. J. Elzinga, T. R. ,Gulledge ,C. Lee, Springer2012
2. Business Process Engineering Study Edition: Reference Models for Industrial Enterprises, A. Scheer, Springer; Study Ed., 2013
3. Collaborative Business Process Engineering and Global Organizations: Framework for Service Integration, U. Bhuvan, A. Ghanbary, H. Younessi, IGI Global SR, 2009

SESC-305 Formal Methods in Software Engineering			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Describe the costs and benefits of formal methods	C	1
2. Construct formal models of sequential software systems	C	2
3. Implement sequential software systems based on formal models	C	3
4. Verify attributes of formal models	C	3
5. Demonstrate formal correctness of simple procedure	C	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Formal methods: What are FM? What FM are not, When, How, and Why use FM? Popular Fallacies and Alternatives. Formal Methods and Project Management: Gathering Requirement, From Information Requirement to Formal Specifications, Validating Formal Specifications. [TB1: Ch. 1,2,3]

2. Introducing Z: What is Z? Informal Requirements, Data Flow Diagrams, State Transition Diagram, State Transition Diagram, State Transition tables. Introducing schemas: Basic Types and Abbreviations, Axiomatic Descriptions, State Schemas, Operation Schemas, Implicit preconditions, Schema Calculus. [TB1: Ch. 4, 5, 6, 7]
3. Elements of Z: Sets and Types, Declarations, Variables, Expressions, Operators, Predicates, Equations and Laws. Structure: Tuple, Records, Relations, Tables, Databases, Pairs and Binary Relations, Functions, Sequences, Operators. [TB1: Ch. 8,9]
4. Logic: Basic Predicates, Using Predicates in Z, Relations as Predicates, Logical

Connectives, Logic and Natural Language, Quantifiers, Z and Boolean Types, Predicates and undefined Expressions. Synthesis: Set Comprehensives, Lambda Expressions, Formal Specifications, Conveniences and shortcuts, Modeling Systems and Change. [TB1: Ch. 10, 11]

5. Schemas and schema calculus: Conjunctions and Disjunctions, Other Schema Operators. Schema types and Bindings: Generics & Free Types [TB1: Ch. 12, 13, 14]
6. Formal Reasoning: Calculation and proof, Laws, Checking Specifications, Preconditions, Formal Reasoning and Intuition, Machine-Checked proof. [TB1: Ch.15]
7. Studies in Z: Document Control System, Text Processing, Eight Queens [TB1: Ch. 16, 17, 18]
8. Computer Graphics and Computational Geometry. Rule-Based Programming: Essential Elements, Facts and Rules, Deducing New Facts, Checking the Rules, Specifying Rule Based Programs. [TB1: Ch. 19, 20]
9. Graphical User Interface: Events, Display and Dialogs, Selecting a Display, Changing Setting Value, Z and State Transition Systems, Changing the Machine State. [TB1: Ch. 21]
10. Safety-Critical Protection System: Partition, Refinement, Enforcing the Safety Requirements. [TB1: Ch. 22]
11. Modeling Large Systems: A Single Subsystem, Many Subsystems, Useful Idioms, Subsystems, Conditions, and Modes. [TB1: Ch. 23].
12. Object-Oriented Programming Model and Z, Inherits and Schema Inclusion, OO Z Dialects. Concurrency and Real-time [TB1: Ch. 24, 25].
13. Refinement, Program Derivation and Formal Verification [TB1: Ch. 26, 27]
14. Converting Z Specification into Code

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. The Way of Z: Practical Programming with Formal Methods by Jonathan Jacky, Cambridge University Press (November 28, 1996)
2. Logic in Computer Science, M. Huth, M. Ryan, Cambridge University Press, 2004
3. Modern Formal Methods and Applications, Hossam A. Gabbar, Springer-Verlag 2006.
4. Formal Software Development: From VDM to Java, Charatan, Quentin, and Aaron Kans. Palgrave Macmillan, 2003.
5. Understanding Z: a Specification Language and its Formal Semantics. J. M. Spivey. 1988. Cambridge University Press, New York, NY, USA.

SESC-304 Cyber Security			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

1. Describe the core information assurance (IA) principles.	C	3
2. Identify the key components of cyber security architecture.	C	3
3. Distinguish system and application security threats and vulnerabilities.	C	3
4. Define types of incidents including categories, responses and timelines for response.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Vulnerabilities in information system, measuring vulnerabilities. [TB1:Ch1]
2. Threat classification, cyber security starts at home and international awareness. [TB1:Ch1]
3. Vulnerabilities in the organization, access authorization and authentication, security services in wireless networks and cloud security. [TB1:Ch2]
4. Risk in information system infrastructure, hardware, software, and cyberspace. [TB1:Ch3].
5. Assets identification, resource access control and securing the assets communication. [TB1:Ch4]
6. Secure information system, information security management. [TB1:Ch4]
7. Cyber security and the CIO, data backup and archiving, cyber trainings and cyber policy. [TB1:Ch5]
8. Building a secure organization, system access control and computer network management securely. [TB1:Ch6]
9. Personal, physical and environmental security and business continuity planning. [TB1:Ch6]
10. Cyberspace Intrusions, ID/PS configuration, ID/PS management and ID/PS classification. [TB1:Ch7]
11. ID/PS implementation and operation in organization. [TB1:Ch7]
12. Cyberspace defense, file protection application, PC performance applications. [TB1:Ch8]
13. Protection tools, security analyzer, password analyzer, firewalls and email protection. [TB1:Ch8]
14. Cyberspace and law, international law and cyber related laws. [TB1:Ch9]
15. Cybercrime, trends in cyber abuse, combating cybercrime. [TB1:Ch9]
16. Cyber warfare and homeland security and distributed defense. [TB1:Ch10]

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Cyberspace and Cyber security 1st Edition by George Kostopoulos
2. Security+ Guide to Network Security Fundamentals, Fifth Edition Mark Ciampa
3. Essential Cyber Security Handbook Kindle Edition by Nam Nguyen

Contents of GE/University Elective Courses

BUSB-102 Principles of Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. The course will cover topics fundamentals and principles of management, administrative police, objectives, and procedures and problems of organizational control and leadership.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to Managers and Management: What as Management and What Do Managers Do? Defining Management, Management Functions, Management Roles, Management Skills, History of Management. [TB2: Ch. 1]
2. Organizational Culture and Environment: The Manager: Omnipotent or Symbolic? The Organization's Culture, The Environment - Defining Environment, The Specific Environment, The General Environment, Influence on Management Practice. [TB1: Ch. 3]
3. Decision Making The Essence of Manager's Job: The Decision Making Process, The Rational Decision Maker, Decision Making Styles, Analyzing Decision Alternatives – Certainty, Risk, Uncertainty. [TB1: Ch. 6]
4. Planning: The Foundations of Planning, The Definition of Planning, Purposes of Planning, Types of Plans, Contingency Factors on Planning, Objectives: The Foundation for Planning, Multiplicity of Objectives, Real Versus Stated Objectives, Traditional Objective Setting, Management by Objectives. [TB2: Ch. 3]
5. Organization Structure and Design: Defining Organization Structure and Design, Building, The Vertical Dimension of Organizations, Building the Horizontal Dimension of Organizations, The Contingency Approach to Organization Design, Application of Organization Design.
6. Motivation: Motivating Employees, What is Motivation? Contemporary Approaches to Motivation, Contemporary Issues in Motivation, From Theory to Practice: Suggestions for Motivating Employees. [TB2: Ch. 10]
7. Leadership: Managers Verses Leaders, Trait Theories, Behavioral Theories, Contingency Theories, Emerging Approaches to Leadership, Contemporary Issues in Leadership. [TB2: Ch. 11]
8. Communication: Communication and Interpersonal Skills, Understanding Communication, Communication Styles of Men and Women, Feedback Skills, Delegation Skills', Conflict Management Skills, Negotiation Skills [TB2: Ch. 12]
9. Controlling - Foundations of Control: What is Control? The Importance of Control, The Control Process, Types of Control, Qualities of Effective Control, The Dysfunctional Side of Control, Ethical Issues in Control; Controlling Tools and Techniques:

Information Controls, Financial Controls, Operations Controls, Behavioral Controls. [TB2: Ch. 13]
10. The Personnel Function: Terminology, Who Does Personnel Work? Staff Role of The Personnel Department Personnel (Human Resource) Functions. [TB3: Ch. 1 & 2]
11. Job Design and Analysis: Job Design, Job Information and Personnel Management, Analyzing Jobs-Obtaining Job Information, Functional Job Analysis, Administration of The Job Analysis Program. [TB3: Ch. 6 & 7]
12. Human Resource Planning: Reasons for Human Resource Planning, The Planning Process. [TB3: Ch. 5]
13. Recruitment and Selections/Testing and Interview: Labor Market Considerations, Recruitment and Selection Policy Issues, The Employment Process, Sources of People, The Selection Process, The Selection Procedure, Testing: Interview. [TB3: Ch. 6 & 7]
14. Miscellaneous: Union and Management, Compensation Administration, Health and Safety [TB2: Ch. 15, 17 & 18]

Teaching Methodology:

Lectures, Written Assignments, Class Discussion

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Management by Robbins, S.P. & Coulter, Mary, Prentice Hall; 10th Edition (November 3, 2008). ISBN-10: 0132090716
2. Fundamentals of Management by Robbins, S.P. & DeCenzo, David A, Prentice Hall; 7th Edition (January 13, 2010). ISBN-13: 978-0132090711
3. Human Resource Management by David A. DeCenzo and Stephen P. Robbins. Wiley; 7th Edition (October 10, 2001). ISBN-10: 0471397857
4. Principles of Management by Charles W. L. Hill and Steven McShane, McGraw-Hill/Irwin; 1st Edition (2006). ISBN-10: 0073530123
5. Principles of Management by Mason Carpenter, Flat World Knowledge, Inc. (2009). ISBN-10: 0982043074
6. Management by Richard L. Daft, South-Western College Pub; 10th Edition (January 27, 2011). ISBN-10: 0538479531
7. Fundamentals of Management by Stephen P. Robbins, David A. DeCenzo and Mary Coulter, Prentice Hall; 7th Edition (January 13, 2010). ISBN-10: 0136109829

BUSB-201 Human Resource Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. After successfully completing of this course, students will be able to understand the core aspects of Human Resource Management required in 21st Century organizations.	C	2

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:
1. Managing Human Resources. [TB 1: Ch. 1] 2. Understanding the External and Organizational Environments. [TB 1: Ch. 2] 3. Ensuring Fair Treatment and Legal Compliance. [TB 1: Ch. 3] 4. HR Planning for Alignment and Change. [TB 1: Ch. 4] 5. Using Job Analysis and Competency Modeling. [TB 1: Ch. 5] 6. Recruiting and Retaining Qualified Employees. [TB 1: Ch. 6] 7. Selecting Employees to Fit the Job and the Organization. [TB 1: Ch. 7] 8. Training and Developing a Competitive Workforce. [TB 1: Ch. 8] 9. Conducting Performance Management. [TB 1: Ch. 9] 10. Developing an Approach to Total Compensation. [TB 1: Ch. 10] 11. Using Performance-Based Pay to Achieve Strategic Objectives. [TB 1: Ch. 11] 12. Providing Benefits and Services for Employees' Well-Being. [TB 1: Ch. 12] 13. Risk Management, Employee Relations, and Risk Management, Health, Safety, and Employee Well-Being. [TB 1: Ch. 13] 14. Understanding Unionization and Collective Bargaining. [TB 1: Ch. 14]
Teaching Methodology:
Lectures, Written Assignments, Class Discussion
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Final Exam
Reference Materials:
1. Managing Human Resources by Susan E. Jackson, Randall S. Schuler and Steve Werner, South-Western College Pub; 11th Edition (June 16, 2011).ISBN-10: 1111580227 2. Management of Human Resources by Gary Dessler, CarolinRekar Munro and Nina D. Cole, Pearson Education Canada; 3rd Edition (February 28, 2010). ISBN-10: 0321687140 3. Human Resource Management by Robert L. Mathis and John H. Jackson, South-Western Cengage Learning; 13th Edition (August 19, 2010). ISBN-10: 053845315X 4. Human Resource Management Applications: Cases, Exercises, Incidents, and Skill Builders by Stella M. Nkomo, Myron D. Fottlerand R. Bruce McAfee, South-Western Cengage Learning; 7th Edition (September 29, 2010). ISBN-10: 0538468076

BUSB-401 Organizational Behavior			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. This course introduces the student to multidisciplinary approaches to human behaviour in organizational settings. Attention will be paid to both public and private sector organizations.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Organizational Behavior: The Quest for People-Centered Organizations and Ethical Conduct [TB 1: Ch.1] 2. Organizational Culture, Socialization, and Mentoring [TB 1: Ch. 3] 3. Key Individual Differences and the Road to Success [TB 1: Ch. 5] 4. Values, Attitudes, Job Satisfaction, and Counterproductive Work Behaviors [TB 1: Ch. 6] 5. Social Perceptions and Attributions [TB 1: Ch.7] 6. Foundations of Motivation [TB 1: Ch.8] 7. Improving Job Performance with Goals, Feedback, Rewards, and Positive Reinforcement [TB 1: Ch.9] 8. Group Dynamics [TB 1: Ch.10] 9. Developing and Leading Effective Teams [TB 1: Ch.11] 10. Individual and Group Decision Making [TB 1: Ch.12] 11. Managing Conflict and Negotiating [TB 1: Ch.13] 12. Communicating in the Digital Age [TB 1: Ch.14] 13. Leadership, Influence, Empowerment, and Politics [[TB 1: Ch.15, 16] 14. Organizational Design, Effectiveness, and Innovation [TB 1: Ch.17]
Teaching Methodology:
Lectures, Written Assignments, Class Discussions
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Final Exam
Reference Materials:
1. Organizational Behavior by Robert Kreitnerand AngeloKinicki, McGraw-Hill/Irwin; 10 Edition (January 17, 2012). ISBN-10: 0078029368 2. Organizational Behavior by Stephen P. Robbins and Timothy A. Judge, Prentice Hall; 15th Edition (January 16, 2012). ISBN-10: 0132834871 3. Meeting the Ethical Challenges of Leadership: Casting Light or Shadow by Craig E. Johnson, SAGE Publications, Inc; 4thEdition (February 28, 2011). ISBN-10: 1412982227

BUSB-202 Business Economics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. This course is mean for understanding core matters of economics so that student shall be able to understand what is going on globally. This course, along with Entrepreneurship course, shall help students to establish their own business.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction to Business and the economic environment [TB 1: Ch. 1] 2. The working of competitive markets [TB 1: Ch. 2] 3. Demand and the consumer [TB 1: Ch. 3] 4. Supply decisions in a perfectly competitive market [TB 1: Ch. 4] 5. Pricing and output decisions in imperfectly competitive markets [TB 1: Ch. 5] 6. Business growth and strategy [TB 1: Ch. 6] 7. Multinational corporations and business strategy in a global economy [TB 1: Ch. 7] 8. Government, the firm and the market [TB 1: Ch. 9] 9. The economy and business activity [TB 1: Ch. 10] 10. National macroeconomic policy [TB 1: Ch. 11] 11. The global trading environment [TB 1: Ch. 12]
Teaching Methodology:
Lectures, Class Discussions
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Final Exam
Reference Materials:
1. John Sloman and Elizabeth Jones, Essentials Economics for Business, 5th Ed., Pearson, 2017. 2. Alan Griffiths and Stuart Wall, Economics for Business & Management: A Student Text, Prentice Hall, 2005 3. Dermot McAleese, Economics for Business: Competition, Macro-stability and Globalization, 3rd Ed., Prentice Hall, 2009.

BUSB-402 Entrepreneurship			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. The course gives students the tools necessary to think creatively, to plan out whether their idea is marketable to investors, guide them through the launch their own business, or to support an employer in launching and growing an entrepreneurial venture.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Entrepreneurship and the Entrepreneurial Mind-Set. [TB 1: Ch. 1] 2. Entrepreneurial Intentions and Corporate Entrepreneurship. [TB 1: Ch. 2] 3. Entrepreneurial Strategy: Generating and Exploiting New Entries. [TB 1: Ch. 3] 4. Creativity and the Business Idea. [TB 1: Ch. 4] 5. Identifying and Analyzing Domestic and International Opportunities. [TB 1: Ch. 5]

6. Intellectual Property and Other Legal Issues for the Entrepreneur. [TB 1: Ch. 6] 7. The Business Plan: Creating and Starting the Venture. [TB 1: Ch. 7] 8. The Marketing Plan. [TB 1: Ch. 8] 9. The Organizational Plan. [TB 1: Ch. 9] 10. The Financial Plan. [TB 1: Ch. 10] 11. Sources of Capital. [TB 1: Ch. 11] 12. Informal Risk Capital, Venture Capital, and Going Public. [TB 1: Ch. 12] 13. Strategies for Growth and Managing the Implication of Growth. [TB 1: Ch. 13] 14. Succession Planning and Strategies for Harvesting and Ending the Venture. [TB 1: Ch. 15]
Teaching Methodology:
Lectures, Written Assignments, Class Discussions
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Final Exam
Reference Materials:
1. Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepherd, McGraw-Hill/Irwin; 9th Edition (September 27, 2012). ISBN-10: 0078029198 2. Entrepreneurship: Ideas in Action by Cynthia L. Greene, South-Western Educational Pub; 5th Edition (January 6, 2011). ISBN-10: 0538496894 3. Entrepreneurship by William D. Bygrave and Andrew Zacharakis, Wiley; 2nd Edition (October 12, 2010). ISBN-10: 0470450371 4. Entrepreneurship: Theory, Process, and Practice by Donald F. Kuratko, South-Western College Pub; 8th Edition (November 14, 2008). ISBN-10: 0324590911 5. Entrepreneurship: Successfully Launching New Ventures by Bruce R. Barringer and Duane Ireland, Prentice Hall; 4th Edition (October 27, 2011)

SS-303 Foreign/Regional Langugae			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. The course will develop student's functional skills of the offered language.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Follow UOS's Relevant Department's Syllabus
Teaching Methodology:
Lectures, Written Assignments
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Final Exam

Contents of SE Regular Track Elective Courses

SEEC-401 Model-Driven Software Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the different types of architectures and the role they play in software systems.	C	2
2. Architecture creation and evolution, architecture analysis, and documenting the architecture.	C	3
3. To develop models and check them for specific properties using modeling tools.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. MDSD – Basic Ideas & Terminology, An overview of MDA Concepts, Architecture-Centric MDSD. [TB 1: Ch. 2]
2. A Typical Web Application: Application Development, Architecture Development. [TB 1: Ch. 3]
3. Common MDSD Concepts and Terminology, Model-Driven Architecture, Architecture-Centric Architecture, Generative Programming. Software Factories, Model-Integrated Computing, Language-Oriented Programming, Domain-Specific Modeling. [TB 1: Ch. 4]
4. Classification: MDSD vs. CASE, 4GL & Wizards, MDSD vs. Roundtrip Engineering, MDSD & Patterns, MDSD & Domain-Driven Design, MDSD, Data Driven Development & Interpreters, MDSD & Agile Software Development. [TB 1: Ch. 5]
5. Meta-modeling: What is Meta-modeling? Meta-levels vs. Level of Abstraction, MOF & UML, Extending UML, UML Profiles, Meta-modeling & OCL, Pitfalls in Meta-modeling. [TB 1: Ch. 6]
6. MDSD-Capable Target Architectures: Software Architecture in the Context of MDSD, What is a Sound Architecture? How do you Arrive at a Sound Architecture, Building Blocks for Software Architecture, Architecture Reference Model, Balancing the MDSD Platform, Architecture Conformance, MDSD &CBD; SOA,BPM & MDSD. [TB 1: Ch. 7]
7. Building Domain Architecture: DSL construction, General Transformation Architecture, Technical Aspects of Building Transformation The Use of Interpreters. [TB 1: Ch. 8]
8. Code Generation Techniques: Code Generation – Why? Categorization, Generation Techniques. [TB 1: Ch. 9]
9. Model Transformations with QVT: History, M2M Language Requirements, Overall Architecture, An Example Transformation, The OMG Standardization Process & Tool Availability, Assessment. [TB 1: Ch. 10]
10. MDSD Tools: Roles, Architecture, Selection Criteria & Pointers: The Role of Tools in the Development Process, Tool Architecture & Selection Criteria, Pointers. [TB 1: Ch.

11]

11. The MDA Standard: Goals, Core Concepts, –UML 2.0, MOF-Meta Object Facility, XMI, PIM/PSM/PDM, Multi-stage Transformations, Action Languages, Core Models, Controlling the PIM to PSM Transformation, Executable UML. [TB 1: Ch. 12]
12. MDSD Process Building Block & Best Practices: Introduction, Separation between Application & Domain Architecture Development, Two-Track Iterative Development, Target Architecture Development Process, Product-Line. [TB 1: Ch. 13]
13. Testing: Test Types, Test in Model-Driven Application Development, Testing the Domain Architecture. [TB 1: Ch. 14]
14. Versioning: What is versioned? Projects & Dependencies, The Structure of Application Projects, Version Management & Build Process for Mixed Files, Modeling in a Team & Versioning of Partial Models. [TB 1: Ch. 15]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Model-Driven Software Development: Technology, Engineering, Management by Thomas Stahl, Markus Voelter and Krzysztof Czarnecki, Publisher: Wiley; 1st Edition (May 19, 2006). ISBN-10: 0470025700
2. Model-Driven Software Engineering in Practice by Marco Brambilla, Jordi Cabot and Manuel Wimmer, Morgan & Claypool Publishers; 1st Edition (September 26, 2012). ISBN-10: 1608458822
3. The Pragmatic Programmer: From Journeyman to Master by Andrew Hunt and David Thomas, Addison-Wesley Professional; 1st Edition (October 30, 1999). ISBN-10: 020161622X
4. Model-Driven Software Development: Integrating Quality Assurance by JorgRech and Christian Bunse, Information Science Reference; 1st Edition (August 22, 2008). ISBN-10: 160566006X
5. Model-Driven Software Development with UML and Java by K. Lano, Course Technology (August 15, 2009). ISBN-10: 1844809528

SEEC-402 Software Engineering Economics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explains how different cost estimation methods are applied.	C	4
2. Presents the fundamentals of production functions, marginal analysis, and future value in the domain of software engineering.	C	3
3. Important techniques such as software business case analysis.	C	3
4. Have a knowledge of software development process selection.	C	4
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. The Software Life-Cycle: The Waterfall Model, Economic Rationale for the WM, Refinements of the WM, Life-Cycle Phase/Activity, The Software Work Breakdown Structure (WBS) Software Maintenance. The Basic COCOMO Model: Introduction, Definitions & Assumptions, Development Effort & Schedule, Phase Distribution, Nominal Project Profiles, The Rayleigh Distribution, Interpolation, Basic Software Maintenance Effort Estimation [TB 1: Ch. 4, 5]
2. Development Modes: Introduction, Basic Effort & Schedule Equations, COCOMO Modes of Software Development, COCOMO Effort & Schedule Equations, Phase Distribution of Effort & Schedule. Activity Distribution. Limitations of Basic COCOMO [TB 1: Ch. 6, 7]
3. Model-Product Level Estimates: Introduction, Software Development Effort Estimation, Estimate of Annual Maintenance, Interpolation & Extrapolation, Estimating the Effects of Adapting Existing Software, Intermediate COCOMO Effort Equations. Component Level Estimation: Introduction, the Component Level Estimating Form (CLEF), Using CLEF with Adapted Software. [TB 1: Ch. 8, 9]
4. Performance Models & Cost Effectiveness Models: Performance Models, Optimal Performance, Sensitivity Analysis, Cost Effectiveness Models. Economies of Scale: Discrete Production Functions, Basic Production Functions, Economies & Diseconomies of Scale, Diseconomies of Scale on Large Software Projects. [TB 1: Ch. 10, 11]
5. Decision Criteria: Minimum Available Budget, Minimum Performance Requirement, Maximum Effectiveness-Cost Ratio, Maximum Effectiveness-Cost Difference, Composite Options. Net Value & Marginal Analysis. [TB 1: Ch. 12,13]
6. Cost Analysis, Interest Calculation, Present Value Calculation, Value of a Series of Cash Flows, Present Value Characteristics, Sensitivity to Interest Rate or Discount Rate, Applications to SE. Figures of Merit: Software Package Selection, Net Value Analysis, Figure of Merit Analysis, A Weighted Sum Analysis for Hardware & Software Selection. [TB 1: Ch. 14, 15]
7. Goals as Constraints: System Reliability & Availability, Figure of Merit Evaluation, Expressing Goals as Constraints, Goals as Constraints: Feasible Sets & Cost Value Contours, Decision Problems with Constraints, SE Applications, Mathematical Optimization Techniques, Capabilities& Limitation of Mathematical Optimization Techniques. Systems Analysis & Constrained Optimization (TB 1: Ch 16, 17)
8. Coping with Un-reconcilable & Un-quantified Goals: In-House vs. Vendor Development, Presentation Methods, Unquantifiable Criteria, Presentation Techniques for Unquantifiable Criteria, Presenting & Interpreting Multivariate Data. Coping with Uncertainties: Decision Rules for Complete Uncertainty, Subjective Probabilities, Decision Rules Under Complete Uncertainty, The Value of Information, Subjective Probabilities, Utility Functions, SE Implications. [TB 1: Ch 18, 19]
9. Detailed COCOMO: Summary & Operational Description: The Software Hierarchy Estimating Form & Procedures, Detailed COCOMO Example, Schedule Adjustment Calculations. Detailed COCOMO Cost Drivers: Product Attributes –Required Software Reliability, Data base Size, Software Product Complexity [TB 1: Ch. 23, 24]
10. Detailed COCOMO Cost Drivers: Computer Attributes –Execution Time, Main Storage Constraint, Virtual Machine Volatility, Computer Turn Around Time [TB 1: Ch 25]
11. Detailed COCOMO Cost Drivers-Personal Attributes: ACAP, AEXP, PCAP, VEXP, LEXP. [TB 1: Ch. 26]

12. Detailed COCOMO Cost Drivers: Project Attributes–Modern Programming Practices, Use of Software Tools, Schedule Constraint [TB 1: Ch 27]

Teaching Methodology:

Lectures, Written Assignments, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Software Engineering Economics by Boehm, Prentice Hall, 1981.ISBN-10: 0138221227.
2. Estimating Software Costs: Bringing Realism to Estimating by Capers Jones, McGraw-Hill Osborne Media; 2nd Edition (April 19, 2007).ISBN-10: 0071483004
3. Software Cost Estimation with COCOMO II by Barry W. Boehm, Chris Abts, A. Winsor Brown and SunitaChulani, Prentice Hall (August 11, 2000). ISBN-10: 0130266922.
4. Software Cost Estimation and Sizing Methods, Issues, and Guidelines by Shari Lawrence Pfleeger, Rand Publishing (September 13, 2005). ISBN-10: 0833037137.
5. Software Engineering Economics and Declining Budgets by Pamela T. Geriner, Thomas R. Gulledge, William P. Hutzler, Springer London, Limited, (31-Jul-2012)

SEEC-403 Big Data Analytics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the Big Data Platform and its Use cases.	C	2
2. Provide an overview of Apache Hadoop, HDFS Concepts and Interfacing with HDFS.	C	3
3. Understand Map Reduce Jobs and learn Apache Spark.	C	3
4. Apply analytics on Structured, Unstructured Data and Exposure to Data Analytics with Scala.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Overview of Big Data: This includes topics such as history of big data, its elements, career related knowledge, advantages, disadvantages and similar topics. [TB 1: Ch. 13, TB2: Ch. 7]
2. Big Data in Real Life: This module focuses on the application perspective of Big Data covering topics such as using big data in marketing, analytics, retail, hospitality, consumer good, defense etc.
3. Technologies for Handling Big Data: Big Data is primarily characterized by distributed data processing frameworks like Hadoop. This module cover topics such as Introduction to Hadoop, functioning of Hadoop, Cloud computing (features, advantages, applications) [TB 1: Ch. 3]
4. Hadoop EcoSystem: This includes learning about Hadoop and its ecosystem which includes HDFS, MapReduce, YARN, HBase, Hive, Pig, Sqoop, Zookeeper, Flume, Oozie etc.

5. Deeply Understanding MapReduce: This module should cover the entire framework of MapReduce and uses of mapreduce. [TB :3 Ch. 1,2]
6. Databases and Data Warehouses: This module should cover all about databases, data warehouses, data mining, and their related introductory knowledge. [TB 1: Ch. 14]
7. Data Storage using HDFS: This includes an entire module of HDFS, HBase and their respective ways to store and manage data along with their commands. [TB 3: Ch. 12]
8. Big Data Semester Project: Discussion about how to collect real data, store data in HDFS, process distributed data using Apache Spark. Justify how it improves performance.
9. Learn Scala Basics: Learn variables, functions, loops, class, objects, case classes
10. Learn Scala: Learn Tuples, Map, Fold, Split, Array Concatenation, Lists, Iterators
11. Apache Spark: Learn How Spark is better than Hadoop, Resilient Distributed Datasets, Immutability, Learn Spark Configurations, Spark Context. [TB 3: Ch. 13]
12. Apache Spark: Understand Map Partition with Index, Accumulators, Broadcasts, and How to run an Apache Spark Job on Cluster [TB 3: Ch. 14]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Cady, Field. *The Data Science Handbook*. John Wiley & Sons, 2017.
2. Stephens-Davidowitz, Seth, and Steven Pinker. Everybody lies: Big data, new data, and what the internet can tell us about who we really are. HarperLuxe, 2017.
3. Bill Chambers and Matei Zaharia. Spark: The Definitive Guide: Big Data Processing Made Simple, OReilly, 2018.

SEEC-404 Software CASE Tools & Applications			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Provide an overview of CASE Tools and their types.	C	2
2. Use CASE Tools for data modeling, process modeling, and UI modeling.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Introduction to: CASE, Types of CASE Tools, Case Environment, Expectations about CASE and the Need for Tool Integration, Example of CASE tool Integration. [TB 1: Ch. No.1]
2. Approaches CASE Tool Integration, Conceptual Model of Integration, Evolution of Integrated CASE Environment Architectures [TB 1: Ch. No.2]
3. Integration as a Design Activity [TB 1: Ch. No.3]

4. Service Based Model of a CASE Environment: Overview of PSE Reference Model, Description of Reference Model Services, Uses of Reference Model [TB 1: Ch. No.4]
5. Properties and Types of Integration Mechanism: The Relationship between Data and Control Model, Presentation Integration [TB 1: Ch. No.5]
6. The Role of Process in Integrated CASE Environments: Nature of Process Integration, Process Integration and CASE Tools and Environments [TB 1: Ch. No.8]
7. Examples of Process and CASE Tool Interactions [TB1 :Ch. No.8]
8. Replacing the Message Service in a CASE Integration Framework: Background, Adding the ToolTalk Interface, Running the Experiment Scenario, Replacing the ToolTalk in the Emulation Framework [TB 1: Ch. No.10]
9. Integration of CASE Tools with CM Systems: Key Concepts Related to CM and CASE Tools Integration, CASE Tool Integration Scenarios Involving CM [TB 1: Ch. No.11]
10. Case Environments in Practice: Background and Studies, Observations, An Example of Transitional CASE Environment, CASE Environment Progress Over the Past Decade [TB 1: Ch. No.12]
11. Object-Oriented Analysis & Design Modeling: Business Process Models, Design Reuse, E-Commerce, ISO [Handouts]
12. Comparison of Popular CASE Tools (Online Material)
13. Practice Real Life Problem for Development Through CASE Tools

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Principles of CASE Tool Integration by Alan W. Brown, Oxford University Press, USA; 1st Edition, (September 1, 1994) ISBN-10: 0195094786
2. Computer Aided Software Engineering by Hausi A. Muller, Ronald J. Norman and Jacob Slonim, Springer; Softcover reprint of the original 1st Edition 1996 (September 27, 2011). ISBN-10: 1461286263.
3. A http://www.umsl.edu/~sauterv/analysis/6840_f09_papers/I%20Gusti/index.html
4. Most popular software CASE tool documentation

SEEC-405 E-Commerce Applications Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the concepts and standards related to the discipline of E-Commerce.	C	2
2. Analyze complex real world problems found in E-Commerce.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. E-Commerce: An overview of e-Commerce, Brick 'N Mortar stores vs Service-based

companies, e-Commerce Models, e-Commerce popular sites: iStockphoto, WooThemes, eBay, Amazon, Play.com. [TB 1: Ch.1]
2. Planning an e-Commerce Framework: Designing a framework, Patterns, ModelView-Controller, Registry, Singleton, Structure, Building a framework, Routing requests. [TB 1: Ch.2]
3. Products and Categories: Product information, Category information, Structuring Content, Versioning, Building products, categories, and content functionality, Routing products and categories. [TB 1: Ch.3]
4. Product Variations and User Uploads: Giving user's choice, giving users control, shopping. [TB 1: Ch.4]
5. Enhancing the User Experience: The importance of user experience, Search, Providing wish lists, Making Recommendations, Stock Checking, Customer's Feed Back, Processing reviews/comments. [TB 1: Ch.5]
6. The Shopping Basket: Creating a Basket, Basket Contents, Managing the Basket, Cleaning the Basket. [TB 1: Ch.6]
7. The Checkout and Order Process: The Process, Authentication, Payment Method, Order Processed. [TB 1: Ch.7]
8. Shipping and Tax: Shipping Methods, Shipping Costs, Shipping Rules, Tracking, Tax Calculation. [TB 1: Ch.8]
9. Discounts, Vouchers, and Referrals: Discount codes, Purchasable Voucher Codes, Referrals. [TB 1: Ch.9]
10. Checkout: Checkout process consideration, Order process review, Authentication & Confirmation. [TB 1: Ch.10]
11. Taking Payment for Orders: Taking payment, Payment System, Payment gateway, Taking Payment Online, Taking payment offline. [TB 1: Ch.11]
12. User Account Features: User Account Area, Changing Details, Viewing & Managing Orders. [TB 1: Ch.12]
13. Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping, etc. [TB 1: Ch.3]
14. Deploying, Security, and Maintenance, SEO. [TB 1: Ch.14, 15]

Teaching Methodology:

Lectures, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. PHP 5 E-commerce Development by Michael Peacock, Packt Publishing (January 20, 2010). ISBN-10: 184719964X
2. E-Commerce, Kenneth Laudon and Carol Guercio Traver, 13th Edition, Pearson, 2017.
3. PHP 5 E-commerce Development, Michael Peacock, Packt Publishing, 2010.
4. Introduction to E-Commerce, Jeffrey F. Rayport, McGraw-Hill, 2nd Edition, 2007.
5. Electronic Commerce, Gary Schneider, Course Technology; 12th Edition 2016

SEEC-406 Enterprise Resource Planning Systems			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	Domain	BT Level*
1. To comprehend the technical aspects of ERP systems.	C	2
2. To understand the steps and activities in the ERP life cycle.	C	2
3. Understand the concepts of reengineering and able to map business processes using mapping techniques.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Introduction to Enterprise Resource Planning Systems. [TB 1: Ch. 1]
2. ERP Technology. [TB 1: Ch. 2]
3. ERP and Business Process Reengineering. [TB 1: Ch. 3
4. Systems Diagramming and the Process Map. [TB 1: Ch. 41]
5. ERP Life Cycle: Planning and Package Selection. [TB 1: Ch. 5]
6. ERP Life Cycle: Implementation and Operation and Maintenance. [TB 1: Ch. 6]
7. ERP Sales, CRM and Knowledge Management. [TB 1: Ch. 7
8. ERP Financials. [TB 1: Ch. 8]
9. Human Capital Management, Self-Service and Outsourcing. [TB 1: Ch. 9]
10. Manufacturing Systems and Supply Chain. [TB 1: Ch. 10]
11. Auditing ERP. [TB 1: Ch. 11]
12. Business Intelligence and Performance Management. [TB 1: Ch. 12]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Modern ERP: Select, Implement & Use Today's Advanced Business Systems by Marianne Bradford, lulu.com (October 19, 2009). ISBN-10: 0557012910
2. Managerial Issues of Enterprise Resource Planning Systems by David Olson, McGraw-Hill/Irwin; 1st Edition (September 10, 2003). ISBN-10: 0072861126
3. Enterprise Resource Planning by Bret Wagner by Ellen Monk, Course Technology; 3rd Edition (February 4, 2008). ISBN-10: 1423901797
4. ERP Systems by DimpiSrivastava by AartiBatra, I K International Publishing House (February 15, 2010). ISBN-10: 9380578148

SEEC-407 Mobile Application Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	Domain	BT Level*
1. Discuss different architectures & framework for Mobile Application development.	C	1

2. Develop mobile applications using current software development environments.	C	3
3. Compare the different performance tradeoffs in mobile application development.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. What is Android? Obtaining the Required Tools, Installing and Configuring the Android SDK Manager, Creating Your First Android Application, Anatomy of an Android Application. [Tb1: Ch 1]
2. The Big Picture, How to Get Started, Your First Android Project, A bit About Eclipse, Enhancing Your First Project [Tb2: Ch 1-6]
3. Understanding Activities, Linking Activities Using Intents, Fragments, Calling Built-In Applications Using Intents, Displaying Notifications. [Tb1: Ch 2]
4. Understanding the Components of a Screen, Adapting to Display Orientation, Managing Changes to Screen Orientation, Utilizing the Action Bar, Creating the User Interface Programmatically, and Listening for UI Notifications. [Tb1: Ch 3]
5. Using Basic Views, Using Picker Views, Using List View to Display Long Lists, Understanding Specialized Fragments. [Tb1: Ch 4]
6. Using Image Views to Display Pictures, Using Menus with Views, Analog Clock and Digital Clock Views. [Tb1: Ch 5]
7. Saving and Loading User Preferences, Persisting Data to Files, Creating and Using Databases. [Tb1: Ch 6]
8. Sharing Data in Android, using a Content Provider, Creating Your Own Content Providers, Using the Content Provider. [Tb1: Ch 7]
9. Sending SMS Messages Programmatically, Getting Feedback after Sending a Message, Sending SMS Messages Using Intent, Receiving SMS Messages, Sending E-mail. [Tb1:Ch 8]
10. Displaying Maps, Getting Location Data, Monitoring a Location, Building a Location Tracker. [Tb1:Ch 9]
11. Consuming Web Services Using HTTP, Accessing Web Services Using the Get Method, Consuming JSON Services, Sockets Programming. [Tb1:Ch 10]
12. Creating Your Own Services, Establishing Communication between a Service and an Activity, Binding Activities to Services, Understanding Threading. [Tb1:Ch 11]
13. Android games Development, Publishing Android Applications [Tb3, Tb1: Ch12]
14. Handling Telephone Calls, Fonts. [Tb2:Ch 41, 42]

Teaching Methodology:

Lectures, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2015.
2. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition, 2014.
3. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 2nd Edition, 2014.

SEEC-408 Enterprise Application Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Develop desktop application of Java programming language.	C	3
2. Develop strong skills to cater Enterprise Application Development needs and challenges.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Object-Oriented Programming Review, Software Architectures Overview: Desktop, File/Server, 2-Tier Client/Server, Multi-Tier Client/Server. [TB 1: Ch. 1]
2. Challenges of Enterprise Application Development, the Platform for Enterprise Solutions, J2EE Scenarios. [TB 1: Ch. 2]
3. J2EE Platform Technologies: Component Technologies, Platform Roles, Platform Services, Service Technologies, Communication Technologies. [TB 1: Ch. 3]
4. The Client Tier: Client Considerations, General Design Issues and Guidelines, Design Issues and Guidelines for Browser Clients, Design Issues and Guidelines for Java Clients. [TB 1: Ch. 4]
5. The Web Tier: The Purpose of the Web Tier, Web-Tier Technologies, Web-Tier Application Structure, Web-Tier Application Framework Design. [TB 1: Ch. 5]
6. The Enterprise JavaBeans Tier: Business Logic and Business Objects, Enterprise Beans as J2EE Business Objects, Remote and Local Client Views, Entity Beans, Session Beans, Message-Driven Beans, Design Guidelines, Portability Guidelines. [TB 1: Ch. 6]
7. Integrating with the Enterprise Information System Tier: Integration Scenarios, J2EE Integration Technologies, Application Integration Design Approaches, Developing an Integration Layer. [TB 1: Ch. 7]
8. Packaging and Deployment: Packaging Components, Roles and Tasks, Packaging J2EE Applications, Deployment Descriptors, Deployment Tools. [TB 1: Ch. 8]
9. Transaction Management: Transactional Concepts, J2EE Platform Transactions, J2EE Transaction Technologies, Client Tier Transactions, Web Tier Transaction Guidelines, Enterprise JavaBeans Tier Transactions, EIS Tier Transactions, J2EE Resource Manager Types. [TB 1: Ch. 9]
10. Security: Security Threats and Mechanisms, Authentication, Authorization, Protecting Messages, Auditing. [TB 1: Ch. 10]
11. J2EE Internationalization and Localization: Internationalization Concepts and Terminology, Using J2SE Internationalization APIs in J2EE Applications, Web Tier Internationalization, EIS Tier Internationalization, Internationalized Application Design, Internationalizing Applications with XML, Logging Messages. [TB 1: Ch. 11]
12. Architecture of the Sample Application: J2EE Architecture Approaches, Sample Application Overview, Designing the Sample Application, Architecture of the Sample Application. [TB 1: Ch. 12]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Term Project, Final Exam
Reference Materials:
1. Designing Enterprise Applications with the J2EE™ Platform by Inderjeet Singh; Beth Stearns; Mark Johnson; 2nd Edition, Prentice Hall (March 25, 2002). Print ISBN-10: 0-201-78790-3 2. Mastering Enterprise JavaBeans 3.0 by Sriganesh, R.P., Brose, G., And Silverman, M. Wiley Publishing, Indianapolis, (2006). ISBN 0-471-78541-5. 3. Core J2EE Patterns: Best Practices and Design Strategies by Deepak Alur, Dan Malksand John Crupi, Prentice Hall; 2nd Edition (May 10, 2003). ISBN-10: 0131422464 4. Sun Certified Enterprise Architect for Java EE Study Guide by Mark Cade and Humphrey Sheil, Prentice Hall; 2nd Edition (February 8, 2010). ISBN-10: 0131482033

SEEC-301 Artificial Intelligence			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the basic principles in artificial intelligence.	C	2
2. Learn representation schemes, problem solving paradigms, constraint propagation, and search strategies.	C	3
3. Explore different areas of AI application such as knowledge representation, natural language processing, expert systems, vision and robotics.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction: What is AI, Foundations of AI, History of AI. Intelligent Agents: Agents and Environments, The Nature of Environments, The Structure of Agents [TB 1: Ch. 1, 2] 2. Problem Solving by Searching: Problem Solving Agents, Searching for Solutions, Uninformed Search Strategies: 3. Breadth-First Search, Depth-First Search, Depth-limited Search, Iterative Deepening, Depth-first Search, Comparison of Uninformed Search Strategies. [TB 1: Ch. 3] 4. Informed Search and Exploration: Informed (Heuristic) Search Strategies: Greedy Best-first Search, A* Search, Heuristic Functions, Local Search Algorithms and Optimization Problems. [TB 1: Ch. 4] 5. Constraint Satisfaction Problems: Backtracking Search for CSPs, Local Search for CSPs. Adversarial Search: Games, Minimax Algorithm, Alpha-Beta Pruning. [TB 1: Ch. 5, 6] 6. Reasoning and Knowledge Representation: Introductions to Reasoning and Knowledge Representation, Propositional Logic, First Order Logic: Syntax and Semantics of First-Order Logic, Knowledge Engineering in First-Order Logic, [TB 1: Ch. 7, 8] 7. Inference in First-Order Logic: Inference rules for quantifiers, A first-order inference rule, Unification, Forward Chaining, Backward Chaining, A backward chaining

algorithm, Logic programming, The resolution inference rule [TB 1: Ch. 9]
8. Introduction to Prolog Programming
9. Reasoning Systems for Categories, Semantic Nets and Description logics, Reasoning with Default Information: Open and closed worlds, Negation as failure and stable model semantic. Truth Maintenance Systems [TB 1: Ch. 10]
10. Reasoning with Uncertainty & Probabilistic Reasoning: Acting Under Uncertainty, Bayes' Rule and Its Use, [TB 1: Ch 13]
11. Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks. [TB 1: Ch. 14]
12. Learning from Observations: Forms of Learning, Inductive Learning, Learning Decision Trees [TB 1: Ch. 18]
13. Knowledge in Learning, Explanation-Based Learning, Inductive Logic Programming. [TB 1: 19]
14. Statistical Learning, Neural Networks, [TB 1: Ch. 20]
15. Philosophical Foundations: Weak AI, Strong AI, The Ethics and Risks of Developing Artificial Intelligence [TB 1: Ch. 26]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Artificial Intelligence: A Modern Approach, by Russell and Norvig, Prentice Hall. 2nd Edition. ISBN-10: 0137903952
2. Artificial Intelligence: A Systems Approach by M. Tim Jones, Jones and Bartlett Publishers, Inc; 1st Edition (December 26, 2008). ISBN-10: 0763773379
3. Artificial Intelligence in the 21st Century by Stephen Lucci , Danny Kopec, Mercury Learning and Information (May 18, 2012). ISBN-10: 1936420236

SEEC-409 Cloud Computing			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand about fundamental concepts of distributed computing, how these techniques work inside today's most widely-used cloud computing systems.	C	1
2. Understanding the basic principles of cloud deployment and Service models.	C	2
3. Deployment of service models of Cloud through simulator/Vmware/Openstack etc.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Distributed systems, Characteristics, Design goals, Types of distributed systems [TB2:1]
2. What is Cloud Computing? Different perspectives, Properties and characteristics, Benefits [TB1: Preface]
3. Service and deployment models of Cloud computing, Service models: IaaS, PaaS, SaaS[TB1:2]
4. From IaaS to PaaS, PaaS and SaaS properties, Issues, characteristics and Implementation[TB9]
5. Modern On-Demand Computing, Amazon's Elastic Cloud, Amazon EC2 Service, Characteristics, Amazon SimpleDB, Amazon Simple Queue Service (Amazon SQS), Amazon CloudFront, Amazon Elastic Block Store (EBS) [TB1: 2]
6. Virtualization, From emulation to virtualization, Goals of virtualization, Types of Virtualization Hosted and Hypervisor, Server Virtualization, CPU Virtualization [TB1:4, 5]
7. Memory Virtualization: Background, Virtualization Techniques: Emulated TLB, Shadow Page Tables, Hardware supported Memory Virtualization, Nested Page Tables [6]
8. Virtualization Practicum. [TB 1: Appendix A]
9. Cloud Federation: Characterization and Conceptual Model, Voluntary or independent model, Horizontal, Vertical, Hybrid model, Architectural models for cloud federation: Semantics based, Market-oriented, Reservoir, Market-oriented, Reservoir, Service oriented architecture, Conceptual Model, Segments in a Federation [TB1: 5, 7]
10. Presence in the Cloud, Presence Protocols, Leveraging Presence, Presence Enabled, The Future of Presence, The Interrelation of Identity, Presence, and Location in the Cloud, Federated Identity Management, Cloud and SaaS Identity Management, Federating Identity, Identity-as-a-Service (IaaS), Compliance-as-a-Service (CaaS), The Future of Identity in the Cloud [TB1: 5]
11. Presence Protocols: XMPP, SIMPLE, SIP [8]
12. Privacy and Its Relation to Cloud-Based Information Systems, Privacy Risks and the Cloud, Cloud Security Challenges, Software-as-a-Service Security, Security Management (People), Security Governance, Risk Management, Risk Assessment, Security Portfolio Management, Security Awareness.[TB1:6]
13. End-User Access to Cloud Computing, YouTube, YouTube API Overview, Widgets, YouTube Player APIs, The YouTube Custom Player, YouTube Data API, Zimbra, Zimbra Collaboration Suite (ZCS), Facebook, Facebook Development, Zoho, Zoho CloudSQL, DimDim Collaborations[TB1:8]
14. Mobile Internet Device and the Cloud, [TB1: 9]
15. Cloud, IOT and Fog Computing [3,4]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, LLC (2010). ISBN 978-1-4398-0680-

7
2. Distributed Computing: Principles and Applications Book by Mei-Ling L. Liu. ISBN-13: 978-0201796445
3. Internet of Things: Principles and Paradigms,book by rajkumar buyya and Amir vahid DastjerDi(Eds.), publisher: Morgan kaufmann, ISBN: 978-0-12-805395-9
4. https://arxiv.org/abs/1601.02752
5. *https://www.vmware.com/pdf/virtualization.pdf*
6. *https://www.vmware.com/pdf/virtualization_considerations.pdf*
7. https://www.researchgate.net/publication/270581440_Cloud_Federation_characterization_and_conceptual_model
8. https://xmpp.org/
9. Architecting the Cloud: Design Decision for Cloud Computing Service Models (SAAS, PAAS and IAAS) Publisher: Wiley India Private Limited; 2014 edition, ISBN-10: 8126550333

SEEC-410 Systems Programming			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Introduction to systems programming, system programming languages and application of those languages to systems level problems.	C	2
2. Design, write, and test moderately complicated low-level programs using a systems programming language	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to the Microsoft Windows Operating System,
2. File Processing, Memory Management, Memory Mapped Files and DLLs,
3. Process management, Threads and scheduling, Thread synchronization,
4. Inter-process Communication, Input/Output, Device Drivers (USB or Parallel Port),
5. File System Drivers, Filter Drivers
6. Introduction to Assembly Language, 80x86 families; program layout. [TB 1: Ch. 1.1, 1.2; 2,3]
7. Data Definitions, Basic Instructions. [TB 1: Ch. 3, 4]
8. Unsigned Arithmetic; Logic and Bit Operations. [TB 1: Ch. 6, 7]
9. Modules; Separate Assembly; Argument Passing [TB 1: Ch. 5,8]
10. Libraries; Combining Assembly and C Code [TB 1: Ch. 13]
11. String Instructions; Arrays [TB 1: Ch. 9]
12. Macros; Structures [TB 1: Ch. 10]
13. Floating Point Instructions [TB 1: Ch. 12]
14. Bit MS-DOS. [TB 1: Ch. 14]

15. BIOS Disk Accessing 16. BIOS Keyboard/Video/Graphics 17. Interrupts; TSR Programs 18. Accessing I/O Ports; 8253 Timer
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Assembly Language for x86 Processors by Kip R. Irvine, Prentice Hall; latest Edition ISBN-10: 013602212X 2. Windows System Programming 3rd edition, Johnson M. Hart, Addison Wesley 3. The Windows NT Device driver book 2nd edition, Art Baker, Prentice Hall.

SEEC-311 Management Information Systems			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand basic concepts of information technology management, its application, development themes, development methodologies, development tools and technologies of Information Systems.	C	2
2. Able to solve common business problems and produce effective solutions to business problems.	C	3
3. Able to design a database application to solve a business problem.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction: Overview of Business Strategy Frameworks, Brief Overview of Organizational Strategies, Brief Overview of Information Systems Strategy [TB1: Ch. 1] 2. Understanding the IS Organization, What a Manager Can Expect from the IS Organization, What the IS Organization Does Not Do, IT Governance. [TB1: Ch. 8] 3. Evolution of Information Resources, Information Resources as Strategic Tools, How Can Information Resources Be Used Strategically? Strategic Alliances, Risks. Information Technology and Organizational Design, Information Technology and Management Control Systems, Information Technology and Culture. [TB1: Ch. 2 Ch.3] 4. Information Technology and the Design of Work. Information Technology and Changing Business Processes. Architecture and Infrastructure [TB1: Ch. 4,5,6,] 5. Information Systems Sourcing. Using Information Ethically [TB2: Ch. 7,9] 6. Techniques: Project management techniques, Organizational techniques, People techniques. IT Project Development Methodologies, Managing Business Knowledge [TB1: Ch. 11, 12] 7. Organizational Theory. Management and Control. Types of Business. Management,

System Theory, Types of Business Information System, Interaction of Business Systems. System Content. [TB2: Ch.4, 5, 6] 8. Computer System Concepts, Computers in Business, System Development [TB2: 10, 11, 14]
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
4. Experiencing MIS, D. M. Kroenke, A. Gemino and P. Tingling. P. 4th Edition. Toronto: Pearson.2016. 5. Business driven information systems, P. Baltzan, B. Detlor, and C. Welsh, 4th Ed., McGraw Hill Ryerson Press, 2015. 6. Fundamentals of Information Systems by Ralph Stair and George Reynolds, Course Technology; 6th Edition (January 1, 2011). ISBN-10: 0840062184 7. Information Systems Development: Methodologies, Techniques & Tools by David Avison and Guy Fitzgerald, McGraw-Hill; 4th Edition (May 1, 2006). ISBN-10: 0077114175 8. Information Systems Analysis and Design by Shouhong Wang and Hai Wang, Universal Publishers (January 1, 2012). ISBN-10: 1612330754

SEEC-411 Game Application Development			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Introduction to game development theory, framework, production and management.	C	2
2. Learn how to create a complete computer game from start to finish.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Building The Foundation, Historical Elements How Did We Get Here 2. Platform And Player Modes, What Is The Framework? [TB 1: Ch. 2] 3. Goals and Genres? What Are The Possibilities? [TB 1: Ch. 3] 4. Player Elements, Player Motivation, Geographic, Psychographics. [TB 1: Ch. 4] 5. Demographics, Gender, Generation, Rating, Applying Player Market to Platform. [TB 1: Ch. 4] 6. Story and Character Development: Classic Charters, Traditional Story Structure, Story Element. [TB 1: Ch. 5] 7. Plot, Game Story Devices, Game Characters [TB 1: Ch. 5] 8. Character Development Element, Point-of-view, Visual Character Development, Verbal

Character Development, Movement, [TB 1: Ch. 5] 9. Visual Character Development, Verbal Character Development, Movements, Chracter Description, Game Storytelling and Documentation [TB 1: Ch. 5] 10. Gameplay: Rules to Play, Interactivity Modes, Game theory, Challenges, balance [TB 1: Ch. 6] 11. Levels: Level Design, Structure, Time, Space. [TB 1: Ch. 7] 12. Interface: Playe-Centerd Design, Interface & Game Feature, Interface Types, Usability. [TB 1: Ch. 8] 13. Audio: The Importance of Game Audio, Sound Effect, Voiceover, Music. [TB 1: Ch. 9] 14. Role & Responsibilities: Company Role, Team Roles, Tools, Business Side of Game Development. [TB 1: Ch. 10] 15. Production and Management, Development Phases, Game Documentation [TB 1: Ch. 11]
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Game Development Essentials by Jeannie Novak, Delmar Cengage Learning; 3rd Edition (August 17, 2011). ISBN-10: 1111307652 2. Game Development Essentials: An Introduction by Jeannie Novak, Delmar Cengage Learning; 3rd Edition (2011). ISBN-10: 1111307652 3. Game Development Essentials: Mobile Game Development by Kimberly Unger and Jeannie Novak, Delmar Cengage Learning; 1st Edition (2011). ISBN-10: 1418052655 4. Game Development Essentials: Game Interface Design by Kevin Saunders and Jeannie Novak, Delmar Cengage Learning; 2nd Edition (2012). ISBN-10: 1111642885 5. Game Development Essentials: Online Game Development by Rick Hall and Jeannie Novak, Delmar Cengage Learning; 1 Edition (2008). ISBN-10: 1418052671 6. Beginning 3D Game Development with Unity: All-in-one, multi-platform game development by Sue Blackman, Apress; 1st Edition (2011). ISBN-10: 1430234229 7. Game Coding Complete by Mike McShaffry and David Graham, Course Technology PTR, 4th Edition, (2012). ISBN-10: 1133776574 8. The Essential Guide to Flash Games: Building Interactive Entertainment with Action Script by Jeff Fulton and Steve Fulton, friends of ED; 1st Edition (2010). ISBN-10: 1430226145

SEEC-426 Software Metrics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
CLO-1: Explains how quantitative and empirical methods are applied to software engineering problems	C	2
CLO-2: Presents the fundamentals of measurement, experimentation, data collection and analysis	C	3
CLO-3: Critically evaluate and discuss different software matrices of different applications in the real world with course participants and learners	C	3

CLO-4: Have a working knowledge of software size measurement (Function Point counting, etc.)	C	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Course Content:

1. Overview of software metrics : Measurement in Software Engineering, Scope of Software Metrics [TB: Ch.1]
2. The Basics of Measurement, Measurement and Models, Measurement Scales and Scale Types [TB: Ch.2]
3. Goal-based framework for software measurement: Classifying Software Measures, Determining What to Measure [TB: Ch.3]
4. Applying the Framework, Software Measurement Validation [TB: Ch.3]
5. Empirical investigation : Principles Of Empirical Studies, Planning Experiments, and Planning Case Studies as Quasi-Experiments, Relevant and Meaningful Studies [TB: Ch.4]
6. Analyzing Software Measurement Data: Statistical Distributions and Hypothesis Testing, Classical Data Analysis Techniques, Examples of Simple Analysis Techniques, Overview of Statistical Tests [TB: Ch.6]
7. Metrics for Decision Support: The Need for Causal Models: From Correlation and Regression to Causal Models, Bayes Theorem and Bayesian Networks (TB: Ch.7]
8. Measuring Internal Product Attributes: Size, Structure, Code Size, Design Size, Functional Size Measures and Estimators, Applications of Size Measures [TB: Ch.8, 9]
9. Functional Size Measures and Estimators, Applications of Size Measures [TB: Ch.8]
10. Design-Level Attributes, Object-Oriented Structural Attributes and Measures [TB: Ch.9]
11. Theory [TB: Ch.11]
12. Measuring External Product Attributes: Modeling Software Quality, Measuring Aspects of Quality, [TB: Ch.10]
13. Usability Measures, Maintainability Measures, and Security Measures [TB: Ch.10]
14. Software Reliability: Measurement And Prediction: Basics of Reliability [TB: Ch.11]
15. Software test metrics; Object-oriented metrics [Handouts]

Teaching Methodology:

Lecturing, Written Assignments, Project.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Software Metrics: A Rigorous and Practical Approach, (3rd ed.), N.E. Fenton and J. Bieman, CRC Press, 2014,
2. Software Metrics: A Guide to Planning, Analysis, and Application, C. Ravindranath Pandian, Auerbach Publications, CRC Press Company, 2004.
3. Metrics and Models in Software Quality Engineering, Stephen H. Kan, 2nd ed., Addison-Wesley Professional, 2002.

SEEC-314 Multimedia Systems and Design			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand complete process of multimedia system specifications, formats, design, testing, and prototyping.	C	2
2. Learn different tools and techniques for integrating multimedia content into a product.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. What is Multimedia? Text [TB1. Ch. 1, 2]
2. Multimedia Authoring and Tools: Multimedia Authoring, Multimedia Production, Multimedia Presentation, Automatic Authoring; Editing and Authoring Tools- Adobe Premiere, Macromedia Director, Macromedia Flash, Dreamweaver; VRML. [TB2: Ch. 2]
3. Handling Images. [TB1. Ch. 3]
4. Handling Sound. [TB1. Ch. 4]
5. Handling Animation. [TB1. Ch. 5]
6. Handling Video. [TB1. Ch. 6]
7. Making Multimedia. [TB1. Ch. 7]
8. Multimedia Skills. [TB1. Ch. 8]
9. Planning and Costing. [TB. Ch. 9]
10. Designing and Producing [TB1. Ch. 10]
11. Content and Talent. [TB1. Ch. 11]
12. The Internet and Multimedia [TB1. Ch. 12]
13. Designing for the World Wide Web; [TB1. Ch. 13]
14. Delivering. [TB1. Ch. 14]

    [Instructors need to devise a content delivery and Lab work plan using a multimedia Authoring tool in line with the contents of the textbook]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Multimedia Making It Work Eighth Edition by Tay Vaughan, McGraw-Hill Osborne Media; 8th Edition (October 29, 2010). ISBN-10: 0071748466
2. Fundamentals of Multimedia by Z. M. Li and M. S. Drew, Prentice Hall (2004), ISBN: 0-13-127256-X
3. Digital Multimedia by N. Chapman and J. Chapman. 2nd Edition, Wiley (2004). ISBN: 0-470-85890-7
4. The Technology of Video and Audio Streaming by David Austerberry, Focal Press; 2nd Edition (2004). ISBN-10: 0240805801
5. Multimedia Security: Watermarking, Steganography, and Forensics by Frank Y. Shih, CRC Press; 1st Edition (2012). ISBN-10: 1439873313
6. Multimedia Computing by Daniel Cunliffe and Geoff Elliott, Lexden Publishing Ltd. (2005). ISBN-10: 1904995055
7. Multimedia Foundations: Core Concepts for Digital Design by Vic Costello, Ed Youngblood and Susan Youngblood, Focal Press; 1st Edition (2012). ISBN-10:

0240813944

SEEC-414 Virtual Reality			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand fundamental techniques, processes, technologies and equipment used in virtual reality systems.	C	2
2. Acquire the basic knowledge about the physiology of human vision, hearing, and perception.	C	2
3. Understand the human interaction with virtual reality interfaces.	C	2
4. Introduce and review recent applications of virtual reality.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Definition of VR, Modern Experiences, Historical Perspective. [TB1: Ch 1]
2. Overview of VR Systems: Hardware, Sensors, Displays, Software, Virtual World Generator, Game Engines, Human Senses, Perceptual Psychology, Psychophysics. [TB1: Ch 2]
3. Geometric Modelling, Transforming Rigid Bodies, Yaw, Pitch, Roll, Axis-angle Representation, Quaternions, 3D Rotation Inverses and Conversions, Homogeneous Transforms, Transforms to Displays, Look-at and Eye Transforms, Canonical View and Perspective Transforms, Viewport Transforms. [TB1: Ch 3]
4. Light Propagation, Lenses and Images, Diopters, Spherical Aberrations, Optical Distortion; More Lens Aberrations; Spectral Properties; The Eye as an Optical System; Cameras. [TB1: Ch 4]
5. Parts of the Human Eye, Photoreceptors and Densities, Scotopic and Photopic Vision, Display Resolution Requirements, Eye Movements, Neural Vision Structures, Sufficient Display Resolution, Other Implications of Physiology on VR. [TB1: Ch 5]
6. Depth Perception, Motion Perception, Vection, Stroboscopic Apparent Motion, Color Perception, Combining Information From Multiple Cues And Senses, Implications Of Perception On VR. [TB1: Ch 6]
7. Graphical Rendering, Ray Tracing, Shading, BRDFs, Rasterization, Barycentric Coordinates, VR Rendering Problems, Anti-Aliasing, Distortion Shading, Image Warping (Time Warp), Panoramic Rendering. [TB1: Ch 7]
8. Velocities, Acceleration, Vestibular System, Virtual World Physics, Simulation, Collision Detection, Avatar Motion, Vection. [TB1: Ch 8]
9. Tracking Systems, Estimating Rotation, IMU Integration, Drift Errors, Tilt and Yaw Correction, Estimating Position, Camera-Feature Detection Model, Perspective N-Point Problem, Sensor Fusion, Lighthouse Approach, Attached Bodies, Eye Tracking, Inverse Kinematics, Map Building, SLAM. [TB1: Ch 9]
10. Remapping, Locomotion, Manipulation, Social Interaction, Specialized Interaction Mechanisms. [TB1: Ch 10]

11. Sound Propagation, Ear Physiology, Auditory Perception, Auditory Localization, Fourier Analysis, Acoustic Modeling, Hrtfs, Rendering, Auralization. [TB1: Ch 11] 12. Perceptual Training, Recommendations for Developers, Best Practices, VR Sickness, Experimental Methods That Involve Human Subjects. [TB1: Ch 12] 13. Touch, Haptics, Taste, Smell, Robotic Interfaces, Telepresence, Brain-Machine Interfaces. [TB1: Ch 13]
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Virtual Reality by Steven M. LaValle. Cambrigde University Press (2017). 2. Fundamentals of Computer Graphics by Peter Shirley, MichaelAshikhmin, and Steve Marschner. A K Peters/CRC Press; 3rd Edition (2009). ISBN: 1568814690

SEEC-415 IOT			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understanding the structure of Internet of Things.	C	1
2. Understand the basic principles of implementing IoT with Fog and Cloud.	C	2
3. Familiarity with Programming frameworks and Big Data analytics in real IoT Applications.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Internet of Things: An Overview, IoT emergence, Internet of EveryThing. [TB1:Ch 1, 3] 2. IoT infrastructures: Open Source Semantic web architecture for managing IoT resources in Cloud. [TB1:Ch 2] 3. Device/Cloud Collaboration Framework for Intelligence Applications IoT. [TB1: Ch,3] 4. Communication Protocols for IoT, Network Layers, Transport and Application layer [TB1: Ch 1, 13] 5. Fog Computing: Principles, Architectures, and Applications.[TB1: Ch 4] 6. Programming Frameworks for Internet of Things, Embedded device Programming languages, IoT programming languages [TB1: Ch 5] 7. Virtualization on Embedded Boards as Enabling Technology for the Cloud of Things[TB1: Ch 6] 8. Micro Virtual Machines (MicroVMs) for Cloud-Assisted Cyber-Physical Systems [TB1: Ch 7] 9. Design and Implement Scalable, Flexible, and open IoT solutions using Web technologies [TB4: Ch 1] 10. IoT data management and Analytics: IoT and Cloud, Real time Analytics in IoT and Fog

Computing, [TB1: Ch 8, TB2 : Ch 1]
11. A Framework for Distributed Data Analysis for IoT [TB1:Ch 9]
12. Security and Privacy in the Internet of Things, TinyTO: Two-Way Authentication for Constrained
    Devices in the Internet of Things [TB2 : Ch 12]
13. Internet of Things Applications, Monitoring and Actuating, Internet of Vehicles and Applications[Tb1 : Ch 15, 16]
14. Cloud-Based Smart-Facilities Management, IoT Services LifeCycle, Scheduling and Resource Management, Validating Applications and use cases [TB1:Ch 17]

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:

1. Internet of Things: Principles and Paradigms 1st Edition, ISBN-10: 012805395X
2. Big Data Analytics: Tools and Technology for Effective Planning, Published October 26, 2017, ISBN 9781138032392
3. https://pdfs.semanticscholar.org/2006/d0fca0546bdeb7c3f0527ffd299cff7c7ea7.pdf
4. Building the Web of Things, ISBN-10:9781617292682

SEEC-416 Semantic Web Techniques			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. This course introduces techniques that are useful stand-alone and can be integrated for building a semantic web.	C	2
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction to the semantic web.
2. Introduction to ontologies.
3. Ontology languages for the semantic web.
4. Resource Description Framework (RDF).
5. Lightweight ontologies: RDF Schema.
6. Web Ontology Language (OWL).
7. Query language for RDF: SPARQL.
8. Ontology Engineering.
9. Semantic web and Web 2.0 and applications of Semantic Web.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Introduction to the Semantic Web and Semantic Web Services, Liyang Yu, Chapman and Hall/CRC, 2007
2. Build Flexible Applications with Graph Data, Toby Segaran, Colin Evans, Jamie Taylor,302 pages O'Reilly Media, 2009
3. Foundations of Semantic Web Technologies, Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph.

SEEC-417 Mobile Computing			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Grasp the concepts and features of mobile computing technologies and applications.	C	1
2. Difficulties in Mobile App Development and standing of Mobile Application Development Today.	C	2
3. Design and implement Mobile Application	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. Introduction to Mobile Computing, Architecture of Mobile Software Applications, Introduction to Mobile Development Frameworks and Tools. [TB2: Ch. 1,2]
2. Creating Consumable Web Services for Mobile Devices: Intro to Web Services, Web Services Languages (Formats), Creating and Debugging Web Services [TB2: Ch. 3].
3. Memory Management: Design Patterns for Limited Memory, Strategies for Allocating Variable to Memory, Memory Management in Mobile Java, Symbian OS Memory Management. [TB1]
4. Mobile Applications: Components of Mobile Application, Workflow for Application Development, Techniques for Composing Application, Application Models in Mobile Java, Symbian OS Application Infrastructure. [TB1]
5. Mobile User-Interface Design: Effective Use of Screen, Understanding Mobile Application Users, Understanding Mobile Information Design, Understanding Mobile Platforms, Using the Tools of Mobile Interface Design. [TB 2: Ch. 4]
6. Dynamic Linking: Introduction to DLL, Implementation Techniques & Plugins, Managing Memory in DLL, Rules of Thumb for Using DLL, Mobile Java and Dynamic Linking, Symbian OS Dynamic Libraries. [TB1]
7. Concurrency: Introduction, Infrastructure for Concurrent Programming, Faking Concurrency, MIDP Java and Concurrency, Symbian OS and Concurrency. [TB1]
8. Managing Resources: Resource-Related Concerns in Mobile Devices, Common Concerns, MIDP Java, Symbian OS. [TB1]
9. Security: Secure Coding and Design, Infrastructure for Enabling Secure Execution, Features in MIDP Java, Symbian OS Security. [TB1]

10. Introduction to Mobile Application Development with Android [TB2: Ch. 6] 11. Introduction to Mobile Application Development with IOS [TB2: Ch. 7] 12. Introduction to Mobile Application Development with Windows Phone [TB2: Ch. 8] 13. Introduction to Mobile Application Development with Blackberry [TB2: Ch. 9]
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Programming Mobile Devices: An Introduction for Practitioners by TommiMikkonen, Wiley; 1st Edition (March 19, 2007). ISBN-10: 0470057386. 2. Professional Mobile Application Development by Jeff McWherter& Scott Gowell, Wrox; 1st Edition (September 4, 2012). ISBN-10: 1118203909 3. Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML by Reza B'Far and Roy T. Fielding, Cambridge University Press (2004). ISBN-10: 0521817331. 4. Mobile Design and Development: Practical concepts and techniques for creating mobile sites and web apps (Animal Guide) by Brian Fling, O'Reilly Media; 1st Edition (2009). ISBN-10: 0596155441. 5. Fundamentals of Mobile and Pervasive Computing by Frank Adelstein, Sandeep KS Gupta, Golden Richard III and Loren Schwiebert, McGraw-Hill Professional; 1st Edition (2004). ISBN-10: 0071412379. 6. Mobile Design Pattern Gallery: UI Patterns for Mobile Applications by Theresa Neil, O'Reilly Media (2012). ISBN-10: 1449314325. 7. Programming Android: Java Programming for the New Generation of Mobile Devices by ZigurdMednieks, Laird Dornin, G. Blake Meike and Masumi Nakamura, O'Reilly Media; 2nd Edition (2012). ISBN-10: 1449316646. 8. Beginning Android 4 Application Development by Wei-Meng Lee, Wrox; 1st Edition (March 6, 2012). ISBN-10: 1118199545

SEEC-418 Data Warehousing			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Learn concepts and skills for designing data warehouses and creating data integration workflows.	C	2
2. Able to use tools for data warehousing: MS SQL and Teradata.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:
1. Introduction to Data Warehousing: Brief History, Characteristics, Architecture, Data Staging and ETL, Multidimentional Model, Meta-data, Accessing Data Warehouse, ROLAP, MOLAP, and HOLAP. [TB1: Ch. 1]

2. Data Warehouse System Lifecycle: Risk Factors, Top-Down vs Bottom-Up, Data Mart Design Phases, Methodological Framework – Data-Driven, Requirement-Driven; Testing Data Marts. [TB1: Ch. 2]
3. Analysis and Reconciliation of Data Sources: Inspecting and Normalization Schemata, Integration Problems, Integration Phases, Defining Mapping. [TB 1: Ch. 3]
4. User Requirement Analysis: Interviews, Glossary-based Requirement Analysis, Additional Requirements. [TB 1: Ch. 4]
5. Conceptual Modeling: Dimensional Fact Model, Events and Aggregation, Temporal Aspects, Overlapping Fact Shcemata, Formalizing the Dimensional Fact Model. [TB 1: Ch. 6]
6. Conceptual Design: ER Schema-based Design, Relational Schema-based Design, XML Schema-based Design, Mixed-approach Design. Requirement-driven Approach Design. [TB 1: Ch. 6]
7. Workload and Data Volume [TB1: Ch. 7]
8. Logical Modeling: MOLAP and HOLAP Systems, ROLAP Systems, Views, Temporal Scenarios. [TB1: Ch. 8]
9. Logical Design: From Fact Schemata to Start Schemata, View Materialization, View Fragmentation. [TB1: Ch. 9]
10. Data-staging Design: Population Reconciled Databases, Cleansing Data, Populating Dimensional Tables, Populating Fact Tables, Populating Materialized View
11. Indexes for the Data Warehouse: B*-Tree Indexes, Bitmap Indexes, Projection Indexes, Join & Star Indexes, Spatial Indexes, Join-Algorithm. [TB1: Ch. 11]
12. Physical Design: Optimizers, Index Selection, Splitting a Database into Tablespaces, Allocating Data Files, Disk Block Size. [TB1: Ch. 12]
13. Data Warehouse Project Documentation: Data Warehouse Levels, Data Mart Level, Fact Level
14. Case Studies, Tools for Data Warehousing: MS SQL and Teradata

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Data Warehouse Design: Modern Principles and Methodologies by MatteoGolfarelli and Stefano Rizzi, McGraw-Hill Osborne Media; 1st Edition (May 26, 2009). ISBN-10: 0071610391
2. Building the Data Warehouse by William H. Inmon, Wiley; 4th Edition (2005). ISBN-10: 0764599445
3. The Data Warehouse Lifecycle Toolkit : Expert Methods for Designing, Developing, and Deploying Data Warehouses by Ralph Kimball, Laura Reeves, Margy Ross and Warren Thornthwaite, Wiley (August 13, 1998). ISBN-10: 0471255475
4. Data Warehousing Fundamentals for IT Professionals by PaulrajPonniah, Wiley; 2ndEdition (2010). ISBN-10: 0470462078
5. Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and AmitAsthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419

SEEC-419 Data Mining			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the applications, concepts, and techniques of data mining.	C	2
2. Learn different data mining tools and apply basic data mining techniques to actual problems.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Data-Mining Concepts: Introduction, Data-Mining Process, Large Data Sets, Data Warehouses for Data Mining, Business Aspects Data Mining. [TB1: Ch. 1]
2. Preparing the Data: Raw Data- Representation, Characteristics, Transformation; Missing Data, Time-Dependent Data, Outlier Analysis. [TB1: Ch. 2]
3. Data Reduction: Dimensions of Large Data Sets, Feature Reduction, Relief Algorithm, Entropy Measure for Ranking Features, PCA, Value Reduction, Feature Discretization: ChiMerge Technique, Case Reduction. [TB1: Ch. 3]
4. Learning From Data: Learning Machine, SLT, Types of Learning Methods, Common Learning Tasks, SVMs, kNN: Nearest Neighbor Classifier, Model Selection versus Generalization, Model Estimation. [TB1: Ch. 4]
5. Statistical Methods: Statistical Inference, Assessing Differences in Data Sets, Bayesian Inference, Predictive Regression, ANOVA, Logistic Regression, Log-Linear Models, LDA. [TB1: Ch. 5]
6. Decision Trees and Decision Rules: Decision Trees, Generating & Pruning Decision Tree, CART Algorithm &Gini Index, Limitations of Decision Trees and Decision Rules. TB1: Ch. 6]
7. Artificial Neural Networks: Model of an Artificial Neuron, Architectures of ANNs, Learning Process, Learning Tasks Using ANNs, Multilayer Perceptrons, Competitive Networks and Competitive Learning, SOMs. [TB1: Ch.7]
8. Ensemble Learning: Ensemble-Learning Methodologies, Combination Schemes for Multiple Learners, Bagging and Boosting, AdaBoost. [TB 1: Ch. 8]
9. Cluster Analysis: Clustering, Similarity Measures, Agglomerative Hierarchical Clustering, Partitional Clustering, Incremental Clustering, DBSCAN Algorithm. BIRCH Algorithm, Agglomerative Hierarchal and Partition Clustering Algorithms, Clustering Validation. [TB 1: Ch. 9]
10. Association Rules: Market-Basket Analysis, Algorithm Apriori, From Frequent Itemsets to Association Rules, Improving the Efficiency of the Apriori Algorithm, FP Growth Method, Associative-Classification Method, Multidimensional Association–Rules Mining. [TB 1: Ch. 10]
11. Web Mining and Text Mining: Web Mining, Web Content, Structure, and Usage Mining, HITS and LOGSOM Algorithms, Mining Path–Traversal Patterns, PageRank Algorithm, Text Mining, Latent Semantic Analysis. [TB 1: Ch. 11]
12. Genetic Algorithms: Fundamentals of GAs, Optimization Using GAs, Schemata, TSP,

Machine Learning Using GAs, GAs for Clustering. [TB 1: Ch. 13]

13. Fuzzy Sets and Fuzzy Logic: Fuzzy Sets, Fuzzy-Set Operations, Extension Principle and Fuzzy Relations, Fuzzy Logic and Fuzzy Inference Systems, Multifactorial Evaluation, Extracting Fuzzy Models from Data, Data Mining and Fuzzy Sets
14. Visualization Methods: Perception and Visualization, Scientific Visualization and Information Visualization, Parallel Coordinates, Radial Visualization, Visualization Using Self-Organizing Maps, Visualization Systems for Data Mining
15. Data Mining Tools: Weka, CBA and Yale, etc.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Data Mining: Concepts, Models, Methods, and Algorithms by MehmedKantardzic, Wiley-IEEE Press; 2nd Edition (August 16, 2011). ISBN-10: 0470890452
2. Data Mining: Concepts and Techniques, Third Edition (The Morgan Kaufmann Series in Data Management Systems) by Jiawei Han, MichelineKamber and Jian Pei, Morgan Kaufmann; 3rd Edition (2011).ISBN-10: 0123814790
3. Principles of Data Mining (Adaptive Computation and Machine Learning) by David J. Hand, HeikkiMannila and Padhraic Smyth, A Bradford Book (August 1, 2001). ISBN-10: 026208290X
4. Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and AmitAsthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419
5. Information-Statistical Data Mining: Warehouse Integration with Examples of Oracle Basics (The Springer International Series in Engineering and Computer Science) by Bon K. Sy and Arjun K., Springer; 1st Edition (2003). ISBN-10: 1402076509
6. Building the Data Warehouse by William H. Inmon,Wiley; 4th Edition (2005).ISBN-10: 0764599445

SEEC-420 Business Intelligence and Analytics			
Credit Hours:	3+0	**Prerequisites:**	None

Course Content:

1. Business Intelligence - An Introduction, Value Drivers, Performance Metrics and Key Performance Indicators, Use Cases for BI. [TB 1: Ch. 1, 2]
2. BI Success Factors. Strategic Versus Tactical Planning, BI Strategy and Plan. [TB 1: Ch. 3,4]
3. BI Environment, BI and Analytics Platform and Strategy, Organizational BI Framework, Services & Systems Evaluation. [TB 1: Ch. 5]
4. Business Process and Information Flow: Information Need & Flow, Information Processing & Information Flow, Information Flow Model, Modeling Frameworks. [TB 1: Ch. 6]
5. Data Requirements Analysis: Business Uses of Information, Metrics: Facts, Qualifiers, and Models, Defining Business Rules, Data Requirement Analysis, Assessing Suitability. [TB 1: Ch. 7]
6. Data Warehouses and the Technical BI Architecture: Data Modeling and Analytics,

Analytical Platforms, Operational Data Stores. Business Metadata: What is Metadata? Types of Metadata, Semantics Metadata Processes for Business Analytics. [TB 1: Ch. 8, 9]

7. Data Profiling: Data Sources, Data Profiling Activities, Data Model Inference, Attribute Analysis, Relationship Analysis, Management Issues. [TB 1: Ch. 10]
8. Business Rules: The Value of Proposition of Business Rules, The Business Rules Approach, Defining Business Rules, Business Rule Systems, Sources of Business Rules, Management Issues. [TB 1: Ch. 11]
9. Data Quality: Virtuous Cycle of Data Quality, Types of Data Flow, Business Impacts of Data Flow, Dimensions of Data Quality, Data Quality Assessment, Data Quality Rules, Data Quality Monitoring and Improvement, Data Quality for Business Analytics, Data Cleansing. [TB 1: Ch. 13]
10. Data Integration: Improving Data Accessibility, Extracting/ Transformation/Loading, Data Latency and Data Synchrony, Data Replication and Change Data Capture, Data Integration and Cloud Computing, Information protection, Merge/Purge and Record Consolidation. [TB 1: Ch. 13]
11. Deriving Insight from Data: Customer Profiles, Behavior, and Lifetime Value; Demographics, Psychographics, Geographic; Geographic Data, Behavior Analysis. [TB 1: Ch. 15, 16]
12. Knowledge Discovery & Delivery: Business Drivers, KD Virtuous Cycle, Direct Versus Unidirectional Knowledge Discovery, Data Mining Activities, Data Mining Techniques. [TB 1: Ch. 17]
13. BI User Types, Standards Reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, Dimensional Analysis, Alerts/ Notifications, Visualizations, Scorcards and Dashboards, Geographical Visualizations, Integrated Analysis. [TB 1: Ch. 18]
14. Installations, Configuring and Maintaining the BI Server, Creating Repositories from Relational Sources, Creating Repositories from OLAP Data Sources, Creating Reports Using Answers and Dashboards.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Business Intelligence by David Loshi, Morgan Kaufmann; 2nd Edition (October 31, 2012). ISBN-10: 0123858895
2. Oracle Business Intelligence 11g Developers Guide by Mark Rittman, McGraw-Hill Osborne Media; 1st Edition (September 18, 2012). ISBN-10: 0071798749
3. Delivering Business Intelligence with Microsoft SQL Server 2012 3/E by Brian Larson, McGraw-Hill Osborne Media; 3rd Edition (March 16, 2012). ISBN-10: 0071759387
4. Business Intelligence by Elizabeth Vitt, Michael Luckevich, and StaciaMisner, Microsoft Press (December 22, 2008). ISBN-10: 073562660X
5. The Data Warehouse Mentor: Practical Data Warehouse and Business Intelligence Insights, by Robert Laberge, 1st Edition, McGraw-Hill Companies, (2012). ASIN: B008UYJJ8C
6. Business Intelligence: A Managerial Approach by Turban, Sharda, Delen, King, 2nd Edition, Prentice Hall (2011). ISBN: 13-978-0-136-10066-9
7. Business Intelligence in Plain Language: A practical guide to Data Mining and Business Analytics by Jeremy Kolb, Applied Data Labs Inc. (2012). ASIN: B009K7INOY

SEEC-302 Database Administration & Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Fully understand the concepts and technical issues of database administration.	C	2
2. Develop understanding of internal functionality of DBMS.	C	3
3. Able to perform database administration tasks like backup and recovery and performance tuning of databases.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Installation; SQL* Plus; Oracle Enterprise Manager; DBA Tools. Oracle Architectural Components: Oracle Server; Oracle Instance.
2. Physical Structure; SGA; Shared Pool; Library Cache; Data Dictionary Cache; Large Pool; User Process; Server Process; Background Processes.
3. Managing an Oracle Instance: Parameter File; Creating SPFILE; Oracle Managed Files; Startup and Shutdown Database; Alert Log File; Background Trace File; User Trace File.
4. Creating Database and Data dictionary.
5. Managing Control Files and Redo Log Files.
6. Managing Tablespaces, Operations with Tablespaces.
7. Data File Management, Segments, Block.
8. Managing Undo Data, Undo Data Statistics: Managing Tables and Users:
9. Indexes Management, Maintaining Data Integrity, Constraints. Managing Privileges.
10. Basic Oracle Net Architecture: Types of Networks, Oracle Net Services, Oracle Shared Server, Connection Manager, Oracle Net Connections.
11. Server Side Configuration: The Listener Process; Configuring Listener, Sessions, Creating and Managing Listener.
12. Client Side Configuration: Host Naming Method, Local Naming Method, Net Assistant, Configurations. Usage and Configuration of Oracle Shared Server.
13. Backup and Recovery, Instance and Media Recovery, Configuration of Archive log mode, User Managed Complete Recovery, Loading Data into Database, Tuning Tools, Sizing Shared Pool, Sizing Buffer Cache, I/O Issues.
14. Tuning Rollback Segments, Latches, Rollback Segment Tuning Shared Servers, Types of Locks, Block Efficiency, Storage hierarchy, Avoiding Dynamic allocation, Statistics, PCTFREE and PCTUSED, Monitoring Index Usage.

Teaching Methodology:

Lectures, Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Oracle Database 11g DBA Handbook by Bob Bryla and Kevin Loney, McGraw-Hill Osborne Media; 1st Edition (December 6, 2007). ISBN-10: 0071496637
2. Database Administration: The Complete Guide to DBA Practices and Procedures by Craig S. Mullins, Addison-Wesley Professional; 2nd Edition (October 21, 2012). ISBN-10: 0321822943
3. Database Systems: A Practical Approach to Design, Implementation and Management by Thomas M. Connolly and Carolyn E. Begg, Addison-Wesley; 5th Edition (2009). ISBN-10: 0321523067
4. Oracle Database 11g The Complete Reference by Kevin Loney, McGraw-Hill Osborne Media; 1st Edition (2008). ISBN-10: 0071598758
5. Oracle Database 11g Release 2 Performance Tuning Tips & Techniques (Oracle Press) by Rich Niemiec, McGraw-Hill Osborne Media; 1st Edition (2012). ISBN-10: 0071780262
6. Online Material URL http://otn.oracle.com

SEEC-422 Advance Database Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Explore the salient features of various types of databases.	C	3
2. Provide an overview data warehousing, OLAP and data mining.	C	3
3. Lean about transaction processing, concurrency control, crash recovery and database security.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. PL/SQL – Introduction To PL/SQL – Declare, Begin Statements, Variables, Control Structure, PL/SQL Transactions – Savepoint, Cursor, PL/SQL Database Objects – Procedures, Functions, Packages, Triggers. Programmatic SQL – Embedded SQL, Dynamic SQL, And ODBC Standard.
2. Transaction Processing And Concurrency Control Definition Of Transaction And ACID Properties. Transaction Processing - Transaction-Processing Monitors, Transactional Workflows, Main-Memory Databases, Real-Time Transaction Systems, Long-Duration Transactions, Transaction Management In Multi-Databases. Concurrency Control – Locks, Optimistic Concurrency Control (Backward and Forward Validations), Timestamping Concurrency Control.
3. Object-Based Databases And Xml Object-Based Databases – Complex Data Types, Structured Types and Inheritance In SQL, Table Inheritance, Array and Multiset Types in SQL, Objectidentity and Reference Types in SQL, Implementing O-R Features, Persistent
4. Programming Languages, OO Vs OR. XML – Structure of XML, Document Schema, Querying and Transformation, API In XML, XML Applications.
5. Data Warehousing: Introduction To Data Warehousing – Concepts, Benefits and

Problems, DW Architecture – Operational Data, Load Manager, Meta Data, DW Data Flows – Inflow, Upflow, Meta Flow, DW Tools and Technologies – Extraction, Cleansing and Transformation Tools, DW DBMS, Admin and Management Tools, Data Marts – Reasons And Issues, Data Warehousing Using Oracle.

6. Data Warehousing Design – Designing, Dimensionality Modeling, Design Methodology, DW Deign Using Oracle.
7. OLAP And Data Mining On-Line Analytical Processing – OLAP Benchmarks, Applications, Benefits, Tools, Categories, Extensions To SQL, Data Mining – Introduction, Techniques, Predictive Modeling, Tools. Data Mining Algorithms – Apriori, Decision Tree, K-Means, Bayesian Classifier.
8. Database Security: Security and Integrity Threats, Defence Mechanisms, Statistical Database Auditing & Control. Security Issue Based On Granting/Revoking of Privileges, Introduction to Statistical Database Security. PL/SQL Security – Locks – Implicit Locking, Types And Levels of Locks, Explicit Locking, Oracles' Named Exception Handlers.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Database System Concepts by A. Silberschatz, H. Korth and S. Sudarshan, McGraw-Hill Science/Engineering/Math; 6th Edition (January 27, 2010). ISBN-10: 0073523321
2. Database Systems – A Practical Approach to Design, Implementation and Management by Thomas Connolly and Carolyn Begg, 5th Edition, ISBN-10: 0321601106.
3. SQL, PL/SQL – The Programming Language of ORACLE by Ivan Bayross, Third Revised Edition, BPB Publication.ISBN-10: 8176560723
4. Data Mining – Concepts and Techniques by Jiawei Han and MichelineKamber, Morgan Kaufmann; 3rd Edition (July 6, 2011). ISBN-10: 0123814790
5. Handbook of Database Security- Application and Trends by M. Gertz, and S. Jajodia, 2008, Springer.
6. Handbook of Database Security: Applications and Trends by Michael Gertz (Editor) and SushilJajodia (Editor), Springer; Softcover reprint of hardcover 1st Edition (November 4, 2010). ISBN-10: 1441943056

SEEC-423 Business Process Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand the key Terms and concepts in Business Process Management.	C	2
2. Learn about the major methodologies and techniques for implementing BPM.	C	2
3. Learn what a BPM management and process-centric organization is and how it works.	C	2

4. Understand the metrics and measurements critical to managing processes	C	3
5. Learn how to identify critical processes.	C	3
*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**		

Course Content:

1. Introduction: Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. [TB 1: Ch. 1]
2. Evolution of Enterprise Systems Architectures: Traditional Application Development, Enterprise Applications and their Integration, Enterprise Modeling and Process Orientation, Workflow Management, Enterprise Services Computing. [TB 1: Ch. 2]
3. Business Process Modeling: Foundation, Conceptual Model and Terminology, Abstraction Concepts, From Business Functions to Business Processes, Activity Models and Activity Instances, Process Models and Process Instances, Process Interactions, Modeling Process Data, Modeling Organization, Modeling Operation, Business Process Flexibility, Architecture of Process Execution Environments. [TB 1: Ch. 3]
4. Process Orchestrations: Control Flow Patterns, Petri Nets, Event-driven Process Chains, Workflow Nets, Graph-Based Workflow Language, Business Process Model and Notation. [TB 1: Ch. 4]
5. Process Choreographies: Motivation and Terminology, Development Phases, Process Choreography Design, Process Choreography Implementation, Service Interaction Patterns, Choreography Modeling in BPMN. [TB 1: Ch. 5]
6. Properties of Business Processes: Data Dependencies, Object Lifecycle Conformance, Structural Soundness, Soundness, Relaxed Soundness, Weak Soundness, Lazy Soundness, Soundness Criteria Overview. [TB 1: Ch. 6]
7. Business Process Management Architectures: Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes: Case Handling. [TB 1: Ch. 7]
8. Business Process Management Methodology: Dependencies between Processes, Methodology Overview, Phases in Detail. [TB 1: Ch. 7]

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Reference Materials:

1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2nd Edition (May 3, 2012). ISBN-10: 3642286151.
2. Business Process Management Common Body Of Knowledge by Yvonne LedererAntonucci, et. al., CreateSpace Independent Publishing Platform (March 8, 2009). ISBN-10: 1442105666
3. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Edition (January 21, 2011). ISBN-10: 3642151892
4. Business Process Management, Second Edition: Practical Guidelines to Successful Implementations by John Jeston and Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
5. Process Management: Practical Guidelines to Successful Implementation by T.S. Malik, Global India Publications Pvt Ltd; 1st Edition (December 31, 2009). ISBN-10:

9380228368
6. Business Process Management: Practical Guidelines to Successful Implementations by John Jeston& Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
7. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody-Cassidy Press (October 17, 2011). ISBN-10: 0982368119
8. Workflow Modeling: Tools for Process Improvement and Application Development by Alec Sharp and Patrick McDermott, Artech House; 2nd Edition (October 31, 2008). ISBN-10: 1596931922
9. Process Analysis and Improvement: Tools and Techniques by Seppanen, Marvic S., Kumar, Sameer & Chandra, Charu (2005). McGraw-Hill
10. Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals (The MK/OMG Press) by Paul Harmon and Business Process Trends, Morgan Kaufmann; 2nd Edition (July 27, 2007). ISBN-10: 0123741521

SEEC-424 Knowledge Management			
Credit Hours:	3+0	**Prerequisites:**	None

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Appraise current thought on knowledge management in the light of contemporary debates on knowledge productivity, strategic capability and organizational learning.	C	2
2. Apply theories of knowledge management relevant to current workplace practice.	C	3
3. Apply the tools and techniques of knowledge management.	C	3

*** BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain**

Course Content:

1. History and paradigms of knowledge management; Types of knowledge: Explicit Knowledge, Tacit Knowledge, Embedded Knowledge, Embrained knowledge, Embodied knowledge, Encoded knowledge, Encultured knowledge; Organizational Internal & External Knowledge; Managers' Knowledge; Personal knowledge. Knowledge Economy: Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents; Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies. [TB1: Ch. 1, 2, 4]
2. KM Processes: Knowledge Discovery/ Detection, Knowledge Capture and Codification, Knowledge Organization, Knowledge Sharing, Explicit Knowledge Sharing, Knowledge transfer, Knowledge Acquisition, Knowledge Verification, Knowledge Utilization, Knowledge Creation, Knowledge Reuse; [TB1: Ch. 3]
3. KM Frameworks and Models: The SECI Model, Alen Frost's Model, Boisot's KM Model, Hedlund's KM Model, Earl's KM Model, Carayannis's KM Model, Wiig's KM Model, Edvinsson's Model of Intellectual Capital, Snowden's KM Model,

Inkpen&Dinur's KM Model. [TB1: Ch. 4]

4. KM Frameworks and Models: Van Buren's Model of IC Management, Bukowitz& Williams's KM Model, Gamble & Blackwell's KM Model, Demerest's KM Model, Frid's KM Model, Stankosky&Baldanza's KM Framework, Kogut& Zander's KM Model, Botha et. al. KM Model, Integrated Knowledge Management Model. [TB1: Ch. 4]
5. 4 Knowledge Capture and Codification: Tacit Knowledge Capture at the Individual, Group, and Organizational Levels, xplicit Knowledge Codification, Cognitive Maps, Decision Trees, Knowledge Taxonomies, The Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence; Strategic and Practical Implications of Knowledge Capture and Codification [TB2: Ch. 4]
6. Knowledge Sharing and Communities of Practice: Sociograms and Social Network Analysis, Knowledge-Sharing Communities, Types of Communities, Roles and Responsibilities in CoPs, Knowledge Sharing in Virtual CoPs, Obstacles to Knowledge Sharing, Strategic and Practical Implications of Knowledge Sharing. [TB2: Ch. 5]
7. Knowledge Application: Knowledge Application at the Individual Level, Characteristics of Individual Knowledge Workers, Bloom ' s Taxonomy of Learning Objectives, Task Analysis and Modeling, Knowledge Application at the Group and Organizational Levels, Knowledge Reuse, Knowledge Repositories, E-Learning and Knowledge Management Application, Strategic & Practical Implications of Knowledge Application. [TB3: Ch.6]
8. The Role of Organizational Culture: Different Types of Cultures, Organizational Culture Analysis, The Effects of Culture on Individuals, Organizational Maturity Models, KM Maturity Models, CoP Maturity Models, Transformation to a Knowledge-Sharing Culture, Impact of a Merger on Culture, Impact of Virtualization on Culture, Strategic and Practical Implications of Organizational Culture. [TB2: Ch.7]
9. Knowledge Management Tools: Knowledge Capture and Creation Tools, Content Creation Tools, Data Mining and Knowledge Discovery, Blogs, Mashups, Content Management Tools, Folksonomies and Social Tagging/Bookmarking, Personal Knowledge Management (PKM), Knowledge Sharing and Dissemination Tools, Groupware and Collaboration Tools, Wikis, Social Networking, Web 2.0, and KM 2.0, Knowledge Acquisition and Application Tools, Intelligent Filtering Tools, Adaptive Technologies, Strategic and Practical Implications of KM Tools and Techniques. [TB2: Ch. 8]
10. Knowledge Management Strategy: Developing a Knowledge Management Strategy, Knowledge Audit, Gap Analysis, The KM Strategy Road Map, Balancing Innovation and Organizational Structure, Types of Knowledge Assets Produced. [TB2: Ch. 9]
11. The Value of Knowledge Management: KM Return on Investment (ROI) and Metrics, The Benchmarking Method, The Balanced Scorecard Method, The House of Quality Method, The Results-Based Assessment Framework, Measuring the Success of Communities of Practice. [TB2: Ch. 10]
12. Organizational Learning and Organizational Memory: How Do Organizations Learn and Remember? Frameworks to Assess Organizational Learning and Organizational Memory, The Management of Organizational Memory, Organizational Learning, The Lessons Learned Process, Organizational Learning and Organizational Memory Models, A Three-Tiered Approach to Knowledge Continuity. [TB2: Ch. 11]
13. The KM Team: Major Categories of KM Roles, Senior Management Roles, KM Roles and Responsibilities within Organizations, The KM Profession, The Ethics of KM. [TB2: Ch. 12]

Teaching Methodology:

Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
Reference Materials:
1. Essentials of Knowledge Management: Concepts, Theories and Practices by M. A. Pasha & S. Pasha, Innovators Knowledge Services (2012). ISBN:978-969-9791-04-8 2. Knowledge Management in Theory and Practice by KimizDalkir, The MIT Press; 3nd Edition (March 4, 2011). ISBN-10: 0262015080 3. The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms by AmritTiwana, Prentice Hall; 2nd Edition (August 29, 2002). ISBN-10: 013009224X 4. Principles of Knowledge Management: Theory, Practice and Cases by ElieGeisler and NilminiWickramasinghe, M.E.Sharpe (January 15, 2009). ISBN-10: 0765613220 5. Knowledge Management: Concepts, Methodologies, Tools and Applications (6-volume set) by Murray E. Jennex, IGI Global; Reprint Edition (August 10, 2007). ISBN-10: 1599049333

Curriculum
of
MS Computer Science
for
Main Campus, Sub Campuses,
and
Affiliated Colleges

Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall 2018)

Curriculum of MS Computer Science Program

MSCS Program's Rationale

Computer Science is the systematic study of the feasibility, structure, expression, and mechanization of the methodical processes (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information, whether such information is encoded in bits and bytes in a computer memory or transcribed in genes and protein structures in a human cell.

Computer Science spans a wide range, from its theoretical and algorithmic foundations to cutting-edge developments in robotics, computer vision, intelligent systems, bioinformatics, and other exciting areas. Computer scientists develop new programming approaches for software development, devise new ways to use computers and develop effective ways to solve computing problems. While other disciplines produce graduates with more immediately relevant job-related skills; computer science offers a comprehensive foundation for research and innovation.

Recent developments in computer hardware, software and communication technologies have offered new exciting opportunities and challenges for creation of innovative learning environments for Computer Science and its curricula design. The challenge of getting all newly emerging technologies incorporated into the curriculum is becoming pivotal for the effectiveness of curricula. There is a need for curricula structures that are really able to meet the challenges of 21st century knowledge driven complex work places. The curriculum is required to provide integration of all components and the foundations that allow accessing all of the new knowledge and technology to fulfill the vision of future. To prepare the graduates for the future is the key rationale behind the MS Computer Science program.

This key rationale leads to develop a MSCS program whichprovides an intensive preparation in the concepts and techniques related to the design, programming and application of computing systems. The program offers a broad spectrum of courses, while simultaneously allowing emphasis in desired areas of specializations. The program also follows HEC guidelines.

MS in Computer Science is a flexible, challenging, and rewarding graduate program that covers the essentials of contemporary applied computer science. In doing so, we emphasize on the enduring foundations of the field and we adhere to a pragmatic style of instruction, blending the best of the art and the science of computing.

Program Structure

The graduate program embody sufficient flexibility to fulfill the requirements of either an "academic" degree (Breadth-Based) obtained in preparation for further graduate study or a terminal "professional" degree (Depth-Based). The program is intended to establish an integrated breadth and depth based curriculum model to assure that the common aspects of various potential graduate programs in Computer Science are captured.

Generally graduate programs are structured with a common core of fundamental material and a wide range of options for rest of the course work. MSCS curriculum structure is

implemented in four-semester time. A project/thesis work is unified with student's chosen depth oriented specialties. Followings are the program's details:

Eligibility

16-years of education with 2.5 CGPA or equivalent in science/engineering discipline preferably with 4 years degree program of BS (SE/CS/IT/EE/CE) or equivalent from HEC recognized university or degree awarding institute.

Degree Requirements

For the award of MS degree, a student must have:

a. Passed courses totalling at least 30 credit hours, including four core courses.
b. Obtained a CGPA of 2.5 or more.

Distribution of Courses:

Followings are the distribution of total credit hours:

Category or Area	Credit Hours
Core	12
Elective	12
Thesis	6
Total Credit Hours	30

List of Core Courses

S No	Course Code	Pre. Req.	Course Title	Credit Hours
1	CSCC-701	None	Advanced Theory of Computation	3(3+0)
2	CSCC-702	Analysis of Algorithms	Advanced Algorithm Analysis	3(3+0)
3	CSCC-703	Operating System	Advanced Operating Systems	3(3+0)
4	CSCC-704	Computer Architecture	Advanced Computer Architecture	3(3+0)

List of Elective Courses

S No	Course Code	Pre. Req.	Course Title	Cr. Hrs.
5	ITEC-707	Computer Networks	Advanced Topics in Wireless Networks	3(3+0)
6	CSEC-717	Artificial Intelligence	Advanced Artificial Intelligence	3 (3+0)
7	CSEC-713	Human Computer Interaction	Advanced Human Computer Interaction	3(3+0)

8	CSEC-707	Web system and technology	Advanced Web development	3(3+0)
9	CSEC-731	None	Advanced Web Engineering	3 (3+0)
10	CSEC-708	None	Agent Based Modeling	3(3+0)
11	CSEC-714	None	Big Data Analysis	3(3+0)
12	CSEC-724	None	Bioinformatics	3(3+0)
13	ITEC-710	None	Business Process Management Trends & Technologies	3 (3+0)
14	CSEC-715	Computer Networks	Cloud Computing	3(3+0)
15	CSEC-711	None	Computational Intelligence	3(3+0)
16	CSEC-722	Linear Algebra	Computer Vision	
17	CSEC-718	None	Digital Image Processing	3(3+0)
18	CSEC-706	DBMS	Distributed Computing	3(3+0)
19	ITEC-703	DBMS	Distributed Database Systems	3(3+0)
20	CSEC-730	OS	Distributed System	3(3+0)
21	ITEC-705	None	Enterprise Data Center Design and Methodology	3 (3+0)
22	CSEC-721	None	Expert Systems	3(3+0)
23	CSEC-704	None	Formal Methods	3(3+0)
24	CSEC-702	None	Functional Programming	3(3+0)
25	CSEC-719	None	Fuzzy Logic	3(3+0)
26	CSEC-703	Linear Algebra	Game Theory	3(3+0)
27	CSEC-733	None	Grammar Engineering	4(3+1)
28	CSEC-727	Design and Analysis of Algorithms	Graph Theory & Algorithms	3(3+0)

29	CSEC-728	None	Information Retrieval	3(3+0)
30	ITEC-702	None	Information Security	3 (3+0)
31	CSEC-725	Probability & Statistics	Information Theory	3(3+0)
32	CSEC-736	None	Intelligent Multi Agent systems	3(3+0)
33	CSEC-723	None	Intelligent Agents Technology	3(3+0)
34	ITEC-708	None	Knowledge Management Systems & Technologies	3 (3+0)
35	CSEC-701	None	Machine Learning	3(3+0)
36	ITEC-701	None	Multimedia Databases	3(3+0)
37	CSEC-716	None	Multimedia Systems Theory & Principles	3(3+0)
38	CSEC-720	None	Natural Language Processing	3(3+0)
39	CSEC-705	None	Parallel Processing: Algorithms and Architectures-I	3(3+0)
40	CSEC-729	Parallel Processir Algorithms and Architectures-I	Parallel Processing: Algorithms and Architectures-II	3(3+0)
41	SEEC-701	Software Engineering	Reliability Engineering	3(3+0)
42	SEEC-705	None	Research Methodology	3(3+0)
43	ITEC-709	None	Service-Oriented Architecture	3(3+0)
44	CSEC-732	None	Soft Computing	3(3+0)
45	SEEC-702	Software Engineering	Software Configuration Management	3(3+0)
46	SEEC-703	Software Engineering	Software Measurement and Metrics	3(3+0)
47	SEEC-704	Software Engineering	Software Risk Management	3(3+0)
48	CSEC-735	None	Speech Recognition and Synthesis	3(3+0)

49	CSEC-737	Probability & Sta	Stochastic Processes	3(3+0)
50	CSEC-726	Probability & Sta	Stochastic Systems	3(3+0)
51	ITEC-706	Computer Networks	Telecom Management	3 (3+0)
52	ITEC-704	Computer Networks	Telecommunication Systems	3 (3+0)
53	CSEC-734	None	Text Processing and Data Analysis	4(3+1)
54	ITEC-711	None	Virtualization in Cloud Computing	3 (3+0)
55	ITCC-701	None	Information Privacy and Security	3 (3+0)
56	ITCC-703	None	Cryptography	3 (3+0)
57	ITCC-704	None	Advanced Database Management Systems	3 (3+0)
58	SECC-701	None	Advanced Requirements Engineering	3(3+0)
59	SECC-702	None	Advanced Software System Architecture	3(3+0)
60	SECC-703	None	Software Testing and Quality Assurance	3(3+0)
61	SECC-704	None	Advance Software Project Management	3(3+0)
62	CSEC-709	None	Swarm Intelligence	3(3+0)
63	CSEC-710	None	Evolutionary Computation	3(3+0)
64	CSEC-712	None	Fog Computing	3(3+0)

Sample Scheme of Study for MSCS Program

2–year Program (4 Semesters/Terms); (30 Credit Hours)

Semester/Term 1			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	CSCC-701	Advanced Theory of Computation	3(3+0)
2	CSCC-702	Advanced Algorithm Analysis	3(3+0)
3	CSCC-703	Advanced Operating Systems	3(3+0)
Total Credit Hrs.			9

Semester/Term 2			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	CSCC-704	Advanced Computer Architecture	3(3+0)

2		Elective I	3(3+0)
3		Elective II	3(3+0)
Total Credit Hrs.			9

Semester/Term 3			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	CSCC-700	Thesis-I	3(0+3)
2		Elective III	3(3+0)
3		Elective IV	3(3+0)
Total Credit Hrs.			9

Semester/Term 4			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	CSCC-700	Thesis-II	3(0+3)
Total Credit Hrs.			3

Course Contents for MS Computer Science

Contents of Core Courses

Course Title: Advanced Theory of Computation

Course Code: CSCC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course aims to teach the basic methods and conclusions of the Theory of Computation. Students learn to apply these methods to problems from different fields and be guided by the results in searching for computational solutions to the problems.

Course Syllabus:
Mathematical Tools and Techniques; Proofs, Principle of Mathematical Induction, Recursive Definitions, Structural Induction. Regular Languages and Regular Expression, Finite Automata. Nondeterministic Finite Automata; Regular & Non-regular Languages; Context-Free Grammars, Regular Grammars, Derivation Tree and Ambiguity, An Unambiguous CFG for Algebraic Expression, Simplified Forms and Normal Forms. Pushdown Automata; Context-Free and Non-Context-Free Languages. Detailed Investigation: Turing Machines, Recursively Enumerable and Languages. Unsolvable Problems, Computable Functions, Measuring and Classifying Complexity, Traceable and Possibly Intractable Problems. P and NP, Polynomial-Time Reduction and NP-Completeness, Cook's Theorem, NP-Complete Problems.

Course Outline:
1. Mathematical Tools and Techniques: Logic and Proofs, Sets, Functions and Equivalence

Relations, Languages. [TB: Ch. 1]

2. Proofs, Principle of Mathematical Induction, Recursive Definitions, Structural Induction. [TB: Ch. 2]
3. Regular Languages and Regular Expression, Finite Automata: Finite Automata: Examples and Definitions. Distinguishing One String from Another, Union, Intersection, and Complements. [TB: Ch. 3]
4. Nondeterministic Finite Automata, Nondeterministic Finite Automata with A-Transitions, Kleene's Theorem. [TB: Ch. 4]
5. Regular & Non-regular Languages, The Criteria for Regularity, Minimal Finite Automata, The Pumping Lemma for Regular Languages, Decision Problems, Regular Languages and Computers. [TB: Ch. 5]
6. Context-Free Grammars, Regular Grammars, Derivation Tree and Ambiguity, An Unambiguous CFG for Algebraic Expression, Simplified Forms and Normal Forms. [TB: Ch. 6]
7. Pushdown Automata: Definitions and Examples, Deterministic Pushdown Automata, A PDA corresponding to a Given CFG, A CFG corresponding to a Given PDA, Parsing. [TB: Ch. 7]
8. Context-Free and Non-Context-Free Languages: The Pumping Lemma for Context-Free Languages, Intersections and Complements of CFLs, Decision Problems Involving Context-Free Languages. [TB: Ch. 8]

Detailed Investigation

9. Turing Machines: Definitions and Examples, Computing Partial Functions with a TM, Combining TMs, Variations of TM, Non-deterministic TM, Universal TM, Models of Computation and the Church-Turing Thesis. [TB: Ch. 9]
10. Recursively Enumerable and Languages: Recursively Enumerable and Recursive, Enumerating a Language, More General Grammars, Context-Sensitive Languages and the Chomsky Hierarchy, Not All Languages are Recursively Enumerable. [TB: Ch. 10]
11. Unsolvable Problems: A No-recursive Language and an Unsolvable Problem, The Halting Problem, Unsolvable Problems Involving TMs, Rice's Theorem, Post's Correspondence Problem, Unsolvable Problems Involving CFG. [TB: Ch. 11]
12. Computable Functions: Primitive Recursive Functions, PRF and Bounded Operations, Unbounded Minimalization and ų-Recursive Functions, Godel Numbering, All Computable Function Are ų-Recursive. [TB: Ch. 12]
13. Measuring and Classifying Complexity: Growth Rates of Function, Time and Space Complexity of a TM, Complexity Classes. [TB: Ch. 13]
14. Traceable and Possibly Intractable Problems: P and NP, Polynomial-Time Reduction and NP-Completeness, Cook's Theorem, NP-Complete Problems. [TB: Ch. 14]

Reference Material:

1. Introduction to Languages and the Theory of Computation by John Martin, McGraw-Hill Science/Engineering/Math; 4th Edition (February 2, 2010). ISBN-10: 0073191469
2. Theory of Computation by George Tourlakis, Wiley; 1st Edition (April 17, 2012). ISBN-10: 1118014782

3. Introducing the Theory of Computation by Wayne Goddard, Jones & Bartlett Publishers; 1st Edition (January 18, 2008). ISBN-10: 0763741256
4. Theory of Computation by Dexter C. Kozen, Springer; 1st Edition (December 15, 2010). ISBN-10: 1849965714
5. Introduction to the Theory of Computation by Michael Sipser, Course Technology; 3rd Edition (June 27, 2012). ISBN-10: 113318779X

Course Title: Advanced Algorithm Analysis

Course Code: CSCC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Analysis of Algorithms

Course Objectives:
This is an advanced course in design and analysis of algorithms covering topics typically not covered in undergraduate algorithms. In this course the students will learn how to : (i) design and implement 'new' algorithms in the real world. (ii) map problems to algorithmic problems. (iii) read and understand algorithms published in journals. (iv) develop writing skills to present your own algorithms (v) collaborate and work together with other people to design new algorithms.

Course Syllabus:
Dynamic Programming, Greedy Algorithms, Amortized Analysis, Fibonacci Heaps, van Emde Boas Trees, Single-Source Shortest Paths, All-Pairs Shortest Paths, Maximum Flow, Multithreaded Algorithms, String Matching Algorithms, Approximation Algorithms, and Parallelism Parallel Graph Algorithms.

Course Outline:
1. Dynamic Programming: Rod Cutting, Matrix-Chain Multiplication, Elements of Dynamic Programming, Longest Common Subsequence, Optimal Binary Search Trees. [TB1: Ch. 15]
2. Greedy Algorithms: An Activity-Selection Problem, Elements of the Greedy Strategy, Huffman Codes, Matroids and Greedy Methods, A Task-Scheduling Problem as A Matroid. [TB1: Ch. 16]
3. Amortized Analysis: Aggregate Analysis, The Accounting Method, The Potential Method, Dynamic Tables. [TB1: Ch. 17]
4. Fibonacci Heaps: Structure Of Fibonacci Heaps, Mergeable-Heap Operations, Decreasing a Key and Deleting a Node, Bounding the Maximum Degree. [TB1: Ch. 19]
5. vanEmde Boas Trees: Preliminary Approaches, A Recursive Structure, The Van Emde Boas Tree. [TB1: Ch. 20]
6. Single-Source Shortest Paths: The Bellman-Ford Algorithm, Single-Source Shortest Paths In Directed Acyclic Graphs, Dijkstra's Algorithm, Difference Constraints and Shortest Paths, Proofs of Shortest-Paths Properties. [TB1: Ch. 24]
7. All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication, The Floyd-Warshall Algorithm, Johnson's Algorithm for Sparse Graphs. [TB1: Ch. 25]
8. Maximum Flow: Flow Networks, The Ford-Fulkerson Method, Maximum Bipartite Matching, Push-Relabel Algorithms, The Relabel-To-Front Algorithm. [TB1: Ch. 26]
9. Multithreaded Algorithms: The Basics of Dynamic Multithreading, Multithreaded Matrix Multiplication, Multithreaded Merge Sort. [TB1: Ch. 27]

10. String Matching: The Naive String-Matching Algorithm, The Rabin-Karp Algorithm, String Matching With Finite Automata, The Knuth-Morris-Pratt Algorithm. [TB1: Ch. 32]
11. Approximation Algorithms: The Vertex-Cover Problem, The Traveling-Salesman Problem, The Set-Covering Problem, Randomization And Linear Programming, The Subset-Sum Problem. [TB1: Ch. 35]
12. Parallel Algorithms: Parallelism, The PRAM Model, Simple Parallel Operations, Parallel Searching, Parallel Sorting, Parallel Numerical Algorithms, Parallel Graph Algorithms. [TB2: Ch. 9]

Reference Material:

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, The MIT Press; 3rd Edition (2009). ISBN-10: 0262033844
2. Analysis of Algorithms: an active learning approach by Jeffrey J. McConnell, Jones & Bartlett Pub; 2nd Edition (November 2, 2007). ISBN-10: 0763707821
3. Approximation Algorithms by Vijay V. Vazirani, Springer (December 1, 2010). ISBN-10: 3642084699
4. Algorithms and Theory of Computation Handbook, Second Edition, Volume 2: Special Topics and Techniques, Chapman and Hall/CRC; 2nd Edition (November 20, 2009). ISBN-10: 1584888202

Course Title: Advanced Operating Systems

Course Code: CSCC-703
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisite: Operating Systems

Course Objectives:

The students will learn about advanced OS concepts, design and internal processes

Course Syllabus:

Operating System Architecture, Multitasking, Multiuser, Multiprocessing, Multi- Threading OS, Operating System Services For Process Management, Process Scheduling Concepts, System Calls For Process Management, Process Communication And Synchronization Concepts, Memory And I/O Management Overview, UNIX Commands For System Administration. Multitasking OS. Multiprocessor Systems. Memory Management. Unit V I/O Systems. File System.

Course Outline:

1. Introduction: Operating System Architecture, Multitasking, Multiuser, Multiprocessing, Multi- Threading OS, Operating System Services for Process Management, Process Scheduling Concepts, System Calls for Process Management, Process Communication And Synchronization Concepts, Memory and I/O Management Overview, UNIX Commands for System Administration.
2. Multitasking OS :Design and Implementation Kernel Of Multitasking OS :Services, Process State Transitions, Functional Specification, Implementation Considerations, System List,

Ready List And Its Manipulation, IPC and Synchronization, Process Management , Interrupt Management

3. Multiprocessor Systems: Introduction, Parallel Hardware And Interconnections, Types of Multiprocessor OS, Sharaing OS, Mutiprocesor OS Design Considerations, Threads, Thread Scheduling, Kernel Mode Processes, Multiprocessor Synchronization, Implementation of Mutual Exclusion.
4. Memory Management: Overview, Pages, Zones, Kmalloc, Vmalloc, Slab Layer, Slab Layer Allocator, Deallocator, Statically Allocating on The Stack, High Memory Mapping. Non Contiguous Memory Management.
5. Unit V I/O Systems: I/O Device Types, I/O Structure, Driver Interfaces, Disk Device Driver Access Strategies, Unification Of Files And I/O Devices, Generalized Disk Device Drivers, Disk Caching, I/O Scheduler.
6. File System: File System Organization, Operations, Implementation, File Descriptors, File Blocks Allocaton, Mapping of File Blocks, System Calls For The File System: Open, Read, Write, Lseek, Close. Mounting and Un Mounting File Systems, Link, Unlink, File System Abstractions, VFS, File System Maintenance, File Security.

Reference Material:

1. Stallings, William, and Goutam Kumar Paul. Operating systems: internals and design principles. Pearson, 2012. ISBN-10: 0024154938;ISBN-13: 978-0024154934
2. Operating systems Concepts and design by Milan Milenkovic, McGraw Hill Higher Education (1992). ASIN: B000OGSITU
3. Operating systems a design oriented approach by charlescrowly, Irwin Professional Publishing (November 1, 1996). ISBN-10: 0256151512
4. The design of the UNIX Operating System by Maurice J. Bach, Prentice Hall; 1st Edition (June 6, 1986). ISBN-10: 0132017997
5. Understanding the Linux kernel Daniel Bovet and Marco Cesati, 3 O'Reilly Media; 3rd Edition (November 2005). ISBN-10: 0596005652
6. Modern Operating Systems by Andrew S. Tanenbaum, Prentice Hall; 3rd Edition (December 21, 2007). ISBN-10: 0136006639
7. Operating Systems Design and Implementation by Andrew S Tanenbaum and Albert S Woodhull, Prentice Hall; 3rd Edition (January 14, 2006)
8. Unix Network Programming, Volume 1: The Sockets Networking API W. Richard Stevens, BillFenner, and Andrew M. Rudoff, ISBN-978-81-203-0749-0, PHI.
9. Linux Kernel Development by Robert Love, Addison-Wesley Professional; 3rd Edition (July 2, 2010). ISBN-10: 0672329468
10. UNIX Systems Programming: Communication, Concurrency and Threads by Kay A. Robbins and Steve Robbins, Prentice Hall; 2nd Edition (June 27, 2003). ISBN-10: 0130424110

Course Title: Advanced Computer Architecture

Course Code: CSCC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Architecture

Course Objectives:
To develop an understanding of high-performance computer architecture, as a foundation for advanced work in computer architecture.

Course Syllabus:
Introduction to Advanced Computer Architecture and Parallel Processing, Multiprocessors Interconnection Networks, Performance Analysis of Multiprocessor Architecture, Shared Memory Architecture, Message Passing Architecture, Abstract Models, Network Computing, Parallel Programming in the Parallel Virtual Machine, Message Passing Interface (MPI), Scheduling and Task Allocation.

Course Outline:
1. Introduction to Advanced Computer Architecture and Parallel Processing: History, Flynn's Taxonomy of Computer Architecture, SIMD Architecture, MIMD Architecture, Interconnection Networks. [TB: Ch. 1]
2. Multiprocessors Interconnection Networks: Interconnection Networks Taxonomy, Bus-Based Dynamic Interconnection Networks, Switch-Based Interconnection Networks, Static Interconnection Networks, Analysis and Performance Metrics. [TB: Ch. 2]
3. Performance Analysis of Multiprocessor Architecture: Computational Models, An Argument for Parallel Architectures, Interconnection Networks Performance Issues, Scalability of Parallel Architectures, Benchmark Performance. [TB: Ch. 3]
4. Shared Memory Architecture: Classification of Shared Memory Systems, Bus-Based Symmetric Multiprocessors, Basic Cache Coherency Methods, Snooping Protocols, Directory Based Protocols, Shared Memory Programming. [TB: Ch. 4]
5. Message Passing Architecture: Introduction to Message Passing, Routing in Message Passing Networks, Switching Mechanisms in Message Passing, Message Passing Programming Models, Processor Support for Message Passing, Example Message Passing Architectures, Message Passing Versus Shared Memory Architectures. [TB: Ch. 5]
6. Abstract Models: The PRAM Model and Its Variations, Simulating Multiple Accesses on an EREW PRAM, Analysis of Parallel Algorithms, Computing Sum and All Sums, Matrix Multiplication, Sorting, Message Passing Model, Leader Election Problem, Leader Election in Synchronous Rings. [TB: Ch. 6]
7. Network Computing: Computer Networks Basics, Client/Server Systems, Clusters, Interconnection Networks, Cluster Examples, Grid Computing. [TB: Ch. 7]
8. Parallel Programming in the Parallel Virtual Machine: PVM Environment and Application Structure, Task Creation, Task Groups, Communication among Tasks, Task Synchronization, Reduction Operations, Work Assignment. [TB: Ch. 8]

9. Message Passing Interface (MPI): Communicators, Virtual Topologies, Task Communication, Synchronization, Collective Operations, Task Creation, One-Sided Communication. [TB: Ch. 9]
10. Scheduling and Task Allocation: The Scheduling Problem, Scheduling DAGs without Considering, Communication, Communication Models, Scheduling DAGs with Communication, The NP-Completeness of the Scheduling Problem, Heuristic Algorithms, Task Allocation, Scheduling in Heterogeneous Environments. [TB: Ch. 10]
    [Instructors need to devise a contents delivery plan]

Reference Material:

1. Advanced Computer Architecture and Parallel Processing by Hesham El-Rewini, MostafaAbd-El-Barr, Wiley-Interscience; 1st Edition (January 18, 2005). ISBN-10: 012383872X
2. Advanced Computer Architectures by Sajjan G. Shiva, CRC Press (2005). ISBN-10: 0849337585
3. Advanced Computer Architecture by By Amit Kumar Mishra, S K Kataria & Sons (2010). ISBN-10: 9380027494
4. Advanced Computer Architecture: A Design Space Approach by DezsoSima, Terence Fountain, Peter Kacsuk, Addison-Wesley; 1st Edition (July 7, 1997). ISBN-10: 0201422913
5. Scalable Parallel Computing Technology, Architecture, Programming by Kai Hwang, Zhiwei Xu, McGraw-Hill Science/Engineering/Math; 1st Edition (February 1, 1998). ISBN-10: 0070317984

Contents of Elective Courses

Course Title: Functional Programming

Course Code: CSEC-702
Course Structure: Lectures: 3 / Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The students will gain an applied understanding of the concepts and practice of functional programming. The will be:

- to use the language to implement algorithms and data types to solve problems.
- to explain common errors in sample programs and offer corrections.
- to discuss functional programming and functional programs more generally:

Course Syllabus:

Computers and modeling, Pictures and functions, Types, The Haskell programming language, Haskell Interpreter, Implementing a Prime Number Test, Haskell Type Declarations, Identifiers in Haskell, Haskell Types, The Prime Factorization Algorithm, The map and filter Functions, Haskell Equations and Equational Reasoning. Mathematical Objects: Logical Connectives and their Meanings, Logical Validity and Related Notions, Making Symbolic Form Explicit. Lambda Algebra. The Use of Logical Proof. Sets, Types and Lists Operations. Relations. Functions. Induction and Recursion. Induction and Recursion over Trees. Induction and Recursion over

Lists. Polynomials. Corecursion.

Course Outline:

1. Introducing functional programming: Computers and modeling, Pictures and functions, Types, The Haskell programming language, Haskell Interpreter, Implementing a Prime Number Test, Haskell Type Declarations, Identifiers in Haskell, Haskell Types, The Prime Factorization Algorithm, The map and filter Functions, Haskell Equations and Equational Reasoning.
2. Mathematical Objects: Logical Connectives and their Meanings, Logical Validity and Related Notions, Making Symbolic Form Explicit.
3. Lambda Abstraction, Definitions and Implementations, Abstract Formulas and Concrete Structures, Logical Handling of the Quantifiers, Quantifiers as Procedures.
4. The Use of Logical Proof: Proof Style, Proof Recipes, Rules for the Connectives, Rules for the Quantifiers, Strategic Guidelines, Reasoning and Computation with Primes.
5. Sets, Types and Lists: Sets, Paradoxes, Types and Type Classes, Special Sets, Algebra of Sets, Pairs and Products, Lists and List Operations.
6. Comprehension and Database Query, Using Lists to Represent Sets, A Data Type for Sets.
7. Relations: The Notion of a Relation, Properties of Relations, Implementing Relations as Sets of Pairs.
8. Implementing Relations as Characteristic Functions, Equivalence Relations, Equivalence Classes and Partitions, Integer Partitions.
9. Functions: Basic Notions, Surjections, Injections, Bijections, Function Composition, Inverse Function, Partial Functions, Functions as Partitions, Products, Congruences.
10. Induction and Recursion: Mathematical Induction, Recursion over the Natural Numbers, The Nature of Recursive Definitions.
11. Induction and Recursion over Trees, Induction and Recursion over Lists, Some Variations on the Tower of Hanoi, Induction and Recursion over Other Data Structures.
12. Polynomials: Difference Analysis of Polynomial Sequences, Gaussian Elimination, Polynomials and the Binomial Theorem, Polynomials for Combinatorial Reasoning.
13. Corecursion: Corecursive Definitions, Processes and Labeled Transition Systems, Proof by Approximation, Proof by Coinduction, Power Series and Generating Functions, Exponential Generating Functions.

Reference Material:

1. The Haskell Road to Logic, Maths and Programming by Kees Doets and Jan van Eijck, College Publications (May 7, 2004). ISBN-10: 0954300696
2. Functional Programming: Practice and Theory by Bruce J. MacLennan Addison-Wesley Professional; 1st Edition (January 11, 1990). ISBN-10: 0201137445
3. Haskell: The Craft of Functional Programming by Simon Thompson, Haskell, Addison-Wesley Professional; 3rd Edition (October 2, 2011). ISBN-10: 0201882957

Course Title: Game Theory

Course Code: CSEC-703
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: Linear Algebra

Course Syllabus:

Introduction To Game Theory, The Two-Person, Zero-Sum Game With Equilibrium Points, The General, Two-Person, Zero-Sum Game. Utility Theory, The Two Person, Non-Zero-Sum Game, The N-Person Game. Strategic Games. Infinite Games and Automata Theory. Back and Forth between Logic and Games. Graph Searching Games. Beyond Nash Equilibrium.

Course Outline:

1. Introduction To Game Theory, The Two-Person, Zero-Sum Game With Equilibrium Points, The General, Two-Person, Zero-Sum Game.
2. Utility Theory, The Two Person, Non-Zero-Sum Game.
3. The N-Person Game
4. Strategic Games: Basic Concepts, Iterated Elimination Of Strategies, Mixed Extension, Variations on the Definition of Strategic Games, Mechanism Design, Pre-Bayesian Games
5. Infinite Games and Automata Theory: Basic Notations And Definitions, Transformation of Winning Conditions, Tree Automata, Beyond Finite Automata.
6. Algorithms for Solving Parity Games: Games on Graphs, Solving Repeated Reachability and Eventual Safety Games, Solving Parity Games.
7. Back and Forth Between Logic and Games: Introduction, Reachability Games and Parity Games, Reachability Games And Logic, Logics With Least And Greatest Fixed-Points, Definability Of Winning Regions in Parity Games, Inflationary Fixed-Point Logic and Backtracking Games.
8. Graph Searching Games: Introduction, Classifying Graph Searching Games, Variants Of Graph Searching Games, Monotonicity of Graph Searching, Obstructions, An Application to Graph-Decompositions, Complexity of Graph Searching.
9. Beyond Nash Equilibrium: Solution Concepts for The 21st Century: Robust and Resilient Equilibrium, Taking Computation into Account, Taking (Lack Of) Awareness into Account, Iterated Regret Minimization.

Reference Material:

1. Davis, Morton D. Game theory: A nontechnical introduction. Courier Corporation, 2012.. ISBN-10: 0486135152
2. Lectures in Game Theory for Computer Scientists by Krzysztof R. Apt (Ed) and Erich Grädel (Ed), Cambridge University Press; 1st Edition (February 14, 2011).
3. Games, Puzzles, and Computation by Robert A. Hearn and Erik D. Demaine, ISBN-10: 1568813228
4. Game Theory by Drew Fudenberg and Jean Tirole, The MIT Press (August 29, 1991). ISBN-10: 0262061414

Course Title: Graph Theory & Algorithms

Course Code: CSEC-727
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Design and Analysis of Algorithms

Course Objectives:
The course is aimed to develop students' understanding of various techniques of graph theory and its applications.

Course Syllabus:
Fundamental Concepts of Graphs, Sub-Graphs, Connected Graphs, Trees, Non-separable Graphs, Connectivity, Planar Graphs, Vertex Colorings, Edge Colourings, Hamilton Cycles, Eigenvalues of Graph, Coverings and Packings in Directed Graphs. Integer Flows and Coverings.

Course Outline:

1. Fundamental Concepts of Graphs: What is A Graph, Simple Graphs, Graph and Their Representations, Isomorphism and Automorrphisms, Labelled Graphs, Graphs Arising From Other Structures, Incidents Graphs, Union and Intersection Graphs ,Cartesian Product, Directed Graphs.
2. Sub-Graphs: Sub-Graphs and Super graphs, Spanning and Induced Sub-Graphs, Decomposition and Coverings, Edge Cuts and Bonds, Even Sub-Graphs, Graph Reconstruction.
3. Connected Graphs: Walks and Connection, Cut Edges, Connection to Diagraphs, Cycle Double Covers.
4. Trees: Forests and Trees, Spanning Tree, Calay's Formula, Fundamental Cycles AndBonds, Co-Tree, Trees And Distance. Applications of Tree.
5. Non-separable Graphs: Cut Vertices, Separations and Blocks, Ear Decompositions, Strong Orientations, Directed Ear Decompositions, Even Cycles Decompositions.
6. Connectivity: Vertex Connectivity, Fan Lemma, Edge Connectivity, Three-Connected Graphs, Submodularity, Determining, ChordalGraphs, Simplicial vertices.
7. Planar Graphs: Plane and Planar Graphs, Duality, Euler's Formula, Bridges, Kuratowski'sTheorem.
8. Vertex Colorings: Chromatic Numbers, Critical Graphs, Girthand Chromatic Number, Perfect Graphs, List Colourings, The Adjacency Polynomial, Chromatic Polynomial. Applications of Vertex Colourings.
9. Edge Colourings: Edge Colouring Number, Vizing's Theorem, Snarks, Covering By Perfect Matchings, List Edge Colouring, Applications of Edge Colourings.
10. Hamilton Cycles: Hamiltonian and non-Hamiltonian graphs, Non-Hamiltonian Planar Graphs, Path Exchanges parity, Hamilton Cycles in Graphs.
11. Eigenvalues of Graph,
12. Coverings and Packings in Directed Graphs.
13. Integer Flows and Coverings.

Reference Material:

1. Graph Theory by J.A Bondy and U.S.R Murty, Springer; 1st Edition (2008). Corr. 3rd

printing 2008 Edition (August 14, 2008). ISBN-10: 1846289696
2. A First Course in Graph Theory by Gary Chartrand and Ping Zhang, Dover Publications (February 15, 2012). ISBN-10: 0486483681
3. Graph Theory and Complex Networks: An Introduction by Maarten van Steen, Maarten van Steen (April 5, 2010). ISBN-10: 9081540610
4. Graphs & Digraphs by Gary Chartrand , Linda Lesniak, and Ping Zhang, Chapman and Hall/CRC; 5th Edition (October 19, 2010). ISBN-10: 1439826277

Course Title: Information Retrieval

Course Code: CSEC-728
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Objectives:
The deals with IR representation, storage, organization & access to information items

Course Syllabus:
Basic Concepts of IR, IR System Block, Diagram. Automatic Text Analysis, Indexing and Classification. Measures of Association. Clustering Algorithms. File Structures. IR Models. Search Strategies. Performance Evaluation. Online IR Systems & Interfaces Standards. Taxonomy and Ontology. Distributed and Parallel IR. Query Processing. Multimedia IR Models & Languages- Data Modeling Techniques to Represent Audio and Visual Document, Query Languages Indexing & Searching- Generic Multimedia Indexing Approach, Query Databases of Multimedia Documents, Display the Results of Multimedia Searches, One Dimensional Time Series, Two Dimensional Color Images, Automatic Feature Extraction. Searching the Web, Challenges, Characterizing the Web, Search Engines, Browsing, Mata Searchers, Web Crawlers, Robot Exclusion, Web Data Mining, Metacrawler, Collaborative Filtering, Web Agents (Web Shopping, Bargain Finder,..), Economic, Ethical, Legal and Political Issues.

Course Outline:
1. Introduction: Basic Concepts of IR, Data Retrieval & Information Retrieval, IR System Block, Diagram. Automatic Text Analysis, Luhn's Ideas, Conflation Algorithm, Indexing and Index Term Weighing, Probabilistic Indexing, Automatic, Classification. Measures of Association, Different Matching Coefficient, Classification Methods, Cluster Hypothesis. Clustering Algorithms, Single Pass Algorithm, Single Link Algorithm, Rochhio's Algorithm and Dendograms.
2. File Structures, Inverted File, Suffix Trees & Suffix Arrays, Signature Files, Ring Structure, IR Models, Basic Concepts, Boolean Model, Vector Model, and Fuzzy Set Model. Search Strategies, Boolean Search, Serial Search, and Cluster based Retrieval, Matching Function
3. Performance Evaluation- Precision and Recall, Alternative Measures Reference Collection (TREC Collection), Libraries & Ibliographical System- Online IR System, Opacs, Digital Libraries - Architecture Issues, Document Models, Representation & Access, Prototypes, Projects & Interfaces, Standards.
4. Taxonomy and Ontology: Creating Domain Specific Ontology, Ontology Life Cycle, Distributed and Parallel IR: Relationships Between Documents, Identify Appropriate Networked Collections, Multiple Distributed Collections Simultaneously, Parallel IR –

MIMD, Architectures, Distributed IR – Collection, Partitioning, Source Selection, Query Processing.

5. Multimedia IR Models & Languages- Data Modeling, Techniques to Represent Audio and Visual Document, Query Languages Indexing & Searching- Generic Multimedia Indexing Approach, Query Databases of Multimedia Documents, Display the Results of Multimedia Searches, One Dimensional Time Series, Two Dimensional Color Images, Automatic Feature Extraction.
6. Searching the Web, Challenges, Characterizing the Web, Search Engines, Browsing, Mata Searchers, Web Crawlers, Robot Exclusion, Web Data Mining, Metacrawler, Collaborative Filtering, Web Agents (Web Shopping, Bargain Finder,..), Economic, Ethical, Legal and Political Issues.

Reference Material:

1. Modern Information Retrieval: The Concepts and Technology behind Search by Ricardo Baeza-Yates and BerthierRibeiro-Neto, Addison-Wesley Professional; 2nd Edition (February 10, 2011). ISBN-10: 0321416910
2. The Geometry of Information Retrieval by C. J. van Rijsbergen, Cambridge University Press (September 13, 2004). ISBN-10: 0521838053
3. Managing Gigabytes: Compressing and Indexing Documents and Images by Ian H. Witten, Alistair Moffat, & Timothy C. Bell, Morgan Kaufmann; 1st Edition (May 17, 1999)
4. Information Retrieval: Algorithms and Heuristics by D. Grossman and O. Frieder, Springer; 2nd Edition (December 20, 2004). ISBN-10: 1402030045
5. An Introduction to Search Engines and Web Navigation by Mark Levene, Wiley; 2nd Edition (October 18, 2010). ISBN-10: 047052684X
6. Multimedia information System by V. S. Subrahamanian, Satish K. Tripathi, Springer, (December 3, 2010). ISBN-10: 1441950427
7. Multimedia mining A highway to intelligent multimedia documents by Chabane Djeraba, Springer; 1st Edition (November 30, 2002). ISBN-10: 1402072473
8. Introduction to Information Retrieval by Christopher D. Manning, Prabhakar Raghavan, &Hinrich Schütze, Cambridge University Press; 1st Edition (July 7, 2008). ISBN-10: 0521865719
9. Search Engines: Information Retrieval in Practice by Bruce Croft, Donald Metzler, & Trevor Strohman, Addison-Wesley; 1st Edition (February 16, 2009). ISBN-10: 0136072240
10. Information Retrieval: Data Structures and Algorithms by William B. Frakesand Ricardo Baeza-Yates, Prentice Hall; 1st Edition (June 22, 1992). ISBN-10: 0134638379

Course Title: Distributed Computing

Course Code: CSEC-706
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: DBMS

Course Objectives:

This course covers the architecture and enabling technologies of Peer-2-Peer and distributed

computing systems and their innovative applications.

Course Syllabus:
Centralized and Decentralized Systems, Taxonomy Dependency Considerations. Discovery Protocols. Structured Document Types. Distributed Security Techniques. Hash Functions. Digital Signature, Secure Channels, Secure Mobile Code. The Web as Distributed Environment: URI Templates, HTTP and Security, Representational State Transfer, the Semantic Web. Peer-2-Peer Environments. Volunteer Computing. Web Services: Architecture and Development, Service-Oriented Architecture. Distributed Objects and Agent Technologies. Grid Computing. P2P Applications Protocols and Architectures. Freenet. Middleware Protocols and Architectures. Web Services Protocols. Distributed Object Deployment Using Jini. P2P Deployment Using Jxta. Web Services Deployment.

Course Outline:
1. Introduction to Distributed Systems: Centralized and Decentralized Systems, Taxonomy Dependency Considerations, Examples of Distributed Applications, and Examples of Middleware. Discovery Protocols: Service and Directory Discovery, Unicast Addressing, UDP, IP Multicast Addressing, Service Location Protocol.
2. Structured Document Types: HTML, XML, XHTML, Document Modelling and Validation. Distributed Security Techniques: Introduction, Design Issues, Hash Functions, Signing Messages with a Digital Signature, Secure Channels, Secure Mobile Code: Creating a Sandbox.
3. The Web - Distributed Environment -, Naming Things in a Uniform Way, URI Templates, Shared Representation of Things, Hypertext Transfer Protocol, HTTP and Security, Representational State Transfer, The Semantic Web. Peer-2-Peer Environments: Introduction, Historical Peer to Peer, The Shift to New Internet Users, Modern Definition of Peer to Peer, Social Impacts of P2P, The P2P Environment, P2P Example Applications, True P2P and Good Distributed Design, Related Projects: Volunteer Computing.
4. Web Services: Introduction, Web Services Architecture and Development, Service-Oriented Architecture. Distributed Objects and Agent Technologies: What Are Distributed Objects? CORBA, Mobile Agents, Objects, Services and Resources, Distributing Objects Using Java, Remote Method Invocation.
5. Grid Computing: Introduction, Social Perspective, History of the Grid, The Grid Computing Architecture, The Criteria for a Grid, Types of Grid, Grid Computing Toolkit.
6. P2P Applications Protocols and Architectures: Gnutella: History of Gnutella, What Is Gnutella? A Gnutella Scenario: Discovering Peers, Gnutella in Operation, Searching Within Gnutella, Gnutella 0.6 Protocol Description, File Downloads, Gnutella Implementations. Scalability: Performance in P2P Networks, Unstructured P2P, Social Networks, Combining Network Topologies, The Convergence of the Napster and Gnutella Approaches, The Structured P2P Approach, New Trends.
7. Freenet: Introduction, Freenet Routing, Freenet Keys, Joining the Network, Current Developments. BitTorrent: What Is BitTorrent? The BitTorrent Protocol, BitTorrent, Inc., New Developments.
8. Middleware Protocols and Architectures: Jini: Introdcution, Jini Architecture, Registering and Using Jini Services, Jini: Tying Things Together, Organization of Jini Services &

Events. Jxta : Background, Jxta Overview and Architecture, Jxta Network Overlay, The Jxta Protocols, Jxta Environment Considerations, Security, NAT and Firewalls.

9. Web Services Protocols: SOAP, WSDL, UDDI, WS-Extensions. OGSA: Overview, OGSI, WS-RF, Higher Level Interfaces. Web 2.0: The Web as Platform, Technologies and APIs, Computing in the Cloud, Ubiquitous Computing.
10. Distributed Object Deployment Using Jini: RMI Security, An RMI Application, A Jini Application, Running Jini Applications.
11. P2P Deployment Using Jxta: Starting the Jxta Platform, Peer Con_guration Using Jxta, Using the Jxta Con_gurator; Example Two: Using Jxta Pipes, P2P Environment: The Jxta Approac.
12. Web Services Deployment: Data Binding, Setup, Container Classes, Server Implementation, Service WSDL, Client Implementation.

Reference Material:

1. From P2P and Grids to Services on the Web: Evolving Distributed Communities by Ian J. Taylor Ian J. Taylor and Andrew Harrison, Springer; 2nd Edition (November 14, 2008). ISBN-10: 1848001223.
2. Peer-to-Peer : Harnessing the Power of Disruptive Technologies by Andy Oram, O'Reilly Media; 1st Edition (March 15, 2001)
3. Structured Peer-to-Peer Systems: Fundamentals of Hierarchical Organization, Routing, Scaling, and Security by Dmitry Korzun and Andrei Gurtov, Springer, (November 12, 2012).
4. K. Hwang and Z. Xu, Scalable Parallel Computing, McGraw-Hill, (1998). ISBN 0-07-031798-4.
5. Ian Taylor: From P2P to Web Services and Grids, Springer-Verlag, (2005). ISBN: 1-85233-869-5.
6. F. Berman, G. Fox, and T. Hey (Editors), Grid Computing, Wiley, (2003). ISBN: 0-470-85319-0.

Course Title: Distributed System

Course Code: CSEC-730
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: OS

Course Objectives:

To help students gain a general understanding of the principles and concepts governing distributed environment in complex applications.

Course Syllabus:

Goals, Architecture, Examples of Distributed Systems, Characteristics, Hardware and Software Concepts, Design Issues, Challenges. System Models. Inter-process Communication and Coordination. Remote Procedural Call. Synchronization and Election. Distributed File Systems. Distributed Shared Memory. Fault Tolerant and Recovery.

Course Outline:

1. Introduction: Introduction to Distributed Systems: Goals, Architecture, Examples of Distributed Systems, Characteristics, Hardware and Software Concepts, Design Issues, Challenges. System Models: Architectural models, fundamental models and Failure Model.
2. Inter-Process Communication and Coordination: Message Passing Communication: Communication Primitives, Message Synchronization and Buffering, Pipe, Pipe and Socket APIs, Group Communication, Multicasting, Remote Procedural Call: Basic Operation, Implementation and Call Semantics, Failure Handling, LRPC Object Oriented Distributed Computing Technologies – Basics, Design Issues of Various Technologies Like RMI and CORBA With Semantics and Executions.
3. Synchronization and Election: Clock Synchronization: Logical and Physical Clocks, Algorithms and Uses, Mutual Exclusion: Centralize, Distributed and Token Ring Algorithms, Comparison. Logical Clocks: Lamport's Logical Clock, Vector Clocks, Global State: Needs, Properties and Various Global States Election Algorithm: Bully and Ring Algorithm.
4. Distributed File Systems: Introduction, Characteristics, File Service Architecture, Sun Network and Coda File System: Overview of NFS, Communication, Processes, Naming, Synchronization, Consistency and Replication, Fault Tolerance and Security, Naming Services: Case Study of Global Name Service and X.500 Directory Service.
5. Distributed Shared Memory: Replication: Introduction, Reasons for Replication, Object Replication and Scaling Technique, Distributed Shared Memory: Design and Implementation Issue; Data Centric Consistency Models - Strict, Sequential, Casual, Pram, Weak, Release, Entry Client-Centric Consistency Models: Eventual, Monotonic Reads, Monotonic Writes, Read Your Writes, Writes Follow Reads
6. Fault Tolerant and Recovery: Fault Tolerance: Concepts, Failure Models, Failure Masking by Redundancy, Process Resilience: Design Issues, Failure Masking and Replication, Agreement in Faulty Systems, Recovery: Introduction, Check-Pointing, Message Logging – Synchronous and Asynchronous, Adaptive Logging

Reference Material:

1. Distributed Systems – Concept and Design by George Coulouris, Jean Dollimore& Tim Kindberg, 4th Edition, Pearson (LPE). ISBN – 978-81-317-1840-7
2. Distributed Systems – Principles and Paradigms by Andrew S. Tanenbaum & Maarten van Steen, Prentice Hall; 2nd Edition (October 12, 2006) . ISBN-10: 0132392275
3. Distributed Computing: Principles, Algorithms, and Systems by Ajay D. Kshemkalyani and MukeshS inghal, Cambridge University Press; (March 3, 2011). ISBN-10: 0521189845
4. Distributed Operating System and Algorithm Analysis by Randay Chow and Theodore Johnson, Pearson (LPE). ISBN – 978-81-317-2859-8
5. Distributed Algorithms by Nancy A. Lynch, Morgan Kaufmann; 1st Edition (March 15, 1996). ISBN-10: 1558603484
6. Distributed Systems: An Algorithmic Approach by Sukumar Ghosh, Chapman and Hall/CRC; 1st Edition (November 22, 2006). ISBN-10: 1584885645

Course Title: Digital Image Processing
Course Code: CSEC-718
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
This course provides an introduction to basic concepts, methodologies and algorithms of digital image processing.

Course Syllabus:
Introduction to Digital Image Processing. Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition. Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing. Intensity Transformations and Spatial Filtering. Spatial Frequency, Fourier Theory, The Discrete Fourier Transform, Investigating Spectra. Filtering of Images, Deconvolution. Color Fundamentals, Color Models. Storage Media, File Formats. Segmentation Fundamentals, Point Line and Edge Detection. Non-contextual techniques. Morphological Image Processing Introduction. Compound Operations, Morphological Filtering, Greyscale Morphology. Image Compression. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Course Outline:
1. What Is Digital Image Processing? The Origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing.
2. Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition.
3. Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing.
4. Intensity Transformations and Spatial Filtering Background, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering.
5. Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods, Using Fuzzy Techniques for Intensity Transformations and Spatial Filtering.
6. Spatial Frequency, Fourier Theory, the Discrete Fourier Transform, Investigating Spectra.
7. Filtering of Images, Deconvolution.
8. Color Fundamentals, Color Models.
9. Storage Media, File Formats, The PBM, PGM, PPM Formats, The Portable Network Graphics (PNG) Format.
10. Segmentation Fundamentals, Point Line and Edge Detection.
11. A Simple Non-contextual Technique: Thresholding, Contextual Techniques, Segmentation using Other Image Properties.
12. Morphological Image Processing Introduction, Basic Concepts, Fundamental Operations.
13. Compound Operations, Morphological Filtering, Greyscale Morphology.
14. Image Compression Introduction, Redundancy, Performance Characterisation, Lossless Compression Techniques, Lossy Compression Techniques, Compression of Moving Images.

15. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Reference Book(s)

1. Digital Image Processing by Rafael C. Gonzalez, Prentice Hall, 3rd Edition, (2008), ISBN 0-13-168728-x
2. Digital Image Processing a practical Introduction using Java by Nick Efford, Addison Wesley, (2000).
3. The Image Processing Handbook by John C. Russ, Taylor & Fransic, 5th Edition, (2007). ISBN 13: 978‐0‐8493‐7254‐4

Course Title: Fuzzy Logic

Course Code: CSEC-719
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: None

Course Objectives:

Fuzzy Logic is an important area having multiple applications in Computing. The course will introduce students with key concepts of Fuzzy Logic.

Course Syllabus:

Introduction Fuzziness, Examples of Fuzziness, Modeling of Fuzziness, Operations on Fuzzy Sets, Fuzziness as Uncertainty. Algebra of Fuzzy Sets. Fuzzy Quantities, Fuzzy Numbers, Fuzzy Intervals. t – Norms, Generators of t – Norms, Isomorphisms of t – Norms, Negations, t – Conorms, Strict De – Morgan Systems, Nilpotent De Morgan Systems, Non-uniqueness of Negations In Strict De Morgan Systems. Fuzzy Implications, Averaging Operators and Negations, Averaging Operators and Nilpotent t-Norms, De Morgan Systems With Averaging Operators, Power of t-Norms, Sensitivity of Connectives. Fuzzy Relations: Binary Fuzzy Relations, Operations On Fuzzy Relations, Approximate Reasoning, Approximate Reasoning In Expert Systems, Modulus Ponens. Universal Approximations: Fuzzy Rule Bases,Desing Methodologies, Approximation Capabilities. Partial Knowledge: Belief Functions, Indicence Algebras, Monotonicity, Beliefs, Densities and Allocations, Möbius Transform, Reasoning with Belief Functions, Decision Making With Belief Functions.

Course Outline:

1. Fuzziness: Introduction, Examples of Fuzziness, Modeling of Fuzziness, Operations on Fuzzy Sets, Fuzziness as Uncertainty
2. Algebra of Fuzzy Sets: Boolean Algebra and Lattices, Equivalence Relations and Partitions, Composing Mappings, Isomorphism, and Homomorphisms, Alpha Cuts, Images of Alpha Level Sets.
3. Fuzzy Quantities, Fuzzy Numbers, Fuzzy Intervals.
4. Basic Connectives: t – Norms, Generators of t – Norms, Isomorphisms of t – Norms, Negations, t – Conorms, Strict De – Morgan Systems, Nilpotent De Morgan Systems, Non-uniqueness of Negations In Strict De Morgan Systems.
5. Fuzzy Implications, Averaging Operators and Negations, Averaging Operators and Nilpotent

t-Norms, De Morgan Systems With Averaging Operators, Power of t-Norms, Sensitivity of Connectives.
6. Fuzzy Relations: Binary Fuzzy Relations, Operations On Fuzzy Relations, Approximate Reasoning, Approximate Reasoning In Expert Systems, Modulus Ponens.
7. Universal Approximations: Fuzzy Rule Bases, Desing Methodologies, Approximation Capabilities
8. Partial Knowledge: Belief Functions, Indicence Algebras, Monotonicity, Beliefs, Densities and Allocations, Möbius Transform, Reasoning with Belief Functions, Decision Making With Belief Functions.

References Material:

1. A First Course in Fuzzy Logic by Hung T. Nguyen and Elbert A. Walker, Chapman and Hall/CRC; 3rd Edition (October 6, 2005).ISBN-10: 1584885262
2. Introduction to the Basic Principles of Fuzzy Set Theory and some of its Applications Communication and Cognition, Gent, 1991
3. Fuzzy Set Theory and its Applications by H. J. Zimmermann, Springer; 4th Edition (October 15, 2001). ISBN-10: 0792374355
4. Fundamentals of Fuzzy Sets by Didier Dubois and HenriPrade, Springer; 1st Edition (January 1, 2000). ISBN-10: 079237732X

Course Title: Expert Systems

Course Code: CSEC-721
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course concentrates on an analysis of the architecture, knowledge and problem-solving style of expert system.

Course Syllabus:

Introduction to Expert Systems. Major Characteristics of Expert Systems. Knowledge Representation. Prolog Programming. Developing Meta Interpreters in Prolog. Inference Techniques. MYCIN. Rule-Based Expert Systems. Backward-Chaining Rule-Based Systems. Designing Backward-Chaining Rule-Based Systems. Forward-Chaining Rule-Based Systems. Designing Forward-Chaining Rule-Based Systems. Frame-Based Expert Systems. Designing a Frame-Based Expert Systems.

Course Outline:

1. Introduction to Expert Systems.
2. Major Characteristics of Expert Systems.
3. Knowledge Representation.
4. Prolog Programming.
5. Developing Meta Interpreters in Prolog.
6. Inference Techniques.
7. MYCIN.
8. Rule-Based Expert Systems.

9. Backward-Chaining Rule-Based Systems.
10. Designing Backward-Chaining Rule-Based Systems.
11. Forward-Chaining Rule-Based Systems.
12. Designing Forward-Chaining Rule-Based Systems.
13. Frame-Based Expert Systems.
14. Designing a Frame-Based Expert Systems.

Reference Material:

1. Expert Systems: Design and Development by Durkin, J., Prentice Hall, New York, NY, 1994 or Latest Edition.
2. Introduction To Expert Systems by Peter Jackson, Addison-Wesley; 3rd Edition (December 23, 1998). ISBN-10: 0201876868
3. Expert Systems Programming: Practical Techniques for Rule-Based Systems by Ken Pedersen, Wiley; 1st Edition (May 8, 1989). ISBN-10: 0471600695
4. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Prentice Hall (April 1990). ISBN-10: 0134771001
5. An Introduction To Expert Systems by James P. Ignizio, Mcgraw-Hill College; (January 1, 1991). ISBN-10: 0079097855
6. Expert Systems by Nikolopoulos, CRC Press; 1st Edition (January 10, 1997). ISBN-10: 0824799275

Course Title: Intelligent Agents Technology

Course Code: CSEC-723
Course Structure: Lectures:3 / Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

After passing this course students will be able to understand about software agent technology including:

- What is agent technology?
- Technological contexts.
- Trends and drivers.
- Agent technologies and tools.
- Applications.
- Challenges.
- Technology roadmaps.

Course Syllabus:

Basics of Intelligent Agents. Intelligent Agents Application. Desktop Agents. Internet Agents. Web search Agents, Information Filtering Agents, Personalized Newspaper, Offline Delivery Agents, URL-minder, Bargain Finder. Intranet Agents. Mobile Agents. Technology of Intelligent Agents. Agent Machinery. Agent Content. Agent Access. Agent Security. Developing Agent Applications.

Course Outline:

1. Intelligent Agents: Attributes of Intelligent Agents, Task level Skills, Knowledge, Communication Skills, End user Taxonomy of Agents, Types of Agents: Desktop Agents, Internet Agents. Mobile agents, Intranet Agents.
2. Desktop Agents: Operating System Agents - An Intelligent Utility System Agent, Interface Agent, Application Agents, Email Agent, Search Agent, Application Suite Agents, Benefits of Desktop Agents.
3. Internet Agents: Web search Agents, Benefits of Search Agents, Information Filtering Agents, Benefits of Information Filtering Agents, Offline Delievery Agents, Benefits of offline Delivery Agents, Notification Agents, URL-minder, Benefits of Notification Agent.
4. Intranet Agents: Intranet Search Agents, Informational Filtering Agents, Collaboration Agents, Lotus Notes Agents, Process Automation Agents – Edify work force; A Process Automation Agent, Database Agents DSS Agent – A Database Agent, Mobile Agents –Cyber Agent; A Java based mobile Agent System, Tabriz AgentWare.
5. Technology of Intelligent Agents: the historical view, technical view, Intelligence & Agency, Machinery, Content, Access & Security, Development Model, Steps towards Automation, Steps Towards Agent-based Application.
6. Agent Machinery: Principles of Reasoning – Inferencing Systems, Rules of Inferencing, Sensors & Actors, RAISE: An Inferencing System for Agents, The Trouble with Rules, Adaptive Inferencing, Learning for Intelligent Agents –Sources of Data for Learning.
7. Agent Content: Knowledge Representation, Agent Communication, World Views –World views for Agents, Classes of World-Views, World Views Models for your business, Knowledge Representation & Agent Access, Intelligent Databases, An Agent Content Framework, Agent Communication Languages, The Knowledge Sharing Effort, Knowledge sharing & Manipulation Language (KQML), Agent Content Creation, Sources of Content in your Business.
8. Agent Access: A Framework for Intelligent Agent Access, Agent Access for Existing Applications –Wrappering, Client/Server Applications, Database & File System Interfaces, User Interface, User Access –Conversational User Interfaces, User Events & Actions, Mobile Agents, Mobile Agent Languages, Mobile Agent Principles, Motivations for Using Mobile Agents, Mobile Agent Scenario, Languages for Mobile Agents, Mobile Agent Issues, Internet Access, Access in your Business.
9. Agent Security: What does Security Do? Security for Agents, Security Basics, Delegation for Agents –Controlled Delegation, Limiting Resource Consumption, Security Issues for Mobile Agents –Delegation & Authentication, Agent Privacy, Security Minded Languages for Agents, Security for Mobile Agents, Trusting Agents – Testing & Training, Training Human Agents, Verification, Reputation.
10. Developing Agent Applications: Learning Interface Agents, Learning Agent Functional Architecture, Event Modeling, Learning Engine, Fact Interpretation, Observations, Instructions, Inference.

Reference Material:

1. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
2. Intelligent Agent Source book by Caglayan, Alper, John Wiley and Sons Ltd (1997). ISBN: 9780471153276

3. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence by Gerhard Weiss, The MIT Press (July 31, 2000). ISBN-10: 0262731312
4. Intelligent Software Agents: Foundations and Applications by Walter Brenner, RüdigerZarnekow, Hartmut Wittig and A.S. Rudd, Springer, (July 31, 2012). ISBN-10: 3642804861
5. Agent Technology for E-Commerce by Maria Fasli, Wiley; 1st Edition (March 6, 2007). ISBN-10: 0470030305

Course Title: Stochastic Systems

Course Code: CSEC-726
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:
The course will introduce students with key concepts of Stochastic Systems.

Course Syllabus:
Overview of Probability. The Axioms of Probability. Repeated Trials. Random Variable. Distribution and Density Functions, Specific Random Variables, Conditional Distributions, Asymptotic Approximations for Binomial Random Variable. Functions of One Random Variable. Two Random Variables. Sequences of Random Variables. Stochastic Convergence and Limit Theorems, Random Numbers, Meaning and Generation. Statistics.

Course Outline:
1. Overview of Probability: Introduction, Definitions, Probability and Induction, Causality Versus Randomness.
2. The Axioms of Probability: Set Theory, Probability Space, Conditional Probability.
3. Repeated Trials: Combined Experiments, Bernoulli Trials, Bernoulli's Theorem and Games of Chance.
4. The Concept of a Random Variable: Introduction, Distribution and Density Functions, Specific Random Variables, Conditional Distributions, Asymptotic Approximations for Binomial Random Variable.
5. Functions of One Random Variable: The Random Variable g(x), The Distribution of g(x), Mean and Variance, Moments, Characteristic Functions.
6. Two Random Variables: Bivariate Distributions, One Function of Two Random Variables, Two Functions of Two Random Variables, Joint Moments, Joint Characteristic Functions, Conditional Distributions, Conditional Expected Values.
7. Sequences of Random Variables: General Concepts, Conditional Densities, Characteristic Functions, and Normality, Mean Square Estimation, Stochastic Convergence and Limit Theorems, Random Numbers: Meaning and Generation.
8. Statistics: Introduction, Estimation, Parameter Estimation, Hypothesis Testing.

Reference Material:
1. Dynamics of Stochastic Systems by V. I. Klyatskin, Elsevier Science; 1st Edition (December 15, 2005). ISBN-10: 0444517960

2. Probability, Random Variables and Stochastic Processes by Athanasios Papoulis and S. Unnikrishna Pillai, McGraw-Hill Europe; 4th Edition (January 1, 2002). ISBN-10: 0071226613
3. Stochastic systems by George Adomian, Academic Press (May 28, 1983). ISBN-10: 012410956X

Course Title: Stochastic Processes

Course Code: CSEC-737
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:
The course will introduce students with key concepts of Stochastic Processes.

Course Syllabus:
Review of basic probability. Systems with Stochastic Inputs, The Power Spectrum, Discrete-Time Processes, Continuity, Differentiation, Integration, Shift Operators and Stationary Processes. Finite Markov Chains. Branching Processes. Renewal Theory. Markov Processes. Brownian Motion. Random Walks and Other Applications. Mean Square Estimation.

Course outline:
1. Review of basic probability: Sample space, event, conditional probability, independent events, Baye's formula, random variable, distribution, cumulative distribution, Bernoulli distribution, binomial distribution, Poisson distribution, geometric distribution, density function, exponential distribution, gamma distribution, expectation, variance, standard deviation, joint distribution, covariance, correlation, mean, moment generating function, Chebyshev's inequality, Law of large numbers, central limit theorem.
2. General Concepts: Definitions, Systems with Stochastic Inputs, The Power Spectrum, Discrete-Time Processes, Continuity, Differentiation, Integration, Shift Operators and Stationary Processes.
3. Finite Markov chains: basics, examples, 1-step and n-step transition probabilities, stationary distributions, classifying states, periodicity of classes, absorption of transient states, reversibility, ruin problem.
4. Branching processes: probability generating function, compound distribution, generations of offspring, extinction, total progeny, generalizations.
5. Renewal theory: sequence generating function, pattern generation, consecutive successes, mean number of trials, breaking even, mean number of occurrences, comparison of patterns, probability of winning, expected duration.
6. Markov processes: Poisson processes, extensions, pure birth processes, Yule process, pure death processes, birth and death processes, linear case, linear growth with immigration, M/M/infinity queue, power supply problem, stationary distributions, examples, absorption, continuous time Markov chains, n-state case.
7. Brownian motion: definition, no drift case, reaching a point, avoiding zero, returning to zero, drift.
8. Random Walks and Other Applications: Random Walks, Cyclostationary Processes, The

Poisson Sum Formula, The Schwarz Inequality.

9. Mean Square Estimation: Introduction, Prediction.

Reference Material:

1. Stochastic Processes: with Applications to Reliability Theory by Toshio Nakagawa, Springer; 1st Edition (June 9, 2011). ISBN-10: 0857292730
2. Stochastic Processes with Applications by Rabi N. Bhattacharya and Edward C. Waymire, Society for Industrial & Applied (August 5, 2009).ISBN-10: 0898716896
3. Probability, Random Variables and Stochastic Processes by Athanasios Papoulis and S. UnnikrishnaPillai, McGraw-Hill Europe; 4th Edition (January 1, 2002). ISBN-10: 0071226613
4. Basic Stochastic Processes: A Course Through Exercises by ZdzislawBrzezniak, Tomasz Zastawniak, Springer (September 6, 2000). ISBN-10: 3540761756
5. Classical and Spatial Stochastic Processes by Rinaldo B. Schinazi, Birkhäuser; 1999 Edition (May 1, 1999). ISBN-10: 1461272033.

Course Title: Multimedia Databases

Course Code: ITEC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Introduction to Multimedia Databases, Multimedia Data, The Human Sensory System and Multimedia, Introduction to SQL and Multimedia, Querying Multimedia Data, Modeling Multimedia Databases, Using Multimedia Metadata, Multimedia Database Architecture and Performance, Multimedia and the Internet, Quality-of-service Issues, Dealing with Text Databases, Content-dependent Metadata, Dealing with Image Databases, Dealing with Video Databases.

Course Outline:

1. Introduction to Multimedia Databases: Introduction, Essential of Database Systems, Multimedia Data, Multimedia Applications.
2. Multimedia Data: Multimedia Data Size, Real-time Nature of Multimedia, Problems with Semantic Nature of Multimedia Data.
3. The Human Sensory System and Multimedia: Human Information Processing, Human Brain and Multimedia Information, The Senses, Converting Data into Sensory Perception.
4. An Introduction to SQL and Multimedia: Introduction to SQL, Methods Using PL/SQL Stored Procedures, Manipulating Large Objects.
5. Querying Multimedia Data: Manipulating Multimedia Data, Classification Problem.
6. Modeling Multimedia Databases: Issues of Designing Multimedia Database Management Systems, Semantic Data Modeling, Object-oriented Design, Object Methods, Object-relational Approach.
7. Using Multimedia Metadata: Classifying Metadata, Generating and Extracting Metadata, The Role of Metadata Standards, Digital Rights Management, Domain-dependent Metadata, Developing Ontologies.
8. Multimedia Database Architecture and Performance: Introduction to Multimedia

Architecture Requirements, Performance Issues in Specific Implementations, Content Management.

9. Multimedia and the Internet: The Internet, Delivery of Multimedia Data, Media Streams, Network Protocols, User Datagram Protocol.
10. Quality-of-service Issues - Internet Service Models, Packets and Datagrams - Sequence and Loss, Network Architecture, Requirements of Applications Involving Multicasting and Interactivity.
11. Dealing with Text Databases: Querying Character Data Using SQL, Statistical Methods for Text Analysis, Querying Multimedia Text.
12. Content-dependent Metadata, Metadata Standards, Indexing Technologies for Text.
13. Dealing with Image Databases: Technologies for Image Processing, The Role of Feature Extraction, Retrieval Methods, Image Analysis and Object Recognition, Image Classification, Image Database Software, Developing Image Media Databases.
14. Dealing with Video Databases: Video Analysis and Segmentation, Storage of Video Objects, Disk Scheduling, Dealing with Moving Images, Metadata for Speech, Metadata for Video, Manipulating Video Data, Video Query Process, Video Applications.

Reference Material:

1. Multimedia Databases: An Object-Relational Approach by Lynne Dunckley, Pearson Education (January 31, 2003). ISBN-10: 0201788993
2. Multimedia Database Systems: Design and Implementation Strategies by Kingsley C. Nwosu, B. Thuraisingham and P. Bruce Berra, Springer; (October 28, 2011). ISBN-10: 146138060X
3. Principles of Multimedia Database Systems by V.S. Subrahmanian, Morgan Kaufmann Publishing Company, San Fransisco, CA. 1998. ISBN: 1558604669.
4. Distributed Multimedia Database Technologies Supported by MPEG-7 and MPEG-21 by HaraldKosch, CRC Press; 1st Edition (November 24, 2003). ISBN-10: 0849318548
5. Multimedia Data Mining: A Systematic Introduction to Concepts and Theory by Zhongfei Zhang and Ruofei Zhang, Chapman and Hall/CRC; 1st Edition (December 2, 2008). ISBN-10: 1584889667

Course Title: Distributed Database Systems

Course Code: ITEC-703
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: DBMS

Course Syllabus:

Distributed Data Processing, Distributed Database Systems, Design Issues, Distributed DBMS Architecture. Distributed Database Design. Database Integration. Data and Access Control. Query Processing. Query Decomposition and Data Localization. Optimization of Distributed Queries. Multidatabase Query Processing. Transaction Management. Distributed Concurrency Control. Distributed DBMS Reliability. Data Replication.

Course Outline:

1. Distributed Data Processing, Distributed Database Systems, Data Delivery Alternatives,

Promises of DDBSs, Complications Introduced by Distribution, Design Issues, Distributed DBMS Architecture.
2. Distributed Database Design: Top-Down Design Process, Fragmentation, Allocation, Data Directory.
3. Database Integration: Bottom-Up Design Methodology, Schema Matching, Schema Integration, Schema Mapping, Data Cleaning.
4. Data and Access Control: View Management, Data Security, Semantic Integrity Control.
5. Overview of Query Processing: Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing.
6. Query Decomposition and Data Localization: Query Decomposition, Localization of Distributed Data.
7. Optimization of Distributed Queries: Query Optimization, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization.
8. Multidatabase Query Processing: Issues in Multidatabase Query Processing, Multidatabase Query Processing Architecture, Query Rewriting Using Views, Query Optimization and Execution, Query Translation and Execution.
9. Transaction Management: Definition of a Transaction, Properties of Transactions, Types of Transactions.
10. Distributed Concurrency Control: Serializability Theory, Taxonomy of Concurrency Control Mechanisms, Locking-Based Concurrency Control Algorithms, Timestamp-Based Concurrency Control Algorithms, Optimistic Concurrency Control Algorithms, "Relaxed" Concurrency Control.
11. Distributed DBMS Reliability: Reliability Concepts and Measures, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols, Dealing with Site Failures, Network Partitioning, Architectural Considerations.
12. Data Replication: Consistency of Replicated Databases, Update Management Strategies, Replication Protocols, Group Communication, Replication and Failures, Replication Mediator Service.

Reference Material:

1. Principles of Distributed Database Systems by M. Tamer Özsu and Patrick Valduriez, Springer, 3rd Edition, (March 2, 2011). ISBN-10: 1441988335
2. Distributed Database Management Systems: A Practical Approach by Saeed K. Rahimi, and Frank S. Haug, Wiley-IEEE Computer Society Pr; 1st Edition (May 23, 2011). ASIN: B005CDYQSC
3. Distributed Systems: Principles and Paradigms by Andrew S. Tanenbaum and Maarten van Steen, Prentice Hall; US Edition (January 15, 2002). ISBN-10: 0130888931
4. Distributed Systems: Concepts and Design by Jean Dollimore, Tim Kindberg and George Coulouris, Addison Wesley; 4th Edition (May 20, 2005). ISBN-10: 0321263545
5. Distributed Database Systems by Chhanda Ray, Pearson (October 3, 2012). ASIN: B009NEMZ0W

Course Title: Formal Methods

Course Code: CSEC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
Modern software development inevitably requires the design and analysis of a number of different artifacts. Formal methods allow the mathematically precise formulation of some of these artifacts. This course is an introduction to the use of formal methods for the specification, design, and automatic analysis of software systems.

Course Syllabus:
Introduction to Formal methods, Introducing Z, Elements of Z, Logic, Using Predicates in Z, Schemas and Schema Calculus, Formal Reasoning, Rule-Based Programming, Graphical User Interface, Safety-Critical Protection System, Modeling Large Systems, Converting Z into Code.

Course Outline:

1. Formal methods: What are FM? What FM are not, When, How, and Why use FM? Popular Fallacies and Alternatives. Formal Methods and Project Management: Gathering Requirement, From Information Requirement to Formal Specifications, Validating Formal Specifications. [TB: Ch. 1,2,3]
2. Introducing Z: What is Z? Informal Requirements, Data Flow Diagrams, State Transition Diagram, State Transition Diagram, State Transition tables. Introducing schemas: Basic Types and Abbreviations, Axiomatic Descriptions, State Schemas, Operation Schemas, Implicit preconditions, Schema Calculus. [TB: Ch. 4,5, 6, 7]
3. Elements of Z: Sets and Types, Declarations, Variables, Expressions, Operators, Predicates, Equations and Laws. Structure: Tuple, Records, Relations, Tables, Databases, Pairs and Binary Relations, Functions, Sequences, Operators. [TB: Ch. 8,9]
4. Logic: Basic Predicates, Using Predicates in Z, Relations as Predicates, Logical Connectives, Logic and Natural Language, Quantifiers, Z and Boolean Types, Predicates and undefined Expressions. Synthesis: Set Comprehensives, Lambda Expressions, Formal Specifications, Conveniences and shortcuts, Modeling Systems and Change. [TB: Ch. 10, 11]
5. Schemas and schema calculus: Conjunctions and Disjunctions, Other Schema Operators. Schema types and Bindings: Generics & Free Types [TB: Ch. 12, 13,14]
6. Formal Reasoning: Calculation and proof, Laws, Checking Specifications, Preconditions, Formal Reasoning and Intuition, Machine-Checked proof. [TB: Ch.15]
7. Graphical User Interface: Events, Display and Dialogs, Selecting a Display, Changing Setting Value, Z and State Transition Systems, Changing the Machine State. [TB: Ch. 21]
8. Safety-Critical Protection System: Partition, Refinement, Enforcing the Safety Requirements. [TB: Ch. 22]
9. Modeling Large Systems: A Single Subsystem, Many Subsystems, Useful Idioms, Subsystems, Conditions, and Modes. [TB: Ch. 23].
10. Converting Z Specification into Code.

Reference Material:

1. Systems and Software Verification: Model-Checking Techniques and Tools. By B. Berard, M. Bidoit, A. Finkel, F. Laroussinie, A. Petit, L. Petrucci, and P. Schnoebelen, Springer, (2013). ISBN-10: 3642074782
2. The Way of Z: Practical Programming with Formal Methods by Jonathan Jacky, Cambridge University Press (November 28, 1996). ISBN-10: 0521559766
3. Z: An Introduction to Formal Methods by Antoni Diller, Wiley; 2nd Edition (July 27, 1994). ISBN-10: 0471939730
4. Model Checking by Edmund M. Clarke Jr., Orna Grumberg, Doron A. Peled , MIT Press, 1st Edition (1999). ISBN-13: 978-0262032704.
5. Reactive Systems: Modelling, Specification and Verification by Luca Aceto, Anna Ingólfsdóttir, Kim Guldstrand Larsen and Jiri Srba, Cambridge University Press (August 13, 2007). ISBN-10: 0521875463
6. Fundamentals of Algebraic Specifications: Equations and Initial Semantics, H. Ehrig & B. Mahr, Springer-Verlag (1985), ISBN 0-387-13718-1.
7. Algebraic Specifications in Software Engineering by I. Van Horebeek & J. Lewi, Springer; 1st Edition (December 19, 1989). ISBN-10: 3540516263

Course Title: Bioinformatics

Course Code: CSEC-724
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
Introduce students to the current bioinformatics concepts and their implementations.

Course Syllabus:
The genetic material. Gene structure and information content. Open reading frames, Introns and exons. Protein structure and function. The nature of chemical bonds. Electronegativity, Hydrophilicity and hydrophobicity. Molecular biology tool. Polymerase chain reaction (PCR), DNA sequencing. Genomic information content. Data Searches and Pairwise Alignments. Substitution Patterns. Estimating substitution numbers. Kimura's two-parameter model, Models with even more parameters, Substitutions between protein sequences. Variations in substitution rates between genes. Molecular clocks. Distance-Based Methods of Phylogenetics. Distance matrix methods. Character-Based Approaches to Phylogenetics: Parsimony, Strategies for faster searches, Consensus trees. Tree confidence. Molecular phylogenies. Genomics and Gene Recognition. Prokaryotic gene structure. GC-content. Prokaryotic gene density. Eukaryotic genomes. Eukaryotic gene structure. Open reading frames. GC-content. Gene expression. Transposition. Repetitive elements. Eukaryotic gene density. Protein Folding: Polypeptide composition. Secondary structure, Tertiary and quaternary structure, Protein folding, Structure prediction, Threading. Proteomics: From genomes to proteomes. Protein classification, Experimental techniques. Inhibitors and drug design. Ligand screening. Docking. Database screening. X-ray crystal structures. Empirical methods and prediction techniques. Postranslational modification prediction.

Course Outline:

1. Molecular Biology And Biological Chemistry: The Genetic Material: Nucleotides, Orientation, Base Pairing, The Central Dogma Of Molecular Biology. Gene Structure and Information Content: Promoter Sequences, The Genetic Code. Open Reading Frames, Introns and Exons. Protein Structure and Function: Primary Structure, Secondary, Tertiary and Quaternary Structure. The Nature of Chemical Bonds: Anatomy of An Atom, Valence. Electronegativity, Hydrophilicity and Hydrophobicity. Molecular Biology Tool: Restriction Enzymes, Gel Electrophoresis, Blotting, Hybridization and Microarrays, Cloning. Polymerase Chain Reaction (PCR), DNA Sequencing. Genomic Information Content: C Value Paradox, Reassociation Kinetics.
2. Data Searches and Pairwise Alignments: Dot Plots. Simple Alignments. Scoring. Gaps: Simple Gap Penalties, Origination and Length Penalties. Scoring Matrices. Dynamic Programming: The Needleman And Wunsch Algorithm. Local and Global Alignments: Global and Semi-Global Alignments, The Smith-Waterman Algorithm. Database Searches: BLAST and Its Relatives, Other Algorithms. Multiple Sequence Alignments.
3. Substitution Patterns: Patterns of Substitutions Within Genes: Mutation Rates. Functional Constraint.Synonymous Vs. Non-synonymous Changes, Indels and Psuedogenes, Substitutions Vs. Mutations, Fixation. Estimating Substitution Numbers: Jukes/Cantor Model, Transitions and Transversions. Kimura's Two-Parameter Model, Models With Even More Parameters, Substitutions Between Protein Sequences. Variations In Substitution Rates Between Genes. Molecular Clocks: Relative Rate Tests, Causes Of Rate Variation In Lineages. Evolution in Organelles.
4. Distance-Based Methods of Phylogenetics: History of Molecular Phylogenetics. Advantages to Molecular Phylogenies. Phylogenetic Trees: Terminology of Tree Reconstruction, Rooted and Unrooted Trees, Gene Vs. Species Trees, Character and Distance Data. Distance Matrix Methods: UPGMA. Estimation of Branch Lengths. Transformed Distance Method, Neighbor's Relation Method, Neighbor-Joining Methods. Maximum Likelihood Approaches. Multiple Sequence Alignments.
5. Character-Based Approaches to Phylogenetics: Parsimony: Informative and Uninformative Sites, Unweighted Parsimony, Weighted Parsimony. Inferred Ancestral Sequences. Strategies for Faster Searches: Branch and Bound, Heuristic. Consensus Trees. Tree Confidence: Bootstrapping, Parametric Tests. Comparison of Phylogenetic Methods. Molecular Phylogenies: The Tree of Life, Human Origins.
6. Genomics and Gene Recognition: Prokaryotic Genomes. Prokaryotic Gene Structure: Promoter Elements, Open Reading Frames, Conceptual Translation, Termination Sequences. GC-Content. Prokaryotic Gene Density. Eukaryotic Genomes. Eukaryotic Gene Structure: Promoter Elements, Regulatory Protein Binding Sites. Open Reading Frames: Introns And Exons, Alternative Splicing, Cpg Islands. GC-Content: Isochores, Codon Usage Bias, Gene Expression: Cdnas And Ests, Serial Analysis of Gene Expression (SAGE), Microarrays. Transposition. Repetitive Elements. Eukaryotic Gene Density.
7. Protein Folding: Polypeptide Composition: Amino Acids. Backbone Flexibility, Phi and Psi. Secondary Structure: Accuracy of Predictions, Chou-Fasman/GOR Method. Tertiary and Quaternary Structure: Hydrophobicity, Disulfide Bonds, Active Structures Vs. Most Stable Structures. Protein Folding: Lattice Models, Off-Lattice Models, Energy Functions and Optimization. Structure Prediction: Comparative Modeling, Threading: Reverse Protein Folding. Predicting RNA Secondary Structures.

8. Proteomics: From Genomes to Proteomes. Protein Classification: Enzyme Nomenclature, Families and Super-Families, Folds. Experimental Techniques: 2D Electrophoresis, Mass Spectrometry, Protein Microarrays. Inhibitors and Drug Design. Ligand Screening: Docking, Database Screening. X-Ray Crystal Structures. Empirical Methods and Prediction Techniques. Postranslational Modification Prediction: Protein Sorting, Proteolytic Cleavage, Glycosylation, Phosporylation and Sulfation.

References Material:

1. Fundamental Concepts of Bioinformatics by Dan E. Krane and Michael L. Raymer, Benjamin Cummings; 1st Edition (September 22, 2002). ISBN-10: 0805346333
2. Bioinformatics For Dummies by Jean-Michel Claverie Ph. D. and Cedric Notredame Ph.D., For Dummies; 2nd Edition (December 18, 2006). ISBN-10: 0470089857
3. Essential Bioinformatics by Jin Xiong, Cambridge University Press; 1 Edition (March 13, 2006). ISBN-10: 0521600820
4. Introduction to Bioinformatics by Arthur Lesk, Oxford University Press, USA; 3rd Edition (June 2, 2008). ISBN-10: 0199208042

Course Title: Service-Oriented Architecture

Course Code: ITEC-709
Course Structure: Lectures: 3/Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

By the end of this course students will be able to understand SOA, Service Orientation and Web Services. The will also be able to analyze and design business based on SOA principles.

Course Syllabus:

Introducing SOA. Web Services & Primitive SOA. Web Services & Contemporary SOA (Activity Management & Composition). Web Services & Contemporary SOA *(Advance Messaging, Metadata & Security).* Principles of Service-Orientation. Service Orientation & Contemporary SOA. SOA Delivery Strategies. Service Oriented Analysis. Service Modelling (Process). Service Oriented Design. WSDL-Related XML Schema Language. SOAP Language Basic, Service Interface Design Tools. Service Oriented Design Steps to Composing SOA. Considerations for Choosing Service Layers, Considerations for Positioning Core SOA Standards (Industry Standards, & SOA, XML & SOA, The WS-I Baisc Profile, WDSL & SOA, XML Schema & SOA, SOAP & SOA, Namespaces & SOA, UDDI & SOA) Considerations for Choosing SOA Extensions (Choosing SOA Characteristics, Choosing WS* Specifications, WS-BPEL & SOA). Entity Centric Business Service Design, Application Service Design, Service Design Guidelines.

Course Outline:

1. Introducing SOA; Fundamental SOA, Common Characteristics, Common Misperceptions about SOA: Common Tangible Benefits Of SOA, Common Pitfalls Of Adopting SOA.
2. Web Services & Primitive SOA: The Web Services Framework, Web Services, Service

Descriptions (WSDL), Messaging (With SOAP).

3. Web Services & Contemporary SOA (Activity Management & Composition): Message Exchange Patterns, Coordination, Atomic Transactions, Business Activities, Orchestration Choreographies.
4. Web Services & Contemporary SOA *(Advance Messaging, Metadata & Security)* Addressing Reliable Messaging, Correlation, Metadata Exchange, Notification & Eventing.
5. Principles of Service-Orientation: Service Orientation & The Enterprise, Anatomy of a Service Oriented Architecture, Common Principles of Service Orientation, How Services-Orientation Principles, Service Orientation & Object Orientation, Native Web Service Support for Service Orientation Principles.
6. Service Orientation & Contemporary SOA: Service Layer Abstraction, Application Service Layer, Business Service Layer, Orchestration Service Layer, Agnostic Services, Service Layer Configuration Scenarios.
7. SOA Delivery Strategies SOA Delivery Lifecycle Phases, Top Down Strategy, Bottom Up Strategy, Agile Strategy.
8. Service Oriented Analysis: Introduction, Benefits of a Business Centric SOA, Deriving Business Services, Deriving Business Services.
9. Service Modelling (Process): Introduction, Modelling Guidelines, Classifying Service Model Logic, Different Modelling Approaches.
10. Service Oriented Design: Introduction, WSDL-Related XML Schema Language, WSDL Language(Like Definitions, Types, Message & Part, Porttype, Interface, & Operation Elements, Input & Output-When Used With Operation, Binding, Input & Output-When Used With Binding, Service, Port & Endpoint, Import, Documentation), SOAP Language Basic (Envelop, Header, Body, Fault) Service Interface Design Tools.
11. Service Oriented Design Steps To Composing SOA, Considerations For Choosing Service Layers, Considerations For Positioning Core SOA Standards (Industry Standards, & SOA, XML & SOA, The WS-I Baisc Profile, WDSL & SOA, XML Schema & SOA, SOAP & SOA, Namespaces & SOA, UDDI & SOA) Considerations For Choosing SOA Extensions (Choosing SOA Characteristics, Choosing WS* Specifications, WS-BPEL & SOA).
12. Service Oriented Design: Overview, Entity Centric Business Service Design, Application Service Design, Service Design Guidelines.

Reference Material:

1. Service-Oriented Architecture (SOA): Concepts, Technology, and Design by Thomas Erl, Prentice Hall (August 12, 2005). ISBN-10: 0131858580
2. Service-Oriented Architecture (SOA): Concepts, Technology, and Design by Thomas Erl, Prentice Hall (August 12, 2005). ISBN-10: 0131858580
3. SOA Design Patterns by Thomas Erl, Prentice Hall PTR; 1st Edition (January 9, 2009)
4. Service-Oriented Architecture (SOA): A Planning and Implementation Guide for Business and Technology by Eric A. Marks and Michael Bell, Wiley; 1st Edition (April 28, 2006). ISBN-10: 0471768944
5. Applied SOA: Service-Oriented Architecture and Design Strategies by Michael Rosen, Boris Lublinsky, Kevin T. Smith and Marc J. Balcer, Wiley; 1st Edition (June 16, 2008). ISBN-10: 0470223650

Course Title: Advanced Web development

Course Code: CSEC-707

Prerequisites: Web Systems and Technologies.

Course Objectives:

To introduce students with Web Systems and Technologies Implement HTML5 coding solutions using HTML5 elements, attributes and values. Apply CSS33 functionality to Web documents using various properties, selectors and techniques. Integrate basic JavaScript coding into a Web page to create HTML5 APIs. Consider HTML5 and CSS33 techniques to apply to both traditional and mobile delivery platforms, including mobile apps .Transform traditional Web pages into mobile Web pages. Understanding PHP frameworks and advanced technologies. Something new in JQuery. Mobile websites and mobile apps development.

Course Syllabus:

Introduction to HTML5 and CSS33, Advanced concepts in HTML5 Structure Elements, Validating HTML5 Code, HTML5 APIs, Cross-Browser Compatible HTML5 Forms, New Form Elements in HTML5, HTML5 Global Attributes for Form Elements, Embedding JavaScript into HTML5 Documents, Cascading Style Sheets (CSS3), Style Guides, , CSS3 Positioning Schemes, The CSS3 Box Model, Introduction to CSS33, Introduction to Advanced CSS33 Techniques, CSS33 2D and 3D Transformations, CSS33 Transitions, CSS33 Animations, CSS33 User Interfaces, Creating Menus and Buttons with CSS33, Advanced PHP concepts, debugging and logging, Runtime error handling using PHP exception handling mechanism, Web services including SOAP,NU SOAP and WSDL. Popular frameworks including CakePHP, Yii, Zend and Codelgniter. Advanced JQuery concepts, JQuery functions, Validating User Input with JavaScript, Migration to Mobile Devices. The Web Development Trifecta.

COURSE OUTLINE:

1. Advanced HTML5 concepts: Structure Elements, Validating HTML5 Code, The <video> Element, The <audio> Element, Introduction to HTML5 Forms, Cross-Browser Compatible HTML5 Forms, New Form Elements in HTML5, HTML5 Global Attributes for Form Elements.
2. HTML5 APIs, Document Object Model (DOM), The Canvas API, The Offline AppCache API, The Geolocation API, The Drag-and–Drop API, The File API, The History API, Retrieving Data with *XMLHttpRequest.*
3. Advanced CSS33 concepts: Cascading Style Sheets (CSS3), Style Guides, CSS3 and HTML, CSS3 Terms and Syntax, Applying CSS3 Styles, Page Layout with CSS3, CSS3 Positioning Schemes, The CSS3 Box Model.
4. Introduction to CSS33, CSS33 Selectors and Properties, CSS33 Background Properties, CSS33 Border Properties, CSS33 Font Properties, CSS33 Text Effects, Introduction to Advanced CSS33 Techniques, CSS33 2D and 3D Transformations, CSS33 Transitions, CSS33 Animations, CSS33 User Interfaces, Creating Menus and Buttons with CSS33.
5. Advanced JavaScript concepts: Learning JavaScript Design Patterns, Introduction to Object-Oriented JavaScript.
6. Advanced PHP concepts: functions, date and time , debugging and logging, string manipulation, database connectivity methods

7. PHP extensions and application repository –PEAR, Smarty Templates, code reuse, feeding a function, return data from a function, Runtime error handling using PHP exception handling mechanism, Send e-mail using SMTP.
8. Web services including SOAP, NU SOAP and WSDL, popular frameworks including CakePHP, Yii, Zend and Codelgniter.
9. Advanced JQuery concepts: Bind/Unbind, Live/Die, Ajax Queue/Sync, Setting up widgets in JQuery Namespace
10. Migration to Mobile Devices, Mobile Web Sites vs. Mobile Apps, Designing Web Sites for Mobile Devices, Page Layout for Mobile Devices, Navigation and Hyperlinks for Mobile Devices, Images and Mobile Design, Validating and Testing Mobile Web Pages, Responsive Web Design.

Course Title: Big Data Analysis

Course Code: CSEC-714
Credit Hours: 3

Course Objectives:
At the end of this course, the student will become familiar with the fundamental concepts of Big Data management and analytics; will become competent in recognizing challenges faced by applications dealing with very large volumes of data as well as in proposing scalable solutions for them; and will be able to understand how Big Data impacts business intelligence, scientific discovery, and our day-to-day life.

Course Syllabus:
Introduction to Big Data, Defining Big Data, Delivering Business benefit from Big Data, Storing Big Data, Analyzing your data characteristics, Overview of Big Data stores, Selecting Big Data Stores, Processing Big Data, Integrating disparate data stores, Employing Hadoop MapReduce, The building blocks of Hadoop MapReduce, Handling streaming data, Tools and Techniques to Analyze Big Data, Abstracting Hadoop MapReduce jobs with Pig, Performing ad hoc Big Data querying with Hive, Creating business value from extracted data, Developing a Big Data Strategy, Employing Hadoop MapReduce, Defining a Big Data strategy for your organization, Enabling analytic innovation, Implementing a Big Data solution.

Reference Material:
1. Big Data: A Revolution that Will Transform how We Live, Work, and Think, Kenneth Cukier and Viktor Mayer-Schönberger, Latest Edition
2. Data-Intensive Text Processing with MapReduce, Morgan & Claypool Publishers, Latest Edition.
3. Learning Spark: Lightning-Fast Big Data Analysis, Andy Konwinski, Holden Karau, Matei Zaharia, and Patrick Wendell, Latest Edition
4. Anand Rajaraman and Jeff Ullman, Mining of Massive Datasets, Cambridge Press, Latest Edition
5. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques. Latest Edition

Course Title: Cloud Computing

Course Code: CSEC-715
Credit Hours: 3
Prerequisite: Computer Networks

Course Objectives:

This course gives an introduction to cloud computing and related techniques, issues, ecosystem and case studies. Students will learn and understand about such fundamental distributed computing "concepts" for cloud computing, how these techniques work inside today's most widely-used cloud computing systems and various research papers will be studied.

Course Syllabus:

Overview of Distributed Computing, Emergence of Cloud Computing, Global Nature of the Cloud, Cloud-Based Service Offerings, Grid Computing , Reliability of Cloud Model, Benefits of Cloud Model, Legal Issues, Key Characteristics of Cloud Computing, Challenges for the Cloud. The Evolution of Cloud Computing. Web Services Delivered from the Cloud: Communication-as-a-Service (CaaS), Infrastructure-as-a-Service, Monitoring-as-a-Service (MaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Storage: HDFS, NAAS, SAN, Distributed Graph Processing, MapReduce , MapReduce Paradigm, MapReduce Examples, Emerging Paradigms, Distributed Graph Processing, Hadoop Scheduling, Dominant-Resource Fair Scheduling, Building Cloud Networks. Virtualization. Federation, Presence, Identity, and Privacy in the Cloud. Security in the Cloud. Common Standards in Cloud Computing. End-User Access to Cloud Computing. Mobile Internet Devices and the Cloud.

Reference Material:

1. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, Latest Edition
2. Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton, Recursive Press, Latest Edition
3. Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide by David S. Linthicum, Addison-Wesley Professional, Latest Edition
4. Cloud Computing Bible by Barrie Sosinsky, Wiley, Latest Edition

Course Title: Machine Learning

Course Code: CSEC-701
Credit Hour: 3
Prerequisites: None

Course Objectives:

In this course, student will learn about the most effective machine learning techniques, and gain practice implementing them and getting them to work. More importantly, student will learn

about not only the theoretical underpinnings of learning, but also gain the practical know-how needed to quickly and powerfully apply these techniques to new problems.

Course Syllabus:

This course provides a broad introduction to machine learning, data mining, and statistical pattern recognition. Topics include: (i) Supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks). (ii) Unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning). (iii) Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI). The course will also draw from numerous case studies and applications, so that you'll also learn how to apply learning algorithms to building smart robots (perception, control), text understanding (web search, anti-spam), computer vision, medical informatics, audio, database mining, and other areas.

Course Outline:

Following is a tentative syllabus for the class:

1. Introduction to machine learning [TB, Chapter 1].
2. Linear regression [RB1, Chapter 3, Section 3.1; RB2, Chapter 3, Section 3.1,3.2].
3. Gradient Descent as general parameter Learning/optimization approach [TB, Chapter 4]
4. Logistic regression, One-vs-all classification, Regularization. [Handout 2; RB1, Chapter 4 and RB2, Chapter 4]
5. Neural Networks. (TB, Chapter 4)
6. Practical advice for applying learning algorithms: How to develop, debugging, feature/model design, setting up experiment structure
7. Probability and Bayesian Analytics. [Handout 3]
8. Naive Bayes. (TB, Chapter 6)
9. Support Vector Machines (SVMs) and the intuition behind them. [RB 1, Chapter 7]
10. Unsupervised learning: clustering and dimensionality reduction.
11. Anomaly detection.
12. Probabilistic Graphical Models: Bayesian Belief Networks [RB, Chapter 8]
13. Probabilistic Graphical Models: Learning from Data [RB, Chapter 8]
14. Probabilistic Graphical Models: EM algorithm [RB 9]
15. Hidden Markov Models [RB Chapter 13]

Reference Material:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning. Springer, 2006.
2. Tom Mitchell, Machine Learning. McGraw-Hill, 1997. [Text Book (TB)]
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning. Springer, 2009

Course Title: Soft Computing

Course Code: CSEC-732
Credit Hours: 3

Course Objectives:
Soft computing is a collection of methodologies, which aim to exploit tolerance for imprecision, uncertainty and partial truth to achieve tractability, robustness and low cost solutions. It is the use of inexact solutions to computationally hard tasks such as the solution of NP-complete problems, for which there is no known algorithm that can compute an exact solution in polynomial time. Soft computing differs from conventional (hard) computing in that, unlike hard computing, it is tolerant of imprecision, uncertainty, partial truth, and approximation. In effect, the role model for soft computing is the human mind.

Course Syllabus:
Overview of Soft Computing, Probabilistic Graphical Models, Bayesian Networks, Inferencing in Graphical Models, Swarm Intelligence, Ant Colony Optimization, Particle Swarm Optimization, Cat Swarm Optimization, Convergence Analysis, Neural Networks, Deep Learning, Convolutional Neural Networks, Relational Learning, Tensor Factorization, Ensemble Methods.

Recommended Books:

1. Fundamentals of Computational Swarm Intelligence, John Wiley & Sons 2011, Andries P.Engelbrecht
2. Deep learning", MIT Press Cambridge (EE.UU.) 2016, Ian Goodfellow, Yoshua Bengio, Aaron Courville
3. Probabilistic graphical models principles and techniques", MIT Press Cambridge, Mass. 2012, Daphne Koller, Nir Friedman
4. Research Articles/Handouts will be provided in the class.

Course Title: Advanced Artificial Intelligence

Course Code: CSEC-717
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites:

Course Objectives:
This course will introduce the key principles in artificial intelligence. It will cover simple representation schemes, problem solving paradigms, constraint propagation, and search strategies. Areas of application such as knowledge representation, natural language processing, expert systems, vision and robotics will be explored. The Prolog programming language will also be introduced.

Course Syllabus:
Introduction to AI, Turing Test, Strong AI vs Weak AI, Heuristics, Applications and Methods,

History of AI. Uninformed Search: Search in IS, Genrate-and-Test Paradigm, Blind Search Algorithm. Informed Search: Heuristics, The Best-First Search, The Beam Search, The A* Search, The Bidirectional Search. Search Using Game: Game Trees and Minimum, Game Theory. Logic in AI: Logic and Representation, Propositional Logic, Predicate Logic, Other Logics. Knowledge Representation: Search Tree, Production System, Objects, Frames, Scripts & the Conceptual Dependency System, Semantic Networks, Recent Approaches, Agents. Prolog Programming. Production Systems: Strong Methods vs. Weak Methods, Production System and Inference Methods, Stochastic Processes and Markov Chain. [Uncertainty in AI: Fuzzy Sets, Fuzzy Logic, Fuzzy Inference, Probability Theory and Uncertainty. [Expert Systems: Characteristics of ES, Knowledge Engineering, Knowledge Acquisition, Classical ES, Case-Based Reasoning. Neural Networks: Introduction, The Perceptron Learning Rule, Back propagation, Discrete Hopfield Networks, Application Areas. Evolutionary Computation: Simulated Annealing, Genetic Algorithms, Genetic, Genetic Programming. Natural Language Processing: History of NLP, Syntax and Formal Grammars, Syntax and Formal Grammar, Statistical Parsing, Hidden Markov Model, Wordnet, Question Answering System. Automated Planning: Planning Terminology, Planning as Search, Hierarchical Planning, Case-Based Planning, Planning Approaches to Learning System. Advanced Computer Games: Rote Learning and Generalization, Signature Table and Book Learning , Programing Methods, Search in Machines

Course Outline:

1. Introduction: Turing Test, Strong AI vs Weak AI, Heuristics, Applications and Methods, History of AI. [TB: Ch. 1]
2. Uninformed Search: Search in IS, Genrate-and-Test Paradigm, Blind Search Algorithm. [TB: Ch. 2],
3. 3: Informed Search: Heuristics, The Best-First Search, The Beam Search, The A* Search, The Bidirectional Search. [TB: Ch. 3]
4. Search Using Game: Game Trees and Minimum, Game Theory. [TB: Ch. 4]
5. Logic in AI: Logic and Representation, Propositional Logic, Predicate Logic, Other Logics. [TB: Ch. 5]
6. Knowledge Representation: Search Tree, Production System, Objects, Frames, Scripts & the Conceptual Dependency System, Semantic Networks, Recent Approaches, Agents.
7. Prolog Programming [Online Resources]
8. Production Systems: Strong Methods vs. Weak Methods, Production System and Inference Methods, Stochastic Processes and Markov Chain. [TB: Ch. 7].
9. Uncertainty in AI:. Fuzzy Sets, Fuzzy Logic, Fuzzy Inference, Probability Theory and Uncertainty. [TB: Ch. 8]
10. Expert Systems: Characteristics of ES, Knowledge Engineering, Knowledge Acquisition, Classical ES, Case-Based Reasoning. [TB: Ch. 9].
11. Neural Networks: Introduction, The Perceptron Learning Rule, Back propagation, Discrete Hopfield Networks, Application Areas. [TB: Ch. 10]
12. Evolutionary Computation: Simulated Annealing, Genetic Algorithms, Genetic, Genetic Programming. [TB: CH. 11]
13. Natural Language Processing: History of NLP, Syntax and Formal Grammars, Syntax and Formal Grammar, Statistical Parsing, Hidden Markov Model, Wordnet, Question Answering System. [TB: Ch. 12]
14. Automated Planning: Planning Terminology, Planning as Search, Hierarchical Planning,

Case-Based Planning, Planning Approaches to Learning System.[TB: Ch. 13]

Reference Material

1. Artificial Intelligence in the 21st Century by Stephen Lucci by Danny Kopec, Mercury Learning and Information (May 18, 2012). ISBN-10: 1936420236
2. Artificial Intelligence: A Modern Approach, 2nd Edition, by Russell and Norvig, Prentice Hall
3. Artificial Intelligence: A Systems Approach by M. Tim Jones, Jones and Bartlett Publishers, Inc; 1st Edition (December 26, 2008). ISBN-10: 0763773379

Course Title: Advanced Human Computer Interaction

Course Code: CSEC-713
Credit Hours: 3
Prerequisite: Human Computer Interaction

Course Objective

This course provides an overview advanced topics of human-computer interaction, Moreover course introduces students to design thinking and the basic practices of interaction design. It will cover the importance of human-computer interaction/interface design, iterative design, input/output techniques, how to design and evaluate interfaces, and research topics. The aim is to identify the important research issues, and to ascertain potentially fruitful future research directions in relation to the multimodal emotion analysis and to human-computer interaction.

Course Syllabus

Accessibility and Assistive Technologies, Affective Interaction, Future Interfaces, Human Factors for Digital Health, Persuasive Games ,Physical Computing and Prototyping, Socio-technical Systems, interaction Design, Mobile and ubiquitous, Evaluation techniques, Programming of Interactive systems(user interfaces), User-Centered Design Methods, Situated interaction, User modeling, Multimodal interaction, Intelligent systems, Affective computing, Cognitive interaction, Software Architectures for User Interfaces

Recommended Books

1. *Interaction Design: Beyond Human-Computer* Interaction by Jenny Preece (Author), Helen Sharp (Author), Yvonne Rogers, Latest Edition.
2. Modern Statistical Methods for HCI, Robertson**,** Judy**,** Kaptein**,** Maurits Latest Edition
3. Handbook of Research on Human-Computer Interfaces, Developments, and Applications
4. João Rodrigues ,Pedro Cardoso Jânio Monteiro and Mauro Latest Edition.
5. *Affective Computing* (MIT Press) by Rosalind W. Picard
6. *Designing the User Interface: Strategies for Effective Human-Computer Interaction* , Latest Edition
7. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale**,** Human-Computer Interaction Latest Edition.

Course Title: Advanced Topics in Wireless Networks

Course Code: ITEC-707
Credit Hour: 3
Prerequisite: Computer Networks

Course Objectives:
The advent of wireless and wired networks convergence and as the Internet is increasingly becoming the tool for a wide range of technical, economical and industrial applications, resources management becomes very crucial and vital issue for any future networks. The objectives of this course are to focus on resource management and performance analysis in transporting multimedia traffic in wireless communication networks. Topics include: traffic characteristics, connection admission control, packet scheduling, access control, and mobility and handoff management.

Course Outline:
Introduction to Radio Resource Management for Wireless Networks, Resource Management for Circuit-Switched Services , Traffic Modeling , Access Control and Admission Control , Mobility Management and Handoff Management , MAC and Packet Transmission Scheduling , Resource Management in Ad Hoc Networks, Applications: Resource Management in Packet Access, CDMA2000 & WCDMA (i.e., UMTS) Systems, Qos and QoE, Internet of Things (IOT) ,WRAN and CRAN, Vehicular Adhoc Network

Recommended Books:

1. J. Zander and S.-L. Kim, Radio Resource Management for Wireless Networks, Artech House Publishers, latest Edition
2. S. Kyriazakos and G. Karesos, Practical Radio Resource Management in wireless networks, Latest Edition.
3. T. Janevski, Traffic Analysis and Design of Wireless IP Networks, Latest Edition Jamalipour, The Wireless Mobile Internet, Wiley, Latest Edition
4. M. Hassan and R. Jain, High Performance TCP/IP Networking, Latest Edition
5. T. S. Rappaport, Wireless communications, Principles and Practice, Latest Edition
6. M. Schwartz, Broadband Integrated Networks, Latest Edition

Course Title: Advanced Web Engineering

Course Code: CSEC-731
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course is aimed to provide students with conceptual understanding required to develop web applications and web services according to international standards**.**

Course Syllabus:
The Need for Web Engineering. Web Effort Estimation. Web Productivity Measurement and Benchmarking. Web Quality. Web Usability. Web System Reliability and Performance. Web Application Testing. Process Improvement in Small Settings. Conceptual Modeling of Web

Applications. Model-Based Web Application Development. W2000: A Modeling Notation for Complex Web Applications. Statistics Analysis. W3C Web Content Accessibility Guidelines. Internationalization. Classroom Group Assignements: Instructors are advised to ask students to review the Current Status of W3C Specifications: HTML, CSS, Best Practices for Authoring HTML, Web Fonts, SMIL, Media Access, Timed Text, SVG, Web Real Time Communication, Audio, Mobile Web Authoring, Device Independence Authoring, CSS Mobile, SVG Tiny, XHTML For Mobile, Mobile Web Applications, Mobile Web for Social Development, Geospatial, Accessible Rich Internet Applications (WAI-ARIA), DOM, DOM events, Declarative Web Applications, JavaScript APIs, Mobile Web Applications, WICD, Widgets, XBL, Web Components, Web Performance. [W3C website]

Course Outline:

1. The Need for Web Engineering: Introduction, Web Applications Versus Conventional Software, The Need for an Engineering Approach, Empirical Assessment [TB:Ch.1]
2. Web Effort Estimation: Introduction. Effort Estimation Techniques, Measuring Effort Prediction Power and Accuracy, Which Is the Most Accurate Prediction Technique? Case Study: Data Validation, Variables and Model Selection, Extraction of effort Equation Model Validation. [TB:Ch.2]
3. Web Productivity Measurement and Benchmarking: Introduction, Productivity Measurement Method, Case Study: Productivity Measure Construction, Productivity Analysis. [TB:Ch.3]
4. Web Quality: Different Perspectives of Quality, Evaluating Web Quality using WebQEM, Case Study: Evaluating the Quality of Two Web Applications: External Quality Requirements, Designing and Executing the Elementary Evaluation, Designing and Executing the Partial/Global Evaluation, Analysis and Recommendations. [TB:Ch.4]
5. Web Usability: Principles and Evaluation Methods: Introduction, Usability in the Software Lifecycle, Web Usability, Web Usability Criteria, Evaluation Methods, Automatic Tools To Support Evaluations, Evaluation of the DEI Application: Design Inspection, Web Usage Analysis.[TB:Ch. 5]
6. Web System Reliability and Performance: Introduction, Web Application Services, Applications Predominantly Dynamic, Testing Loop Phase, Performance Improvements, Case Study: Service Characterization and Design, Testing Loop Phase, System Consolidation and Performance Improvement. [TB:Ch.6]
7. Web Application Testing: Introduction, Web Application Testing: Challenges and Perspectives, Web Application Representation Models, Unit Integration and System Testing of a Web Application, Strategies for Web Application Testing, Tools for Web Application Testing. [TB:Ch.7]
8. An Overview of Process Improvement in Small Settings: Initiating SPI Efforts, Process Improvement Cycle, Process Assessments, Implementation in Small Settings. [TB:Ch.8]
9. Conceptual Modeling of Web Applications: The OOWS Approach: Introduction, A Method to Model Web Applications, A Strategy To Develop the Web Solution, Case Study: *Valencia CF Web Application.* [TB:Ch.9]
10. Model-Based Web Application Development: The OOHDM approach, Building an Online CD Store with OOHDM, From Design to Implementation, Discussion and Lessons Learned. [TB:Ch.10]

11. W2000: A Modeling Notation for Complex Web Applications: Introduction, Modeling Elements, Models, Example Application: Information Model, Navigation Model, Presentation Model, 4 Service Model. [TB:Ch.11]
12. Statistics Analysis: Describing Individual Variables, Types of Variables, Descriptive Statistics, The Normal Distribution, Overview of Sampling Theory, Other Probability Distributions, Identifying Relationships in the Data: Chi-Square Test for Independence, Correlation Analysis, Regression Analysis Analysis of Variance (ANOVA), Comparing Two Estimation Models. [TB:Ch.12]
13. W3C Web Content Accessibility Guidelines: Introduction to Web Accessibility, Essential Components of Web Accessibility, How People with Disabilities Use the Web, Improving the Accessibility of Your Web Site, Managing Accessibility, Evaluating Web Accessibility. Standards, guidelines, and techniques for making accessible websites: WCAG, ATAG, UAAG, WAI-ARIA. [W3C website]
14. Internationalization: Internationalization of Web Design and Applications, Internationalization of Web Architecture, Internationalization of XML, Internationalization of Web Services. [W3C website]

Classroom Group Assignments: Instructors are advised to ask students to review the Current Status of W3C Specifications: HTML, CSS, Best Practices for Authoring HTML, Web Fonts, SMIL, Media Access, Timed Text, SVG, Web Real Time Communication, Audio, Mobile Web Authoring, Device Independence Authoring, CSS Mobile, SVG Tiny, XHTML For Mobile, Mobile Web Applications, Mobile Web for Social Development, Geospatial, Accessible Rich Internet Applications (WAI-ARIA), DOM, DOM events, Declarative Web Applications, JavaScript APIs, Mobile Web Applications, WICD, Widgets, XBL, Web Components, Web Performance. [W3C website]

Reference Material:

1. Web Engineering: A Practioner's Approach by Roger Pressman and David Lowe, McGraw-Hill Science/Engineering/Math; 1st Edition (January 22, 2008). ISBN-10: 0073523291
2. Web Engineering by Emilia Mendes and Nile Mosley, Springer; Softcover reprint of hardcover 1st Edition. 2006 edition (November 9, 2010). ISBN-10: 3642066453
3. W3C Online Resources

Course Title: Agent Based Modeling

Course Code: CSEC-708
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Introduction to agent based modeling. Introduction to Net Logo. Complexity in Social Worlds. Net Logo Commands. Net Logo Procedures. Model properties (Why agent-based objects?, Agents, environments, and timescales).Biological systems: fireflies, flocking, slime mold, bees, ants (flocking behavior slime mold).Biological systems: predator/prey, debugging (Verification

and validation).Social systems: segregation, Schelling, Micro motives and Macro behavior. A self-forming neighborhood model. Cellular automata. Critical phenomena. Sand piles. Current research topics in Agent Based Modeling.

Reference Material:

1. Agent-Based Models, Nigel Gilbert, SAGE Publications, 2008

Course Title: Business Process Management Trends & Technologies

Course Code: ITEC-710
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course will cover topics fundamentals and principles of Business Process Management. The course is designed to achieve following objectives:

1. Understand the key terms and concepts in BPM
2. Learn the major methodologies and techniques for implementing BPM
3. Discover the various technologies that support BPM
4. Learn what a BPM management and process-centric organization is and how it
5. works
6. Understand the metrics and measurements critical to managing processes
7. Learn how to identify critical processes

Course Syllabus:

Introduction d BPM, Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. Evolution of Enterprise Systems Architectures. Business Process Modeling. Process Orchestrations. Process Choreographies. .Modeling in BPMN. Properties of Business Processes. Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes. Business Process Management Methodology. Business Process Management Technologies.

Course Outline:

1. Introduction: Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization.
2. Evolution of Enterprise Systems Architectures: Traditional Application Development, Enterprise Applications and their Integration, Enterprise Modeling and Process Orientation, Workflow Management, Enterprise Services Computing.
3. Business Process Modeling: Foundation, Conceptual Model and Terminology, Abstraction Concepts, From Business Functions to Business Processes, Activity Models and Activity Instances, Process Models and Process Instances, Process Interactions, Modeling Process Data, Modeling Organization, Modeling Operation, Business Process Flexibility**,** Architecture of Process Execution Environments.
4. Process Orchestrations: Control Flow Patterns, Petri Nets, Event-driven Process Chains, Workflow Nets, Graph-Based Workflow Language, Business Process Model and

Notation.

5. Process Choreographies: Motivation and Terminology, Development Phases, Process Choreography Design, Process Choreography Implementation, Service Interaction Patterns, Choreography Modeling in BPMN.
6. Properties of Business Processes: Data Dependencies, Object Lifecycle Conformance, Structural Soundness, Soundness, Relaxed Soundness, Weak Soundness, Lazy Soundness, Soundness Criteria Overview.
7. Business Process Management Architectures: Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes: Case Handling.
8. Business Process Management Methodology: Dependencies between Processes, Methodology Overview, Phases in Detail.
9. Business Modeling Specifications
10. Six Sigma and Lean
11. BPM Implementation and Governance
12. BPM Technology (BPM Suites)

Reference Material:

1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2ndEdition(May 3, 2012). ISBN-10: 3642286151.
2. Business Process Management Common Body Of Knowledge by Yvonne Lederer Antonucci, et. al., CreateSpace Independent Publishing Platform (March 8, 2009). ISBN-10: 1442105666
3. Business Process Change: A Guide for Business Managers and BPM and Six Sigma by Paul Harmon (2007) Professionals (2nd edition). Morgan Kaufmann Publishers.
4. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Edition (January 21, 2011). ISBN-10: 3642151892
5. Business Process Management, 2nd Edition: Practical Guidelines to Successful Implementations by John Jeston and Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
6. Process Management: Practical Guidelines to Successful Implementation by T.S. Malik, Global India Publications Pvt Ltd; 1st Edition (December 31, 2009). ISBN-10: 9380228368
7. Business Process Management: Practical Guidelines to Successful Implementations by John Jeston & Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
8. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody-Cassidy Press (October 17, 2011). ISBN-10: 0982368119
9. Workflow Modeling: Tools for Process Improvement and Application Development, 2nd Edition by Alec Sharp and Patrick McDermott, Artech House; 2nd Edition (October 31, 2008). ISBN-10: 1596931922
10. Process Analysis and Improvement: Tools and Techniques by Seppanen, Marvic S., Kumar, Sameer & Chandra, Charu (2005). McGraw-Hill
11. Business Process Change: A Guide for Business Managers and BPM and Six Sigma

Professionals (The MK/OMG Press) by Paul Harmon and Business Process Trends, Morgan Kaufmann; 2nd Edition (July 27, 2007). ISBN-10: 0123741521

Course Title: Computer Vision

Course Code: CSEC-722
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: Linear Algebra

Course Objectives:
The course concentrates on the knowledge of Computer Vision and its importance in Computing area having multiple applications.

Course Syllabus:
Introduction to Computer Vision, Image formation, Processing, Feature Detection and Matching, Alignment, Image Stitching, Dense Motion Estimation, Structure from Motion, Recognition, Computational Photography, Stereo Correspondence, 3D Reconstruction, Image-based Rendering, Statistical Texture Description, Methods Based on Spatial Frequencies, Laws' Texture Energy Measures, Texture Recognition Method Applications.

Course Syllabus:
1. Computer Vision an Introduction.
2. Image formation.
3. Image Processing.
4. Feature Detection and Matching.
5. Feature-based Alignment.
6. Image Stitching.
7. Dense Motion Estimation.
8. Structure from Motion.
9. Recognition.
10. Computational Photography.
11. Stereo Correspondence.
12. 3D Reconstruction.
13. Image-based Rendering.
14. Statistical Texture Description, Methods Based on Spatial Frequencies, Co-occurrence Matrices, Edge Frequency, Primitive Length (Run Length).
15. Laws' Texture Energy Measures, Fractal Texture Description, Multiscale Texture Description – Wavelet Domain Approaches, other Statistical Methods of Texture Description, Syntactic Texture Description Methods, Shape Chain Grammars, Graph Grammars, Primitive Grouping in Hierarchical Textures, Hybrid Texture Description methods, Texture Recognition Method Applications.

Reference Material:
1. Computer Vision Algorithms and Applications by Richard Szeliski, Springer, (2011), ISBN-13: 978-1848829343
2. Image Processing, Analysis, and Machine Vision by Milan Sonka, CL Engineering, 3rd

Edition, (2008), ISBN-13: 9780495082521
3. Computer Vision: Models, Learning, and Inference by Dr Simon J. D. Prince, Cambridge University Press, (2012), ISBN-13: 978-1107011793

Course Title: Enterprise Data Center Design and Methodology

Course Code: ITEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course is aimed to introduce students with the essential knowledge about Data Center and methodologies that optimizes availability, scalability, and performance for that environment and provides centralized management services.

Course Syllabus:
Introduction to Data Centers, Application Architecture Models, Data Center Architecture, Data Center Services. Data Center Requirements. **S**erver Architecture. Application Architectures. Data Center Design. Network Infrastructure. Power Distribution. **D**ata Center Security. Server Load-Balancing. Designing the Data Center Infrastructure. Integrating Security into the Infrastructure. Server Performance Metrics. Server Capacity Planning. Performance Metrics of Data Center Devices.

Course Outline:
1. Overview of Data Centers: Introduction to Data Centers, Application Architecture Models, Data Center Architecture, Data Center Services.
2. Data Center Requirements: Data Center Pre-requisites, Budget Constraints, Selecting Geographical Location, Retrofitting.
3. Server Architecture: Network Attachment, Client and Server Packet Processing, TCP and Server Applications, UDP and Server Applications, Server Availability, Configuring a Web Server, Network Architecture Design Options.
4. Application Architectures: Taxonomy of Applications and Hosted Servers, Integration of Applications, Multitier Applications, Network Architecture Considerations, Multitier Design.
5. Data Center Design: Characteristics of an Outstanding Design, Guidelines for Planning a Data Center, Types of Server Farms and Data Centers, Data Center Topologies, Fully Redundant Layer 2 and Layer 3 Designs, Fully Redundant Layer 2 and Layer 3 Designs with Services, Design and Plan against Vandlism, Data Center Case Studies.
6. Network Infrastructure: Modular Cabling Design, Points of Distribution, Internet Access, Best Practices.
7. Power Distribution: Estimating Power Needs, UPS, Generators, UPDs, ESD.
8. Data Center Security: The Need for a Secure Data Center, Vulnerabilities and Common Attacks, Network Security Infrastructure, Security Fundamentals, Data Center Security Framework.
9. Server Load-Balancing: Introduction to Load Balancing, Key Concepts of Load Balancing, Redundancy Protocol, Connection and Session State Failover, Generic Load Balancer

Architecture.

10. Designing the Data Center Infrastructure: Topology Overview, Switching Paths, Using VLANs to Virtualize the Physical Data Center Infrastructure, Link Redundancy and Load Distribution, Spanning-Tree Considerations, Internal Redundancy Considerations, Over view of Layer 2 & Layer 3 Data Center Design refrence to Infrastucture, Using OSPF in Data Center Design, Using EIGRP in Data Center Design, Layer 3 Configuration.
11. Integrating Security into the Infrastructure: Defining Security Zones, Internet Edge, Campus Core, Intranet Server Farms, Server-Farm Design Alternatives, Management Network.
12. Server Performance Metrics: Benchmarking, Aspects of System Performance, Factors Impacting CPU Performance, SPEC Benchmarking.
13. Server Capacity Planning: Server Sizing and Capacity Planning, Identifying the Slowest Link, Capacity Planning for Servers.
14. Performance Metrics of Data Center Devices: Traffic Patterns Overview, Performance Metrics Overview, Load Balancer and SSL Offloader Metrics.
15. Best Practices in IT: Defining Best Practices, Deploying Best Practices, Benefits of BP, Systems Management BP, Servers Cluster BP, Data Storage BP, Network Management BP, Documentation Best Practices.

Reference Material:

1. Data Center Fundamentals by Mauricio Arregoces and Maurizio Portolani, Cisco Press (December 14, 2003). ISBN-10: 1587050234
2. Administering Data Centers: Servers, Storage, and Voice over IP by Kailash Jayaswal, Wiley; 1st Edition (November 28, 2005). ISBN-10: 047177183X
3. The Datacenter as a Computer: An Introduction to the Design of Warehouse-Scale Machines by Urs Hoelzle and Luiz Andre Barroso, Morgan and Claypool Publishers; 1st Edition (May 29, 2009).ISBN-10: 159829556X

Course Title: Information Security

Course Code: ITEC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Introduction to Information Security, The Need for Security, Legal, Ethical, and Professional Issues in Information Security, Risk Management, Planning for Security, Security Technology, Security Technology, Cryptography, Physical Security, Implementing Information Security, Security and Personnel, Information Security Maintenance and eDiscovery.

Course Outline:

1. Introduction to Information Security: History of IS, What is Security, CNSS Security model, Component of Information Systems, Balancing Information Security and Access, Approaches to Information Security Implementation, The Security System Development Life Cycle, Security Professionals and the Organizations, Communities of Interest.
2. The Need for Security: Business Need, Threats, Attacks, Secure Software Development.
3. Legal, Ethical, and Professional Issues in Information Security: Laws and Ethics in

Information Security, International Laws and Legal Bodies, Ethics and Information Security, Codes of Ethics and Professional Organizations, International Agencies.

4. Risk Management: Introduction to RM, Risk Identification, Risk assessment, Risk Control Strategies, Selecting a risk Control Strategy, Quantitative VS qualitative Risk Control Practices, Risk Control Practices.
5. Planning for Security: Information Security Planning and Governance, Information Security Policies, Standards, and Governance, Information Security Blue Prints, Continuity Strategies.
6. Security Technology: Firewalls, VPNs, and Wireless: Access Control, Firewalls, Protecting Remote Connections.
7. Security Technology: Intrusion Detection and Prevention Systems and Other Security Tools: Intrusion Detection and Presentation Systems, Honeyspots, Honeynets, and Padded Cell Systems, Scanning and Analysis Tools, Biometric Access Control.
8. Cryptography: Foundations of Cryptography, Cipher Methods, Cryptographic Algorithms, Cryptography Tools, Protocols for secure Communications, Attack on Cryptosystems.
9. Physical Security: Physical Access Controls, Fire Security and Safety, Failure of Supporting Utilities and Structural Collapse, Interception of Data, Considerations for Physical Security.
10. Implementing Information Security: Information Security Project Management, Technical Aspects of Implementation, Nontechnical Aspects of Implementation, Information Security Certifications.
11. Security and Personnel: Positioning and Staffing Function, Credentials of Information Security Professionals, Employment Policies and Practices, Security Considerations for Non-employees.
12. Information Security Maintenance and eDiscovery: Security Management Maintenance Models, Digital Forensics.

[Instructors need to devise a contents delivery plan]

Reference Material:

1. Principles of Information Security Michael E. Whitman and Herbert J. Mattord, Course Technology; 4th Edition (January 1, 2011). ISBN-10: 1111138214
2. Information Systems Security Professional Study Guide by James M. Stewart, Mike Chapple, and Darril Gibson, Sybex; 6th Edition (July 10, 2012). ISBN-10: 1118314174
3. Information Security: An Integrated Collection of Essays by Marshall D. Abrams, Harold J. Podell, Sushil Jajodia, Ieee Computer Society (September 1994). ISBN-10: 0818636610
4. Secrets and Lies: Digital Security in a Networked World by Bruce Schneier, Wiley; 1st Edition (January 30, 2004).
5. Information Security Management Handbook By Harold F. Tipton, Micki Krause, Auerbach Publications; 6th Edition (March 17, 2008). ISBN-10: 1420067087

Course Title: Information Theory

Course Code: CSEC-725
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:
The course will introduce students with key concepts of Information Theory.

Course Syllabus:
Information Sources. Pair Processes. Block Independent Channels. Entropy. The Entropy Ergodic Theorem. Distortion and Approximation. Approximating Random Vectors and Processes. Distortion and Entropy. Relative Entropy. Information Rates. Distortion and Information. Ergodic Theorems for Densities. Source Coding Theorems. Asynchronous Block Codes, Sliding-Block Source Codes, Geometric Interpretation, Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Course Outline:
1. Information Sources: Probability Spaces and Random Variables, Random Processes and Dynamical Systems, Distributions, Standard Alphabets, Expectation, Asymptotic Mean Stationarity, Ergodic Properties.
2. Pair Processes: Channels, Codes, and Couplings, Pair Processes, Channels, Stationarity Properties of Channels, Extremes: Noiseless and Completely Random Channels, Deterministic Channels and Sequence Coders, Stationary and Sliding-Block Codes, Block Codes, Random Punctuation Sequences, Memoryless Channels, Finite-Memory Channels, Output Mixing Channels.
3. Block Independent Channels, Conditionally Block Independent Channels, Stationarizing Block Independent Channels, Primitive Channels, Additive Noise Channels, Markov Channels, Finite-State Channels and Codes, Cascade Channels, Communication Systems, Couplings, Block to Sliding-Block: The Rohlin-Kakutani Theorem.
4. Entropy: Entropy and Entropy Rate, Divergence Inequality and Relative Entropy, Basic Properties of Entropy, Entropy Rate, Relative Entropy Rate, Conditional Entropy and Mutual Information, Markov Approximations, Relative Entropy Densities.
5. The Entropy Ergodic Theorem: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, The Asymptotic Equipartition Property.
6. Distortion and Approximation: Distortion Measures, Fidelity Criteria, Average Limiting Distortion, Communications Systems Performance, Optimal Performance, Code Approximation.
7. Approximating Random Vectors and Processes, The Monge/Kantorovich/Vasershtein Distance. Variation and Distribution Distance, Coupling Discrete Spaces with the Hamming Distance, Process Distance and Approximation, Source Approximation and Codes, d-bar Continuous Channels.
8. Distortion and Entropy: The Fano Inequality, Code Approximation and Entropy Rate, Pinsker's and Marton's Inequalities, Entropy and Isomorphism, Almost Lossless Source Coding, Asymptotically Optimal Almost Lossless Codes, Contents xv, Modeling and

Simulation.

9. Relative Entropy: Divergence, Conditional Relative Entropy, Limiting Entropy Densities, Information for General Alphabets, Convergence Results.
10. Information Rates: Information Rates for Finite Alphabets, Information Rates for General Alphabets, A Mean Ergodic Theorem for Densities, Information Rates of Stationary Processes, The Data Processing Theorem, Memoryless Channels and Sources,
11. Distortion and Information: The Shannon Distortion-Rate Function, Basic Properties, Process Definitions of the Distortion-Rate Function, The Distortion-Rate Function as a Lower Bound, Evaluating the Rate-Distortion Function.
12. Ergodic Theorems for Densities: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, Ergodic Theorems for Information Densities.
13. Source Coding Theorems:Source Coding and Channel Coding, Block Source Codes for AMS Sources, Block Source Code Mismatch, Block Coding Stationary Sources, Block Coding AMS Ergodic Sources Subadditive Fidelity Criteria.
14. Asynchronous Block Codes, Sliding-Block Source Codes, Geometric Interpretation, Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Reference Material:

1. Entropy and Information Theory by Robert M. Gray, Springer; 2nd Edition. Edition (February 3, 2011). ISBN-10: 1441979697
2. Information and Coding Theory by Gareth A. Jones, J.Mary Jones, Springer; 2000 Edition (July 31, 2000). ISBN-10: 1852336226
3. Information Theory And Evolution by John Scales Avery, World Scientific Publishing Company; 2nd Edition (July 16, 2012). ISBN-10: 9814401234
4. Elements of Information Theory by Thomas M. Cover, Joy A. Thomas, Wiley-Interscience; 2nd Edition (July 18, 2006). ISBN: 0-471-24195-4

Course Title: Intelligent Multi Agent Systems

Course Code: CSEC-736
Course Structure: Lectures: 3/Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Intelligent Multi Agent Systems is an important area having multiple applications in Computing. The course will introduce students with key concepts and knowledge of Intelligent Multi Agent Systems.

Course Syllabus:

Basics of Intelligent Agents, Multi agent Systems, Agent Interaction Protocols, Distributed Problem Solving & Planning, Distributed Planning, Search Algorithm for Agents, Distributed Rational Decision Making, Learning in Multi agent Systems, Computational Organization Theory, Formal Methods in Distributed Artificial Intelligence (DAI), Industrial and Practical Applications of DAI, Design: The Conceptual Context, The Process, System Implementation, System Operation, Development Tools. Groupware and Computer Supported Cooperative Work.

Distributed Models for Decision Support.Concurrent Programming for DAI.

Course Outline:

1. Intelligent Agents: What are Agents, Intelligent Agents, Agents& Expert Systems, Abstract Architecture for Intelligent Agents, Concrete Architecture for Intelligent Agents, Agent Programming, METATEM Multi Agent systems.
2. Multi agent Systems: Characteristics of Multi agent Environment, Agent Communications, Knowledge Query & Implementation Language (KQML), Knowledge Interchange Format (KIF), Ontologies.
3. Agent Interaction Protocols: Coordination & Cooperation Protocol, Contract-net, blackboard systems, Multi agent belief Maintenance, Market Mechanism.
4. Distributed Problem Solving & Planning: Task Structure, Task Sharing, Result Sharing.
5. Distributed Planning: Centralized Planning for Distributed Plan, Distributed Planning for Centralized Plans, Distributed Planning for Distributed Plans, Distribution Plan Representation & Execution.
6. Search Algorithm for Agents: Filtering Algorithm, Hyper Resolution Based Consistency Algorithm, Asynchronous Backtracking & Weak Commitment Search, Path Finding Problem: Asynchronous Dynamic Programming, A*, Moving Target Search, Real Time Bidirectional Search, Real Time Multi Agent System.
7. Distributed Rational Decision Making: Evaluation Criteria, Voting, Auctions, Bargaining, General Equilibrium Market Mechanism, Contract Nets, Coalition Formation.
8. Learning in Multi agent Systems: General Characterization, Learning & Activity Coordination, Learning About & From Other Agents, Learning & Communication.
9. Computational Organization Theory: Organization, Computational Organization Theory, Modeling Organizations Concepts, Agent and Agency, Organizational Design, Task, Technology, Dynamics, Methodological Issues: Virtual Experiments and Data Collection, Validation and Verification, Computational Frameworks.
10. Formal Methods in DAI (Distributed Artificial Intelligence): Logic-Based Representation and Reasoning, Cognitive Primitives, BDI Implementations: Coordination, Communications; Social Primitive; Tools and Systems: Direct Implementations & Partial Implementations, Traditional Approaches.
11. Industrial and Practical Applications of DAI: Overview of the Industrial Life-Cycle, Use of Agents in the Life Cycle, Agents in Product Design, Agents in Planning and Scheduling, Agents in Real-Time Control, Industry Constrains in the Life Cycle of an Agent-Based System: Requirements, Positioning, and Specification, Design: The Conceptual Context, Design: The Process, System Implementation, System Operation, Development Tools.
12. Groupware and Computer Supported Cooperative Work: Groupware, Computer Supported Cooperative Work, Aspects of Groupware, Keepers, Coordinators, Communicators, Team-Agents, Agent Models, Multi-Aspect Groupware, Social and Group Issues in Designing Groupware Systems, Supporting Technologies and Theories, Keepers, Coordinators, Communicators, Team-Agents, Other Taxonomies of Groupware, Space/Time Matrix, Application Area, Groupware and Internet, Internet as Infrastructure Internet as Presumed Software.
13. Distributed Models for Decision Support: Decision Support Systems, The Decision Support Problem, Knowledge-Based Decision Support, Distributed Decision Support

Models, An Agent Architecture for Distributed Decision Support Systems, Information Model, Knowledge Model, Control Model, Application Case Studies, Environmental Emergency Management, Energy Management, Road Traffic Management.

14. Concurrent Programming for DAI: Defining Multi-agent Systems, Actors, Semantics of Actors, Equivalence of Actor Systems, Actors and Concurrent Programming, Representing Agents as Actors, Mobility of Actors, Resource Model, Agent Ensembles, Customizing Execution Contexts, Interaction Protocols, Coordination, Naming and Groups.

Reference Material:

1. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence by Gerhard Weiss, The MIT Press (July 31, 2000). ISBN-10: 0262731312
2. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
3. Intelligent Software Agents: Foundations and Applications by Walter Brenner, RüdigerZarnekow, Hartmut Wittig and A.S. Rudd, Springer; Softcover reprint of the original 1st Edition (July 31, 2012). ISBN-10: 3642804861
4. Agent Technology for E-Commerce by Maria Fasli, Wiley; 1st Edition (March 6, 2007). ISBN-10: 0470030305

Course Title: Knowledge Management Systems & Technologies

Course Code: ITEC-708
Course Structure: Lectures:3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

By the end of the course, students should be able to:

- Appraise current thought on knowledge management in the light of contemporary debates on knowledge productivity, strategic capability and organizational learning;
- Apply theories of knowledge management relevant to current workplace practice;
- Apply the tools and techniques of knowledge management.

Course Syllabus:

History and paradigms of knowledge management. Types of knowledge. Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents. Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies. KM Processes: Discovery/ Detection, Capture and Codification, Organization, Sharing, transfer, Acquisition, Verification, Utilization, Creation, Reuse. KM Frameworks and Models. KM Frameworks and Models. Knowledge Capture and Codification. Knowledge Codification. Knowledge Taxonomies. Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence. Strategic and Practical Implications of Knowledge Capture and Codification. Knowledge Sharing and Communities of Practice. Knowledge Application. The Role of Organizational Culture. Knowledge Management Tools. Knowledge Management Strategy. The Value of Knowledge Management. Organizational Learning and Organizational Memory. The

KM Team. The KM Profession, The Ethics of KM.

Course Outline:

1. History and paradigms of knowledge management; Types of knowledge: Explicit Knowledge, Tacit Knowledge, Embedded Knowledge, Embrained knowledge, Embodied knowledge, Encoded knowledge, Encultured knowledge; Organizational Internal & External Knowledge; Managers' Knowledge; Personal knowledge. Knowledge Economy: Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents; Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies.
2. KM Processes: Knowledge Discovery/ Detection, Knowledge Capture and Codification, Knowledge Organization, Knowledge Sharing, Explicit Knowledge Sharing, Knowledge transfer, Knowledge Acquisition, Knowledge Verification, Knowledge Utilization, Knowledge Creation, Knowledge Reuse;
3. KM Frameworks and Models: The SECI Model, Alen Frost's Model, Boisot's KM Model, Hedlund's KM Model, Earl's KM Model, Carayannis's KM Model, Wiig's KM Model, Edvinsson's Model of Intellectual Capital, Snowden's KM Model, Inkpen & Dinur's KM Model.
4. KM Frameworks and Models: Van Buren's Model of IC Management, Bukowitz & Williams's KM Model, Gamble & Blackwell's KM Model, Demerest's KM Model, Frid's KM Model, Stankosky & Baldanza's KM Framework, Kogut & Zander's KM Model, Botha et. al. KM Model, Integrated Knowledge Management Model.
5. Knowledge Capture and Codification: Tacit Knowledge Capture at the Individual, Group, and Organizational Levels, xplicit Knowledge Codification, Cognitive Maps, Decision Trees, Knowledge Taxonomies, The Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence; Strategic and Practical Implications of Knowledge Capture and Codification
6. Knowledge Sharing and Communities of Practice: Sociograms and Social Network Analysis, Knowledge-Sharing Communities, Types of Communities, Roles and Responsibilities in CoPs, Knowledge Sharing in Virtual CoPs, Obstacles to Knowledge Sharing, Strategic and Practical Implications of Knowledge Sharing.
7. Knowledge Application: Knowledge Application at the Individual Level, Characteristics of Individual Knowledge Workers, Bloom ' s Taxonomy of Learning Objectives, Task Analysis and Modeling, Knowledge Application at the Group and Organizational Levels, Knowledge Reuse, Knowledge Repositories, E-Learning and Knowledge Management Application, Strategic & Practical Implications of Knowledge Application.
8. The Role of Organizational Culture: Different Types of Cultures, Organizational Culture Analysis, The Effects of Culture on Individuals, Organizational Maturity Models, KM Maturity Models, CoP Maturity Models, Transformation to a Knowledge-Sharing Culture, Impact of a Merger on Culture, Impact of Virtualization on Culture, Strategic and Practical Implications of Organizational Culture.
9. Knowledge Management Tools: Knowledge Capture and Creation Tools, Content Creation Tools, Data Mining and Knowledge Discovery, Blogs, Mashups, Content Management Tools, Folksonomies and Social Tagging/Bookmarking, Personal Knowledge Management (PKM), Knowledge Sharing and Dissemination Tools, Groupware and Collaboration Tools, Wikis, Social Networking, Web 2.0, and KM 2.0, Knowledge Acquisition and Application

Tools, Intelligent Filtering Tools, Adaptive Technologies, Strategic and Practical Implications of KM Tools and Techniques.

10. Knowledge Management Strategy: Developing a Knowledge Management Strategy, Knowledge Audit, Gap Analysis, The KM Strategy Road Map, Balancing Innovation and Organizational Structure, Types of Knowledge Assets Produced.
11. The Value of Knowledge Management: KM Return on Investment (ROI) and Metrics, The Benchmarking Method, The Balanced Scorecard Method, The House of Quality Method, The Results-Based Assessment Framework, Measuring the Success of Communities of Practice.
12. Organizational Learning and Organizational Memory: How Do Organizations Learn and Remember? Frameworks to Assess Organizational Learning and Organizational Memory, The Management of Organizational Memory, Organizational Learning, The Lessons Learned Process, Organizational Learning and Organizational Memory Models, A Three-Tiered Approach to Knowledge Continuity.
13. The KM Team: Major Categories of KM Roles, Senior Management Roles, KM Roles and Responsibilities within Organizations, The KM Profession, The Ethics of KM.

Reference Material:

1. Essentials of Knowledge Management: Concepts, Theories and Practices by M. A. Pasha & S. Pasha, Innovators Knowledge Services (2012). ISBN:978-969-9791-04-8
2. Knowledge Management In Theory And Practice by Kimiz Dalkir, The MIT Press; 3rd Edition (March 4, 2011). ISBN-10: 0262015080
3. The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms by Amrit Tiwana, Prentice Hall; 2nd Edition (August 29, 2002). ISBN-10: 013009224X
4. Principles of Knowledge Management: Theory, Practice and Cases by Elie Geisler and Nilmini Wickramasinghe, M.E.Sharpe (January 15, 2009). ISBN-10: 0765613220
5. Knowledge Management: Concepts, Methodologies, Tools and Applications (6-volume set) by Murray E. Jennex, IGI Global; Reprint edition (August 10, 2007). ISBN-10: 1599049333

Course Title: Multimedia Systems Theory & Principles

Course Code: CSEC-716
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course introduces students with theory and principles of multimedia contents constituting multimedia system.

Course Syllabus:

Introduction to Multimedia and Tools, Graphics and Image Data Representations, Color in Image and Video, Basics of Digital Audio, Lossless Compression Algorithms, Lossy Compression Algorithms, Image Compression Standards, Basic Video Compression Techniques, MPEG Video Coding MPEG-1, 2, 4-7; Basic Audio Compression Techniques, MPEG Audio Compression.

Course Outline:

1. Introduction to Multimedia: What is Multimedia? Multimedia and Hypermedia, Overview of Multimedia Software Tools. [TB1: Ch. 1]
2. Graphics and Image Data Representations: Graphics/Image Data Types, Popular File Formats. [TB1: Ch. 3]
3. Color in Image and Video: Color Science, Color Models in Images, Color Models in Video Fundamental Concepts in Video: Types of Video Signals, Analog Video, Digital Video. [TB1: Ch. 4, 5]
4. Basics of Digital Audio: Digitization of Sound, MIDI: Musical Instrument Digital Interface, Quantization and Transmission of Audio. [TB1: Ch. 6]
5. Lossless Compression Algorithms: Introduction, Basics of Information Theory, Run-Length Coding, Variable-Length Coding (VLC), Dictionary-Based Coding, Arithmetic Coding, Lossless Image Compression. [TB1: Ch. 7]
6. Lossy Compression Algorithms: Distortion Measures, The Rate-Distortion Theory, Quantization, Transform Coding, Wavelet-Based Coding, Wavelet Packets. [TB1: Ch. 8]
7. Image Compression Standards: The JPEG Standard, The JPEG2000 Standard, The JPEG-LS Standard. [TB1: Ch. 9]
8. Basic Video Compression Techniques: Introduction to Video Compression, Video Compression Based on Motion Compensation, Search for Motion Vectors, H.261, H.263. [TB1: Ch. 10]
9. MPEG Video Coding MPEG-1 and 2. [TB1: Ch. 11]
10. MPEG Video Coding MPEG-4, 7. [TB1: Ch. 12]
11. Basic Audio Compression Techniques: ADPCM in Speech Coding, G.726 ADPCM, Vocoders. [TB1: Ch. 13]
12. MPEG Audio Compression: Psychoacoustics, MPEG Audio. [TB1: Ch. 13]

Reference Material:

1. Fundamentals of Multimedia by Z. M. Li and M. S. Drew, Prentice Hall (2004), ISBN: 0-13-127256-X
2. Digital Multimedia by N. Chapman and J. Chapman. 2nd Edition, Wiley 2004, ISBN: 0-470-85890-7
3. The Technology of Video and Audio Streaming by David Austerberry, Focal Press; 2nd Edition (2004). ISBN-10: 0240805801
4. Multimedia Security: WaTermarking, Steganography, and Forensics by Frank Y. Shih, CRC Press; 1st Edition (2012), ISBN-10: 1439873313
5. Multimedia Computing by Daniel Cunliffe and Geoff Elliott, Lexden Publishing Ltd (2005). ISBN-10: 1904995055
6. Multimedia Foundations: Core Concepts for Digital Design by Vic Costello, Ed Youngblood and Susan Youngblood, Focal Press; 1st Edition (2012). ISBN-10: 0240813944

Course Title: Natural Language Processing

Course Code: CSEC-720
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Objective:
Natural language processing (NLP) is one of the most important technologies of the information age. Understanding complex language utterances is also a crucial part of artificial intelligence. Applications of NLP are everywhere because people communicate most everything in language: web search, advertisement, emails, customer service, language translation, radiology reports, etc. There are a large variety of underlying tasks and machine learning models behind NLP applications. Upon completing, you will be able to recognize NLP tasks in your day-to-day work, propose approaches, and judge what techniques are likely to work well. This course will cover the fundamental concepts in NLP.

Course Syllabus:
This course covers a range of topics in computational linguistics/natural language processing, including its introduction to Regular Expressions, Text Normalization, Edit Distance, N- gram Language Models, Naive Bayes and Sentiment Classification, Logistic Regression,
Vector Semantics, Neural Networks and Neural Language Models, Part-of-Speech Tagging,
Sequence Processing with Recurrent Networks, Formal Grammars of English/Urdu, Syntactic Parsing, etc.

Course Outline:
1. Introduction [TB1, Ch. 1]
2. Regular Expressions, Text Normalization, and Edit Distance: Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance, etc. [TB1, Ch. 2]
3. N-gram Language Models: N Grams, Evaluating Language Models, Generalization and Zeros, Smoothing, etc. [TB1, Ch.3]
4. Naive Bayes and Sentiment Classification: Naïve Bayes Classifiers and their training with examples, Its optimization for sentiment analysis and for other text classification, etc. [TB1, Ch.4]
5. Logistic Regression: Classification: The sigmoid; Learning in Logistics Regression; The Cross
   Entropy loss function; Gradient Descent, Regularization, etc. [TB1, Ch. 5]
6. Vector Semantics: Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF Weighting terms in the vector, etc. [TB1, Ch. 6]
7. Neural Networks and Neural Language Models: Units, The XOR problem, Feed Forward Neural Network, Training Neural Nets, etc. [TB1, Ch. 7]
8. Part-of-Speech Tagging: Word Classes, Penn POS Tagset, POS Tagging, HMM POS Tagging, etc. [TB1, Ch. 8]
9. Sequence Processing with Recurrent Networks: Simple Recurrent Networks, Applications of
   RNNs, Deep Networks, Managing Context in RNNs, etc. [TB1, Ch. 9]
10. Formal Grammars of English/Urdu: Constituency, Context Free Grammars, Rules of

English/Urdu, Treebanks, etc. [TB1, Ch. 10]
11. Syntactic Parsing: Ambiguity, CKY Parsing, Partial Parsing, etc. [TB1, Ch. 11]

Reference Material:

1. Daniel Jurafsky and James H. Martin. 2018. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Third Edition. Prentice Hall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural
3. Language Processing. MIT Press.
4. Steven Bird. 2009. Natural Language Processing with Python. O'Reilly. (Free on SearchWorks)
5. Philipp Koehn. 2010. Statistical Machine Translation. Cambridge.
6. Yoshua Bengio. 2009. Learning Deep Architectures for AI. Technical Report. (Free from
7. Stanford network)
8. Frederick Jelinek. 1998. Statistical Methods for Speech Recognition. MIT Press.
9. James Allen. 1995. Natural Language Understanding. Benjamin/Cummings, 2ed. Psycholinguistics: Tanenhaus & Trueswell (2006), Human Sentence Processing website

Course Title: Grammar Engineering

Course Code: CSEC-733
Course Structure: Lectures: 3/ Lab: 1
Credit Hours: 4
Prerequisites:

Course Objective:

Natural language processing (NLP) enables computers to make use of data represented in human language (including the vast quantities of data available on the web) and to interact with computers on human terms. Applications from machine translation to speech recognition and web-based information retrieval demand both precision and robustness from NLP technology. Meetings these demands will require better hand-built grammars of human languages combined with sophisticated statistical processing methods. This course focuses on the implementation of linguistic grammars, drawing on a combination of sound grammatical theory and engineering skills.

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Course Syllabus:

Introduction, LFG, Templates, C & F description, Agreement, Determiners, Rules & alternations, Adjuncts, Obliques, Prepositions, Pronouns, Punctuation, Generation & Optimality, Complements, Uncertainty, Imperatives, Finite-State Morpholog, Free Word Order and the Shuffle Operator, Coordination

Course Outline:

1. 1.Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]

4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:

1. Crouch, Dick, Mary Dalrymple, Ronald M. Kaplan, Tracy Holloway King, John T. Maxwell III, und Paula Newman (2008). XLE Documentation. Palo Alto: Palo Alto Research Center.
2. Butt, Miriam, Tracy Holloway King, Maria-Eugenia Nino and Fred-erique Segond. 1999. A Grammar Writer's Cookbook. CSLI Publications.
3. Dalrymple, Mary. 2001. Lexical-Functional Grammar. Academic Press.
4. Kaplan, Ronald M. und John T. Maxwell III (1995). Constituent Coordination in Lexical-
5. Functional Grammar. In Dalrymple, Mary, Ronald M. Kaplan, John T. Maxwell III, und Annie
6. Zaenen (eds.)(1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications. First published in Proceedings of COLING-88, vol. 1 (1988). Budapest.
7. Kaplan, Ronald M. und Annie Zaenen (1989). Long-distance Dependencies, Constituent Structure, and Functional Uncertainty. In Baltin, Mark und Anthony Kroch (eds.), Alternative
8. Conceptions of Phrase Structure, pp. 17-42. Chicago University Press. Republished in Dalrymple et al. (eds.) (1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications.
9. Kaplan, Ronald M., John T. Maxwell III, Tracy Holloway King, und Dick Crouch (2004). Integrating Finite-state Technology with Deep LFG Grammars. Proceedings of the Workshop on Combining Shallow and Deep Processing for NLP. Proceedings of ESSLLI 2004.

Course Title: Reliability Engineering

Course Code: SEEC-701
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:

Introduction to Reliability Engineering. The Need for Reliable Software. Software Reliability Engineering Concepts. Basic Definitions. Software Reliability and System Reliability. The Dependability Concept. Reliability Modeling. Availability Modeling. Statistical Reliability Models for Software Reliability. Best Current Practices of software Reliability Engineering. Software Metrics for Reliability Assessment. Software Testing and Reliability. Software

Reliability Tools. Review of Reliability Theory. Analytical Techniques and Basic Statistics for Reliability Engineering. Current research topics in Reliability Engineering.

Course Outline:

1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:

1. An Introduction to Reliability and Maintainability Engineering, Ebeling, C. E., Waveland Press, Inc., second edition. 2009 (ISBN 1-57766-625-9)
2. IEEE Recommended Practice in Software ReliabilityHandbook of Software Reliability Engineering by Michael R. Lyu. Published by IEEE Computer Society Press and McGraw-Hill Book Company, 2008

Course Title: Software Configuration Management

Course Code: SEEC-702
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:

Management of the SCM Process. Organizational Context for SCM. Constraints and Guidance for the SCM Process. Planning for SCM. SCM Plan. Surveillance of Software Configuration Management. Software Configuration Identification. Identifying Items to Be Controlled. Software Library. Software Configuration Control. Requesting, Evaluating, and Approving Software Changes. Implementing Software Changes. Deviations and Waivers. Software Configuration Status Accounting. Software Configuration Status Information. Software Configuration Status Reporting. Software Configuration Auditing. Software Functional Configuration Audit. Software Physical Configuration Audit. In-process Audits of a Software Baseline. Software Release Management and Delivery. Software Building. Software Release Management. Software Configuration Management Tools.Current research topics in Software Configuration Management.

Course Outline:

1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:

1. Software Configuration Management Patterns: Effective Teamwork, Practical Integration by Stephen P. Berczuk, Brad Appleton, 2003

Course Title: Software Measurement and Metrics

Course Code: SEEC-703
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:
Introduction to quality control and planning needs (Measurement Concepts, Measurement as a support process, Review Metrics Models and Standards). Measurement goals (Formulating problem and goal statement, Prioritize information needs and objectives, Formalize measurement goals). Specify Measures (Identify questions and indicators, Identify data elements, Operational definitions for measures). Specify Data Collection and Storage Procedures. Sources of data. How to collect and store the measurement data? Specify Analysis Procedures. Potential data analyses. Methods and tools for measuring software. Develop software measurement reporting. Current research topics in Software Measurement and Metrics.

Reference Material:
1. Metrics and Models in Software Quality Engineering, Stephen H. Kan, Addison Wesley, 2003
2. Measuring the Software Process, Anita Carleton, William A. Florac, Addison-Wesley 1999
3. The Big Book of Six Sigma training Games, Chris Chen and Hadley Roth, McGraw-Hill, 2005

Course Title: Software Risk Management

Course Code: SEEC-704
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:
What is risk and risk management?. Motivation for risk management. Reasons we don't do risk management. SEI's Risk Management paradigm. Identifying and recording software risk. Risk Taxonomy. Tools and methods for identifying and recording risks. Analyzing and classifying risks. Complex project management theory. Software Risk Identification. Software Risk Analysis. Software Risk Planning. Software Risk Monitoring. Software Qualitative Risk Analysis. Quantitative Risk Analysis. Risk management and the SDLC. Risk management in CMM. Other useful tools for successful risk management. Current research topics in Software Risk Management.

Reference Material:
1. Software Engineering Risk Management by Dale Walter Karolak, 1995, ISBN9780818671944
2. Applied Software Risk Management: A Guide for Software Project Managers by C. Ravindranath Pandian, 2006, ISBN 9780849305245

3. Software Risk Management by Boehm, Barry, W. IEEE Computer Society Press, ISBN 10: 0818689064

Course Title: Speech Recognition and Synthesis

Course Code: CSEC-735
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Objective:
This course offers an in-depth introduction to automatic speech recognition (ASR), the problem of automatically extracting text from human speech. This class will cover many theoretical and practical aspects of machine learning techniques that are employed in large-scale ASR systems. Apart from teaching classical algorithms that form the basis of statistical speech recognition, this class will also cover the latest deep learning techniques that have made important advances in achieving state-of-the-art results for speech recognition.

Course Syllabus:
This course is an introduction to automatic speech recognition, speech synthesis, and dialogue systems, from the computer science and linguistics (rather than EE) perspective. Focus on understanding of key algorithms including the noisy channel model, Hidden Markov Models (HMMs), GMM (Gaussian Mixture Model) acoustic models, A* and Viterbi decoding, N- gram language modeling, unit selection synthesis, dialogue architectures, and the role of linguistic knowledge (esp. phonetics, intonation, pronunciation variation, disfluencies, emotion).

Course Outline:

1. Overview of Course, Intro to Probability Theory, and ASR Background: N-gram Language Modeling J+M New Chapter 4: N-grams
2. TTS: Background (part of speech tagging, machine learning, classification, NLP) and Text Normalization J+M New Chapter 7: Phonetics , J+M New Chapter 8 Speech Synthesis, pages 1-10 , J+M New Chapter 5 Word Classes and Part-of-Speech Tagging, pages 1-36, but skip section 5.6 , Optional Advanced Reading: Chapter 4 "Text Segmentation and Organisation" from Taylor, Paul. 2007. Chapter 5 "Text Decoding" from Taylor, Paul. 2007.
3. TTS: Grapheme-to-phoneme, Prosody (Intonation, Boundaries, and Duration) and the Festival software J+M New Chapter 8, pages 10-25 , Read sections 1, 2, 3, 4, 5, and 6.1 and 6.1.1 from Alan Black's lecture notes on TTS and Festival. , Festival manual (used as Festival's scripting language): Introduction to Scheme for C Programmers, from Cal Tech. Optional Advanced Reading: Chapter 6 "Prosody Prediction from Text" from Taylor, Paul. 2007.
4. TTS: Waveform Synthesis (Diphone and Unit Selection Synthesis) J+M New Chapter 8, pages 25-end Optional Advanced Reading: Chapter 16 "Unit Selection Synthesis" from Taylor, Paul. 2007. Optional Advanced Reading: Optional: Section 7 from Alan Black's lecture notes on TTS and Festival. Optional Advanced Reading: The rest of Section 6 of Alan Black's lecture notes

5. ASR: Noisy Channel Model, Bayes, HMMs, Forward, Viterbi J+M New Chapter 6: Hidden Markov Models, pages 1-20 J+M New Chapter 9: Automatic Speech Recognition, pages 1-12
6. ASR: Feature Extraction and Acoustic Modeling, Evaluation J+M New Chapter 9: Automatic Speech Recognition pages 12-31, 31-45 J+M New Chapter 10: Speech Recognition: Advanced Topics pages 11-16
7. ASR: Learning (Baum-Welch) and Disfluencies J+M New Chapter 9: Automatic Speech Recognition 46-52 , J+M New Chapter 10: Speech Recognition: Advanced Topics pages 1-11

Reference Material:

1. The new edition of Jurafsky and Martin. 2007. Speech and Language Processing.
2. Selected chapters from Taylor, Paul. 2007. Text-to-Speech Synthesis
3. Some papers from the literature

Course Title: Telecom Management

Course Code: ITEC-706
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Networks

Course Objectives:

The course provides the understanding of the operation and management of a telecommunication business.

Course Syllabus:

Introduction to Telecommunication Management and Planning. Telecommunication Strategic Planning. Developing Requirements and Specifications. Managing Long-Distance Services. Managing Internet Services. Managing PBX and Key Telephone Equipment. Managing Automatic Call Distributors. Managing Voice Processing Equipment. Managing Local Area Network and Internets. Managing Wide Area Networks. Managing Video and Audio Conferencing Equipment. Managing Convergence. Developing a Telecommunication Operations Plan. Disaster Prevention and Recovery. Telecommunications Project Management. Managing Telecommunications Security.

Course Outline:

1. Introduction to Telecommunication Management and Planning
2. Telecommunication Strategic Planning
3. Developing Requirements and Specifications
4. Managing Long-Distance Services
5. Managing Internet Services
6. Managing PBX and Key Telephone Equipment
7. Managing Automatic Call Distributors
8. Managing Voice Processing Equipment
9. Managing Local Area Network and Internets
10. Managing Wide Area Networks

11. Managing Video and Audio Conferencing Equipment
12. Managing Convergence
13. Developing a Telecommunication Operations Plan
14. Disaster Prevention and Recovery
15. Telecommunications Project Management
16. Managing Telecommunications Security

Reference Material:

1. The Irwin Handbook of Telecommunications Management by James Harry Green, McGraw-Hill; 3rd Edition (March 22, 2001). ISBN-10: 0071370587
2. Telecom Management Crash Course : A Telecom Company Survival Guide by P. J. Louis, McGraw-Hill Professional; 1st Edition (June 1, 2002). ISBN-10: 0071386203
3. The Essentials of Telecommunications Management: A Simple Guide to Understanding a Complex Industry by Jayraj Ugarkar, AuthorHouse (March 29, 2010). ISBN-10: 1434397254

Course Title: Telecommunication Systems

Course Code: ITEC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Networks

Course Objectives:

The course provides an in-depth investigation of telecommunications system concepts and Terminology. The course covers the most popular telecommunication networks and forthcoming technologies.

Course Syllabus:

Communication Channel and the Communication Network Technologies. Digital Telephony. Switching and Signaling Systems. Switching Fabric Interfaces and ICs, Optics and the Future. Cellular Systems. Fixed Wireless Access Technologies. Digital Subscriber Loop. Transmission Techniques. Telecommunication Systems Testing. Embedded Systems Design for Telecommunications.

Course Outline:

1. Communication Channel and the Communication Network: Introduction and Development of Telecommunications, Signals in Communication, Characteristics of the Communication Channel, The Communication Networks, Enabling Technologies.
2. Digital Telephony: From Analog to Digital, Advantages and Disadvantages of Digital Techniques, PCM Techniques and Standards, Low Bit-Rate Voice Coding, Voice over the Internet, Devices for Digital Telephony.
3. Switching and Signaling Systems Switching, Circuit Switching and Packet Switching, Signaling Systems, Digital Exchanges, Private Branch Exchanges and Key Phone Systems, Merging Data and Voice, Packet Switching Systems, Switching Fabric Interfaces and ICs, Optics and the Future.
4. Cellular Systems: Advantages and Constraints of Wireless Access, Basic Components of

Wireless Access, Cellular System Operation, The Cellular Radio Environment, Frequency Assignment and Multiple Access Schemes for Cellular Systems, Capacity of Cellular Systems, First Generation Cellular Systems and Standards, Second Generation Cellular Systems and Standards, Third Generation Cellular Systems and Standards, Mobile Device Hardware, Architecture, and Implementation, Technological Trends.

5. Fixed Wireless Access: Access Technologies, WLL Technologies Primarily for Voice Provision, Broadband Fixed Wireless Access Systems, Enabling Technologies.
6. Digital Subscriber Loop: Signal Impairment and the Channel Length, DSL Techniques, Different Versions of DSL, Spectral Consideration in DSL, Operation of DSL, DSL Chip Sets, ISO Seven-Layer Model, ATM, and DSL Systems, End-to-End ADSL Systems and Standards.
7. Transmission Techniques.
8. Telecommunication Systems Testing: Transmission Line Behavior, Decibel Measurements, Basic TDM Techniques and Digital Transmission Systems, Plesiochronous Higher-Order Digital Multiplexing, Synchronous Digital Multiplexing, Optical Networks, Emerging Technologies.
9. Embedded Systems Design for Telecommunications: AMR Speech Codecs and the GSM Environment, Digital Signal Processor Architecture, AD6526 Multiprocessor Architecture, AMR Speech Codec, Algorithmic Complexity of the AMR Speech Codec, Implementation considerations of AMR Speech Codec and porting the Code.

Reference Material:

1. Essentials of Modern Telecommunications Systems by Nihal Kularatna and Dileeka Dias, Artech House (May 2004). ISBN-10: 1580534910
2. The Irwin Handbook of Telecommunications by James Harry Green, McGraw-Hill; 5th Edition (October 26, 2005). ISBN-10: 0071452222
3. Telecommunications Essentials: The Complete Global Source for Communications Fundamentals, Data Networking and the Internet, and Next-Generation Networks by Lillian Goleniewski, Addison-Wesley Professional; 1st Edition (January 5, 2002). ISBN-10: 0201760320
4. Fundamentals of Communications Systems by Michael Fitz, McGraw-Hill Professional; 1st Edition (June 27, 2007). ISBN-10: 0071482806

Course Title: Text Processing and Data Analysis

Course Code: CSEC-734
Course Structure: Lectures: 3/Labs: 1
Credit Hours: 4
Prerequisites: None

Course Objectives:

The processing and analysis of large datasets has become a regular task in sciences. This introductory course into the scripting language PERL provides the basis for designing rapid, reproducible and scalable solutions to this problem. The scripting language PERL is an intuitive and powerful tool for developing custom-tailored solutions for problems ranging from basic data handling and management up to the design of complex workflows and novel algorithms for data analysis. In this course we will introduce the basic concepts of PERL, making you familiar with

the various data types and the general structure of PERL scripts, but also with the basic concepts of a structured and standardized data analysis. Based on specific examples from NLP we will guide you through the implementation of first algorithms in PERL aiding in the solution of your particular data analysis problems.

Course Syllabus:
Background, Introduction to Perl, Scalar Data, Built in Functions, Arrays, Functions, Writing Safe Code, Control Structures, File Input / Output, Introduction to Text Processing, Text Processing Functions, Loop Control, Hashes, DBM Databases, Advanced Sorting, Regular Expressions, Environment Variables, CGI-Programming, Process Management, References and Data Structures, Graphics, Javascript

Course Outline:
1. Course goals, syllabus, and introduction to Perl. [TB1, Ch 1]
2. Scalar data [TB1, Ch 2]
3. Lists and arrays [TB1, Ch 3]
4. Subroutines [TB1, Ch 4]
5. Hashtables, Input/Output [TB1, Ch 5-6]
6. HTML (Internet)
7. Files and directories [TB1, Ch 11-12]
8. Modules, basic CGI [TB1, Ch 13]
9. Regular expressions [TB1, Ch 7]
10. Regular expressions (cont.) [TB1, Ch 8-9]
11. More control structures, strings, sorting [TB1, Ch 10-15]
12. Simple databases; DBI, DBM [TB1, Ch 16]
13. Internet tools, processes, advanced topics [TB1, Ch 14, 17]

Reference Material:
1. Learning Perl by Randal L. Schwartz and Tom Phoenix, 3rd edition, known as the Llama book.
2. Programming Perl by Larry Wall, Tom Christiansen, and Jon Orwant, 3rd edition, known as the Camel book.
3. CPAN: Comprehensive Perl Archive Network. Online, at http://www.cpan.org/
4. Perl Cookbook by Tom Christiansen and Nathan Torkington, known as the Cookbook.
5. Mastering Perl/Tk by Stephen Lidie and Nancy Walsh

Course Title: Virtualization in Cloud Computing

Course Code: ITEC-711
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
This course gives an inside look as traditional physical data centers evolve and morph into virtual entities and cloud environments. Students will learn in-depth details and considerations for planning, designing, and migrating to Virtualized Data Centers (VDCs) and cloud

environments. They will learn to design VDC and cloud infrastructures, maintaining the most robust and elastic computing, network, and storage environments.

Course Syllabus:
Virtualization, Virtualization Types, Virtualization Management, Cloud Computing, Service Models, Cloud Adoption and Barriers, Return on Investment and Cloud Benefits; Typical Design Patterns and Use Cases, Design Patterns, Cloud Use Cases, Deployment Models, IaaS as a Foundation, Cloud Consumer Operating Model. Data Center Architecture and Technologies. IT Services. The Cisco Cloud Strategy. Cloud Management Reference Architecture. Cloud Service Fulfillment. Cloud Service Assurance. Billing and Chargeback. Technical Building Blocks of IaaS. Automating and Orchestration Resources. Cloud Capacity Management. Case Study - Hybrid Cloud: Cisco Cloud Enablement Services, Company Profile, Business Goals, Cloud Strategy, Cloud Maturity, IT Platform, Cloud Reference Model, Private Cloud Services, Orchestration and Automation Transition Architecture, Telco Solution, Solution, Out-of-the-Box Services, Diggit Service Requirements.

Course Outline:
1. Virtualization: Virtualization Types, Virtualization Management, Cloud Computing, Service Models, Cloud Adoption and Barriers, Return on Investment and Cloud Benefits; Typical Design Patterns and Use Cases, Design Patterns, Cloud Use Cases, Deployment Models, IaaS as a Foundation, Cloud Consumer Operating Model.
2. Data Center Architecture and Technologies: Architecture, Architectural Building Blocks of a Data Center, Design Evolution, Virtual PortChannel (vPC), Layer 2 Multi-Pathing (L2MP), Network Services and Fabric Evolution in the DC, Service Assurance, Evolution of the Services Platform.
3. IT Services: Classification of IT Services and Information, Four Cornerstones of Cloud Economics.
4. The Cisco Cloud Strategy: A Brief History of IT Service Delivery, The Cisco Cloud Strategy: An Overview, Infrastructure Evolution to Support Cloud Services.
5. Cloud Management Reference Architecture: Standards, TMF eTOM, IT Infrastructure Library (ITLI), ITU-T TMN, Building Cloud Models Using Standards, Integration of Management Systems/Functions.
6. Service Fulfillment: Cloud Fulfillment Using ITILV3, Cloud End-to-End Service Provisioning Flow, Service Orchestration, Cloud End-to-End Architecture Model.
7. Service Assurance: Cloud Assurance Flow Using the ITIL Process, Cloud End-to-End Monitoring Flow, Service Assurance Architecture.
8. Billing and Chargeback: Billing and Chargeback Terminology, Cloud Consumers and Providers, Cloud Services Billing Considerations, Cloud Order-to-Cash Process Flow, Billing and Charging Architecture.
9. Technical Building Blocks of IaaS: IaaS Service Composition, Developing and Offering Cloud Products, Persisting Service Data.
10. Automating and Orchestration Resources: Building the Cloud, Adding Services to the Cloud, Creation and Placement Strategies, Service Life Cycle Management.
11. Cloud Capacity Management: Tetris and the Cloud, Cloud Capacity Model, Demand

Forecasting, Procurement in the Cloud.

12. Case Study - Hybrid Cloud: Cisco Cloud Enablement Services, Company Profile, Business Goals, Cloud Strategy, Cloud Maturity, IT Platform, Cloud Reference Model, Private Cloud Services, Orchestration and Automation Transition Architecture, Telco Solution, Solution, Out-of-the-Box Services, Diggit Service Requirements.

Reference Material:

1. Cloud Computing: Automating the Virtualized Data Center by Venkata Josyula, Malcolm Orr and Greg Page, Cisco Press; 1st Edition (December 9, 2011). ISBN-10: 1587204347.
2. IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach by Mickey Iqbal, Mithkal Smadi, Chris Molloy, and Jim Rymarczyk, Mc Press; 1stEdition (January 1, 2011). ISBN-10: 1583473548
3. Microsoft Private Cloud Computing by Aidan Finn, Hans Vredevoort, Patrick Lownds, and Damian Flynn, Sybex; 1stEdition (July 10, 2012). ISBN-10: 1118251474
4. Advanced Server Virtualization: VMware and Microsoft Platforms in the Virtual Data Center by David Marshall , Wade A. Reynolds, and Dave McCrory, Auerbach Publications; 1st Edition (May 17, 2006). ISBN-10: 0849339316
5. Data Center Virtualization: A practical guide to successful deployments of a Virtualized Data Center Infrastructure by Sukento Sukirya, Pete Gore, Brian Clay, and Pierre Vachon, Cisco Press (December 14, 2003). ISBN-10: 1587050234

Course Title: Information Privacy and Security

Course Code: ITCC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Overview of e-security: Threats, risks, consequences, Sources of threats, Attacks classification, Preventive measures, remedial measures, Cryptography for e-security: Historical perspective, Confusion vs. diffusion, Stream ciphers vs. block ciphers, Keys and key management, Key exchange (peer to peer, peer - key server - peer), Diffie Helman key sharing scheme, Symmetric key cryptography vs asymmetric key cryptography, Trapdoor functions, GPG: Overview of GPG, Commands and CLI, GPG trust model, GUI – KGPG, Seahorse, Frontends – Kleopatra, enigmail 2, Practical applications: PKI, CA. X509 certificates, SSL/TLS, HTTPS, IPV6 and IPSEC, Proxies and Firewalls, Misc. techniques: Encryption using non-cryptographic tools (vi, zip), Authentication principles and methods, Passwords, two-factor authentication, One-way encryption, Steganography, Hamming, Chaffing and Winnowing, Management aspects: System Administration policies, Security audit, Penetration testing and ethical hacking, Mandatory Access control, Discretionary Access Control, Monitoring and logging tools

Reference Materials:

1. William Stallings, Cryptography and network security, Pearson Education.
2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone , Handbook of Applied

Cryptography, CRC Press.
3. Margaret Cozzens, Steven J Miller, The mathematics of encryption, American Mathematical Society

Course Title: Cryptography

Course Code: ITCC-703
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Elementary number theory: Prime numbers, Factoring, Modular arithmetic, Fermat's & Euler's theorems, gcd, Euclid's algorithm, Discrete logarithm problem, Public key encryption: Public key crypto systems, RSA algorithm, Elliptic Curve cryptography, Hash digests: Properties of cryptographic hash functions, Merkle Damgard construction, md family, sha family, Digital signatures, sha3, Block ciphers: Block cipher principles, Feistel networks, S boxes and P boxes, Block cipher modes of operation, DES, 3DES, AES, Interactive Proofs, Zero-Knowledge Proofs, Zero-Knowledge Proofs of Knowledge, Non-Interactive Zero-Knowledge Proofs, Secure Protocols, Two-Party Secure Computation, Multiparty Secure Computation, Chosen Ciphertext Security

Reference Materials:
1. The course materials will consist of research papers related to each topic.

Course Title: Advanced Database Management Systems

Course Code: ITCC-704
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Objectives:
Make Students fully understand the concepts and technical issues of Database Administration, Management System and can Administrator Huge Database implemented in a DBMS.

Course Syllabus:
Overview Of Database Systems, The Relational Model, Relational Algebra, Evaluating Relational Operators, A Typical Relational Query Optimizer, Overview Of Transaction Management, Parallel And Distributed Databases, Object-Database Systems, Deductive Databases, Data Warehousing And Decision Support, Data Mining, Information Retrieval And Xml Data, Spatial Data Management, Advanced Topics: Advanced Transaction Processing, Data Integration, Mobile Databases, Main Memory Databases, Multimedia Databases, Geographic Information Systems, Temporal Databases, Biological Databases, Information Visualization ..

Course Outline:

1. Overview of Database Systems: A Historical Perspective, File Systems versus a DBMS, Advantages of a DBMS, Levels of Abstraction in a DBMS, Queries in a DBMS, Transaction Management, Structure of a DBMS. [Ch. 1]
2. The Relational Model: Introduction to the Relational Model, Integrity Constraints over Relations, Enforcing Integrity Constraints, Querying Relational Data, Logical Database Design: ER to Relational, Introduction to Views [Ch. 3]
3. Relational Algebra: Introduction to Relational Algebra, Introduction to Relational Calculus [Ch. 4]
4. Evaluating Relational Operators: The' Selection Operation, General Selection Conditions, The Projection Operation, The Join Operation, The Set Operations, Aggregate Operations, The Impact of Buffering [Ch. 14]
5. A Typical Relational Query Optimizer: Translating SQL Queries into Algebra, Estimating the Cost of a Plan, Relational Algebra Equivalences, Enumeration of Alternative Plans, Nested Subqueries, The System R Optimizer, Other Approaches to Query Optimization [Ch. 15]
6. Overview Of Transaction Management: The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock-Based Concurrency Control, Performance of Locking, Transaction Support in SQL, Introduction to Crash Recovery.[Ch. 16]
7. Parallel And Distributed Databases: Introduction, Architectures for Parallel Databases, Parallel Query Evaluation, Parallelizing Individual Operations, Parallel Query Optimization, Introduction to Distributed Databases, Types of Distributed Databases, Distributed DBMS Architectures, Storing Data in a Distributed DBMS, Distributed Catalog Management, Distributed Query Processing, Updating Distributed Data, Distributed Transactions, Distributed Concurrency Control, Distributed Recovery [Ch. 22]
8. Object-Database Systems: Introduction, Structured Data Types, Operations on Structured Data, Encapsulation and ADTs, Inheritance, Objects, aIDs, and Reference Types, Database Design for an ORDBMS, ORDBMS Implementation Challenges, OODBMS, Comparing RDBMS, OODBMS, and ORDBMS [Ch. 23]
9. Deductive Databases: Introduction to Recursive Queries, Datalog, Theoretical Foundations, Recursive Queries with Negation, From Datalog to SQL, Evaluating Recursive Queries [Ch. 24]
10. Data Warehousing And Decision Support: Introduction to Decision Support, OLAP: Multidimensional Data Model, Multidimensional Aggregation Queries, Implementation Techniques for OLAP, Data 'Warehousing, Views and Decision Support, View Materialization, Maintaining Materialized Views. [Ch. 25]
11. Data Mining: Introduction to Data Mining, Counting Co-occurrences, Mining for Rules, Tree-Structured Rules, Clustering, Similarity Search over Sequences, Incremental Mining and Data Streams, Additional Data Mining Tasks.
12. Information Retrieval and Xml Data: Colliding Worlds: Databases, IR, and XML, DBMS versus IR Systems, Introduction to Information Retrieval, Indexing for Text Search, Web

Search Engines, Managing Text in a DBMS, A Data Model for XML, XQuery: Querying XML Data, Efficient Evaluation of XML Queries. [Ch. 27]

13. Spatial Data Management: Types of Spatial Data and Queries, Applications Involving Spatial Data, Introduction to Spatial Indexes, Indexing Based on Space-Filling Curves, Region Quad Trees and Z-Ordering: Region Data, Grid Files, R Trees: Point and Region Data, Issues in High-Dimensional Indexing [Ch. 28]
14. Advanced Topics: Advanced Transaction Processing, Data Integration, Mobile Databases, Main Memory Databases, Multimedia Databases, Geographic Information Systems, Temporal Databases, Biological Databases, Information Visualization [Ch. 29]

Reference Material:

1. Database Management Systems, 3rd Edition by Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill; 3rd edition (August 14, 2002). ISBN-10: 0072465638
2. Advanced Database Systems by Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T. Snodgrass, V.S. Subrahmanian, Roberto Zicari, Morgan Kaufmann; 1st Edition (May 15, 1997). ISBN-10: 155860443X
3. XQuery by Priscilla Walmsley ISBN: 0596006349 (Chapter 1-8)
4. Spatial Databases: With Application to GIS by Hilippe Rigaux. ISBN: 1558605886 (Chapter 2, 6)
5. Advanced Database Systems by Carlo Zaniolo, Stefano Ceri (Chapter 5, 6)
6. Foundations of Semantic Web Technologies by Pascal Hitzler. ISBN: 142009050X (Chapter 5, 6)
7. Principles of Distributed Database Systems by Ozsu, M. Tamer. ISBN: 0136597076 (Chapter "Introduction", "Architecture" and "Parallel Databases")
8. Hadoop: The Definitive Guide byTom White. ISBN: 1449389732 (Chapter 1, 2, 5, 6)
9. An Advanced Course in Database Systems: Beyond Relational Databases by S. W. Dietrich and S. D. Urban, Prentice Hall, 2005. ISBN-10: 0130428981
10. Database Systems: A Practical Approach to Design, Implementation and Management by Thomas M. Connolly and Carolyn E. Begg, Addison-Wesley; 5th Edition (2009). ISBN-10: 0321523067
11. Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber and Jian Pei, Morgan Kaufmann; 3rd Edition (2011). ISBN-10: 0123814790
12. Data Mining: Concepts, Models, Methods, and Algorithms by Mehmed Kantardzic, Wiley-IEEE Press; 2nd Edition (2011). ISBN-10: 0470890452
13. Data Warehousing Fundamentals for IT Professionals by Paulraj Ponniah, Wiley; 2nd Edition (2010). ISBN-10: 0470462078

Course Title: Advanced Requirements Engineering

Course Code: SECC-701
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Syllabus:
Software Requirements Fundamentals: Product and process requirements, Functional and non-functional requirements, Emergent properties, Quantifiable requirements, System and software requirements. Requirements Process: Process models, Process actors, Process support and management, Process quality and improvement. Requirements Analysis: Requirements sources, Elicitation techniques. Requirements Analysis: Requirements classification, Conceptual modeling, Architectural design and requirements allocation, Requirements negotiation, Formal analysis. Requirements Specification: System definition document, System requirements document, Software requirements specification. Requirements Validation*:* Requirements reviews, Prototyping, Model validation, Acceptance tests. Practical Considerations: Iterative nature of the requirements process, Change management, Requirements attributes, Requirements tracing, Measuring requirements. Software Requirements Tools. Current research topics in requirement engineering.

Reference Material:

1. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Bruce R. Maxim, 8th Ed, McGraw-Hill Education, 2015.
2. Object-Oriented Analysis, Design and Implementation, Brahma Dathan, Sarnath Ramnath, 2nd Ed, Universities Press, India, 2014.
3. Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures, Hassan Gomaa, Cambridge University Press, 2011.
4. Applying UML & Patterns: An Introduction to Object-Oriented Analysis & Design and Iterative Development, Craig Larmen, 3rd Edition.
5. Head First Design Patterns, Eric Freeman, Elisabeth Freeman, Kathy Sierra and Bert Bates, O'Reilly Media, Inc., 2004.

Course Title: Advanced Software System Architecture

Course Code: SECC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
Quality attributes in the context of architecting. Qualitative and quantitative assessment of architectures. Architectural modeling through Architecture Description Languages. System modeling its relation to software architecting. Architecting for evolution and variability. Partitioned and layered architectures. System-of-Systems and Ultra-Large Scale Systems.

Software Product Lines and Configurable Software. Self-Adaptive Software. Architectural Description Languages. Feature Modeling. Architecture and Model-Based Testing. Current research topics in software system architecture..

Reference Material:

1. Designing Software Architectures: A Practical Approach (SEI Series in Software Engineering), Humberto Cervantes, Rick Kazman, 1st Edition, Addison-Wesley Professional, 2016.
2. Software Product Lines: Practices and Patterns, P. Clements and L. Northrup, Addison-Wesley, 2002.
3. Software Architecture : Foundations, Theory, and Practice, R. Taylor, N. Medvidović and E.M. Dashofy, John Wiley, 2010

Course Title: Software Testing and Quality Assurance

Course Code: SECC-703
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Testing techniques. Black Box testing, White Box and Grey Box testing techniques. Quality Assurance planning and execution. Automated testing topics include constructing a framework, scripting techniques, generating a test data, generating test architecture, pre/post-processing, test maintenance, and job specific metrics. Current research topics in Software Testing and Quality Assurance.

Reference Material:

1. Software Quality Assurance: Integrating Testing, Security, and Audit (Internal Audit and IT Audit), Abu Sayed Mahfuz, Auerbach Publications, 2016.
2. Practical Model-Based Testing: A Tools Approach, Mark Utting and Bruno Legeard, Morgan Kaufmann Publishers Inc., San Francisco, CA, 2006.
3. Software Quality Engineering, Testing, Quality Assurance, and Quantifiable improvements, Jeff Tian, IEEE Computer Society, 2005.
4. Introduction to Software Engineering, P Ammann and J Offutt, Cambridge University Press, 2008.

Course Title: Parallel Processing: Algorithms and Architectures-I

Course Code: CSEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: Advanced Algorithm of Analysis

Course Objectives:

The course covers the needed perspective, taxonomy, and analysis tools for the understanding key concepts of parallel processing. It also delimits the models of parallel processing which has become quite important in recent years.

Course Syllabus:
Introduction to Parallelism. Types of parallelism. Parallel Algorithms. Parallel Algorithm Complexity. P RAM and Basic Algorithms. Shared-Memory Algorithms. Sorting and Selection Networks. Circuit-Level Examples. Sorting on a 2-D Mesh or Torus. Routing on a 2-D Mesh or Torus. Numerical 2-D Mesh Algorithms. Other Mesh-Related Architectures.

Course Outline:
1. Introduction to Parallelism: Why parallel processing? Parallel processing ups and downs, Types of parallelism: A taxonomy, Constraints of parallel processing, Effectiveness of parallel processing. Introduction to Parallel Algorithms: Some simple computations, some simple architectures, Algorithms for a linear array, Algorithms for a binary tree, Algorithms for a 2D mesh, Algorithms with shared variables.
2. Parallel Algorithm Complexity: Asymptotic complexity, Algorithm optimality and efficiency, Complexity classes, Parallelizable tasks and the NC class, Parallel programming paradigms, Solving recurrences. Models of Parallel Processing: Development of early models, SIMD versus MIMD architectures, Global versus distributed memory, The PRAM shared-memory model, Distributed-memory or graph models, Circuit model and physical realizations.
3. PRAM and Basic Algorithms: PRAM submodels and assumptions, Data broadcasting, Semigroup or fan-in computation, Parallel prefix computation, Ranking the elements of a linked list, Matrix multiplication. More Shared-Memory Algorithms: Sequential rank-based selection, A parallel selection algorithm, A selection-based sorting algorithm, Alternative sorting algorithms, Convex hull of a 2-D point set, Some implementation aspects.
4. Sorting and Selection Networks: What is a sorting network? Figures of merit for sorting networks, Design of sorting networks, Batcher sorting networks, Other classes of sorting networks, Selection networks. Other Circuit-Level Examples: Searching and dictionary operations, A tree-structured dictionary machine, Parallel prefix computation, Parallel prefix networks, The discrete Fourier transform, Parallel architectures for FFT.
5. Sorting on a 2-D Mesh or Torus: Mesh-connected computers, Theshearsort algorithm, Variants of simple shearsort, Recursive sorting algorithms, A non-trivial lower bound, Achieving the lower bound,
6. Routing on a 2-D Mesh or Torus: Types of data routing, Useful elementary operations, Data routing on a 2-D array, Greedy routing algorithms, Other classes of routing algorithms, Wormhole routing
7. Numerical 2-D Mesh Algorithms: Matrix multiplication, Triangular system of equations, Tridiagonal system, Arbitrary system of linear equations, Graph algorithms, Image-processing algorithms
8. Other Mesh-Related Architectures: Three or more dimensions, Stronger and weaker connectivities, Meshes augmented with non-local links, Meshes with dynamic links, Pyramid and multi-grid systems, Meshes of trees

Reference Material:
1. Introduction to Parallel Processing: Algorithms and Architectures by Behrooz Parhami, Springer; (2006) ISBN-10: 0306459701
2. Parallel Algorithms and Architectures by Michel Cosnard and Denis Trystram, Intl

Thomson Computer Pr (Sd) (September 1996). ISBN-10: 0534946070
3. Parallel Processing and Parallel Algorithms: Theory and Computation by Seyed H Roosta, Springer; 1st Edition (December 10, 1999). ISBN-10: 0387987169
4. Introduction to Parallel Algorithms by Joseph JaJa, Addison-Wesley Professional; 1stEdition (April 3, 1992). ISBN-10: 0201548569

Course Title: Parallel Processing: Algorithms and Architectures-II

Course Code: CSEC-729
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: Parallel Processing: Algorithms and Architectures - I

Course Objectives:
The course is the 2nd part of the Parallel Processing. It continue covering the needed perspective, taxonomy, and analysis tools for the understanding key concepts of parallel processing. It also delimits the models of parallel processing which has become quite important in recent years.

Course Syllabus:
Hypercubes and Their Algorithms. Sorting and Routing on Hypercubes. Sampler of other Networks: Performance parameters for networks, Star and pancake networks, Ring-based networks, Composite or hybrid networks, Hierarchical (multi-level) networks, Multi-stage interconnection networks. Emulation and Scheduling. Data Storage, Input, and Output. Reliable Parallel Processing. Shared-Memory MIMD Machines. Data-Parallel SIMD Machines.

Course Outline:
1. Hypercubes and Their Algorithms: Definition and main properties, Embeddings and their usefulness, Embedding of arrays and trees, A few simple algorithms, Matrix multiplication, Inverting a lower triangular matrix.
2. Sorting and Routing on Hypercubes: Defining the sorting problem, Bitonic sorting, Routing problems on a hypercube, Dimension-order routing, Broadcasting on a hypercube, Adaptive and fault-tolerant routing. Other Hypercubic Architectures: Modified and generalized hypercubes, Butterfly and permutation networks, Plus-or-minus-2i network, The cube-connected cycles, Shuffle and shuffle-exchange networks.
3. Sampler of Other Networks: Performance parameters for networks, Star and pancake networks, Ring-based networks, Composite or hybrid networks, Hierarchical (multi-level) networks, Multi-stage interconnection networks. Emulation and Scheduling: Emulations among architectures, Distributed shared memory, The task scheduling problem, A class of scheduling algorithms, Some useful bounds for scheduling, Load balancing and dataflow systems

4. Data Storage, Input, and Output: Data access problems and caching, Cache coherence protocols, Multi-threading and latency hiding, Parallel I/O technology, Redundant disk arrays, Interfaces and standards.
5. Reliable Parallel Processing: Defects, faults, failures, Defect-level methods, Fault-level methods, Error-level methods, Malfunction-level methods, Degradation-level methods. System and Software Issues: Coordination and synchronization, Parallel programming, Software portability and standards, Parallel operating systems, Parallel file systems, Hardware/software interaction
6. Shared-Memory MIMD Machines: Variations in shared memory, MIN-based BBN Butterfly, Vector-parallel Cray Y-MP, Latency-tolerant Tera MTA, CC-NUMA Stanford DASH, SCI-based Sequent NUMA-Q. Message-Passing MIMD Machines: Mechanisms for message passing, Reliable bus-based Tandem NonStop, Hypercube-based nCUBE3, Fat-tree-based Connection Machine, Omega-network-based IBM SP2, Commodity-driven Berkeley NOW.
7. Data-Parallel SIMD Machines: Where have all the SIMDs gone? The first supercomputer: ILLIAC IV, Massively parallel Goodyear MPP, Distributed Array Processor (DAP), Hypercubic Connection Machine, Multi-connected MasPar MP-2. Past, Present, and Future: Milestones in parallel processing, Current status, issues, and debates, TFLOPS, PFLOPS, and beyond, Processor and memory technologies, Interconnection technologies, The future of parallel processing.

Reference Material:

1. Introduction to Parallel Processing: Algorithms and Architectures by BehroozParhami, Springer; (2006). ISBN-10: 0306459701
2. Parallel Algorithms and Architectures by Michel Cosnard and Denis Trystram, Intl Thomson Computer Pr (Sd) (September 1996). ISBN-10: 0534946070
3. Parallel Processing and Parallel Algorithms: Theory and Computation by Seyed H Roosta, Springer; 1st Edition (December 10, 1999). ISBN-10: 0387987169
4. Introduction to Parallel Algorithms by Joseph JaJa, Addison-Wesley Professional; 1st Edition (April 3, 1992). ISBN-10: 0201548569

Course Title: Research Methodology

Course Code: SEEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Introduction to Research. Objectives of Research. Importance of Research Methodology in Research Study. Types of Research. Steps in Conducting Research. What is Literature Review? Why need for Literature Review. Types of Literature Review. Systematic Literature Review Protocol. Problem Statement and Problem formulation. Criteria for selecting a problem. Identifying Types of variables in Research. Types of hypothesis. Identifying Target Population. Types of Sampling. Sampling Techniques. Quantitative Research Methods. Scientific Methods.

Design of Quantitative Surveys. Techniques to Conduct Quantitative Methods. Introduction to Qualitative Research. Qualitative Research Methods. Data Analysis and Theory in Qualitative Research Articles. Introduction to Mixed Methods Research. Design of Mixed Methods Research. Evaluation of Mixed Methods Research. Case Study. How to Conduct a Case Study. Case Study Protocol. Importance and Benefits of Case Study. Types of Statistical Tests to Conduct Data Analysis. Data Analysis Tools. Introduction to SPSS. Hands on Practice of SPSS. How to Define variables in SPSS. How to Record Collected Data in SPSS. Types of Tests via SPSS including Regression. Correlation. Cross tabulation and others. How to write Good Research Proposal. Contents of Thesis. Important Elements of Research Thesis.

Reference Material:

1. Research design: Qualitative, quantitative and mixed methods approaches, Creswell, J. W. Thousand Oaks, CA: Sage,4th Ed. 2014

Course Title: Swarm Intelligence

Course Code: CSEC-709
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course is aimed to provide students' knowledge of up-to-date efficient variants of different meta heuristics together with their potential applications. Also to develop the interest of students in both research and development.

Course Syllabus:

Introduction to swarm intelligence and key principles, From real to virtual ants, Introduction to mobile robotics, unsupervised multi-agent machine-learning, Collective movements in natural societies, Multi-level modeling of self-organized systems, Combined modeling, Division of labor and task-allocation mechanisms, Market-based and threshold-based algorithms, Aggregation and segregation, Distributed structure building.

Course Outline:

1. Introduction to swarm intelligence and key principles (e.g., self-organization, stigmergy), natural and artificial examples, computational and embedded SI. Foraging, trail laying/following mechanisms. Open-space, multi-source foraging experiments: biological data and microscopic models.
2. From real to virtual ants: Ant System (AS), the first combinatorial optimization algorithm based on ant trail/following principles. Application to a classical operational research problem: the Travel Salesman Problem (TSP). From AS to Ant Colony Optimization (ACO). Ant-based algorithms (ABC, Ant-Net) applied to routing in telecommunication networks. Definitive assignment of course projects.
3. Introduction to mobile robotics: basic hardware and software concepts centered around the differential drive vehicle used in the course (e-Puck). Introduction to control architecture for mobile robots with special focus on reactive control architectures.
4. Introduction to unsupervised multi-agent machine-learning techniques for automatic design and optimization: terminology and classification, Genetic Algorithms (GA) and Particle

Swarm optimization (PSO). Comparison between both techniques in theory and practice.

5. Application of machine-learning techniques to automatic control design and optimization in single-robot and multi-robot experiments. Specific issues for automatic control design and optimization in collective systems (e.g., credit assignment problems, noise resistance).
6. Collective movements in natural societies; focus on flocking phenomena. Collective movements in artificial systems: Reynolds' virtual agents (Boids) and experiments with multi-robot systems (flocking, formation).
7. Multi-level modeling of self-organized robotic systems: microscopic and macroscopic models; Markov formalism; linear and nonlinear micro-to-macro mapping, model analysis.
8. Combined modeling and machine-learning methods for control optimization. Diversity and specialization metrics.
9. Division of labor and task-allocation mechanisms, part I: threshold-based algorithms.
10. Division of labor and task-allocation mechanisms, part II: market-based algorithms and comparisons between threshold-based and market-based algorithms. A short tutorial on sensor networks, networked robotic systems and their relation with Swarm Intelligence.
11. Aggregation and segregation. Social insects, data clustering algorithms, and collective robotics experiments.
12. Distributed structure building in natural and artificial systems.

Reference Material:

1. Computational Intelligence: An Introduction, Andries Engelbrecht, Wiley, 2007
2. “Swarm Intelligence: From Natural to Artificial Systems", E. Bonabeau, M. Dorigo, and G. Theraulaz, Santa Fe Studies in the Sciences of Complexity, Oxford University Press, 1999. ISBN: 0195131592

Course Title: Evolutionary Computation

Course Code: CSEC-710
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

It is intended as a fundamental introduction, as well as a survey of the many aspects of evolutionary algorithms (EAs), in particular GA, GP, ES, and will concentrate on the basic concepts of representation, operators and overall control, followed by examples of the use of these concepts in important applications. As such, this course will not do much in-depth study of any one area. Rather the course is intended as a good introduction for those who have had no exposure to EC and as a stepping stone for those interested in more specific areas.

Course Syllabus:

Evolutionary Computation, Genetic Algorithms, Genetic Programming, Swarm Intelligence, Ant Colony Optimization, Particle Swarm Optimization, Multi Objective Optimization, Neighboring Algorithms, Co-Evolution, Differential Evolution

Course Outline:

1. Introduction to Evolutionary Computation, Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, A simple evolutionary algorithm.
2. Search Operators, Recombination/Crossover for strings (e.g., binary strings), e.g., one-point, multi-point, and uniform crossover operators, Mutation for strings, e.g., bit-flipping, Recombination/Crossover and mutation rates, Recombination for real-valued representations, e.g., discrete and intermediate recombination, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc, Why and how a recombination or mutation operator works?
3. Selection Schemes, Fitness proportional selection and fitness scaling, Ranking, including linear, power, exponential and other ranking methods, Tournament selection, Selection pressure and its impact on evolutionary search
4. Search Operators and Representations, Mixing different search operators, An anomaly of self-adaptive mutations, The importance of representation, e.g., binary vs. Gray coding, Adaptive representations
5. Evolutionary Combinatorial Optimization, Evolutionary algorithms for TSPs, Evolutionary algorithms for lecture room assignment, Hybrid evolutionary and local search algorithms
6. Co-evolution, Cooperative co-evolution, Competitive co-evolution
7. Niching and Speciation, Fitness sharing (explicit and implicit), Crowding and mating restriction
8. Constraint Handling, Common techniques, e.g., penalty methods, repair methods, etc. Analysis, Some examples
9. Genetic Programming, Trees as individuals, Major steps of genetic programming, e.g., functional and terminal sets, initialization, crossover, mutation, fitness evaluation, etc. Search operators on trees, Automatically defined functions, Issues in genetic programming, e.g., bloat, scalability, etc., Examples
10. Multi objective Evolutionary Optimization, Pareto optimality, Multi objective evolutionary algorithms
11. Learning Classifier Systems, Basic ideas and motivations, Main components and the main cycle, Credit assignment and two approaches
12. Theoretical Analysis of Evolutionary Algorithms, Schema theorems, Convergence of EAs, Computational time complexity of EAs, No free lunch theorem

Reference Material:

1. Evolutionary Computation: A Unified Approach, Ken De Jong, 2006.
2. How to Solve It: Modern Heuristics, Z. Michalewicz and D. B. Fogel, Springer, 2000.
3. Computational Intelligence: An Introduction, Andries Engelbrecht, Wiley, 2007

Course Title: Computational Intelligence

Course Code: CSEC-711
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course is aimed to provide students' knowledge of up-to-date efficient variants of different meta heuristics together with their potential applications. Also to develop the interest of students in both research and development.

Course Syllabus:
Optimization, Constrained, unconstrained optimization, Parameter space, function space, and fitness space, Local and global optima, Multi-objective optimization, Classification / Learning, Classification (Supervised Learning), Clustering (Unsupervised Learning), Reinforcement Learning, Control Systems, Expert Systems

Course Outline:

1. Introduction to Computational Intelligence topics, Fundamental concepts
2. Introduction to Evolutionary Computing, Evolutionary computation terms, Canonical genetic algorithm
3. Evolutionary computation variations, Evolutionary programming and Evolution strategies
4. Implementation of Evolutionary Computing
5. Swarm Intelligence, Particle Swarm Optimization
6. Classification, Learning, and Adaptation, Supervised, Unsupervised, Reinforcement Learning
7. Data partitioning and Cross Validation, Error metrics: Mean squared error, receiver operating characteristic curves, Neural Networks and Evolutionary Computation: Explanation and Sensitivity Analysis
8. Neural Networks Implementation, Evolutionary and swarm-based neural networks
9. Fuzzy sets,Membership functions, linguistic variables
10. Fuzzy Logic, Fuzzy set operators, Fuzzy rule-based systems
11. Fuzzification, defuzzification
12. Fuzzy control
13. Evolving fuzzy rule systems
14. Basic ANN Code
15. Neuro-fuzzy systems
16. Fuzzy-GA systems
17. Support Vector Machines
18. Probabilistic reasoning: Bayesian reasoning and Dempster-Shafer theory
19. Bayesian belief networks
20. Fuzzy belief networks
21. Evolving belief networks
22. Artificial Immune Systems

Reference Material:

1. Russell Eberhart and Yuhui Shi - Computational Intelligence: Concepts to Implementations (2007)
2. Fakhreddine Karray and Clarence de Silva - Soft Computing and Intelligent Systems Design (2004)
3. Andries Engelbrecht - Computational Intelligence: an Introduction (2007
4. Amit Konar - Computational Intelligence: Principles, Techniques, and Applications (2005)
5. Vojislav Kecman - Learning and Soft Computing: Support Vector Machines, Neural Networks, and Fuzzy Logic Models (2001)

Course Title: Advanced Software Project Management

Course Code: SECC-704
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: Software Engineering
Course Objectives:

To develop students' ability to plan and manage software development projects successfully, maximizing the return from each stage of the software development life cycle.

Course Syllabus:

Comparison of PM Tools, PMI's Knowledge Areas, PMI Framework, PMI Process Groups, Project Planning, Project Evaluation, comparison of Software Effort Estimation techniques, Comparison of different software development and designing models. Analyzing different risk management methodologies. Studying latest conference and journal papers related to state of the art techniques.

Reference Material:

1. Software Project Management by Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009). ISBN-10: 0077122798
2. A Guide to the Project Management Body of Knowledge, 3rdEdition (PMBOK Guides), ISBN-13: 978-1930699458
3. Mastering Software Project Management: Best Practices, Tools and Techniques by Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing (2010). ISBN-10: 1604270349
4. Effective Project Management: Traditional, Agile, Extreme by Robert K. Wysocki, Wiley; 6th Edition (2011). ISBN-10: 111801619X
5. The Software Project Manager's Handbook - Principles that work at work by Dwayne Phillips, 2ndEdition, IEEE Computer Society Press and Wiley Inter-science, 2004. ISBN 0-471-67420-6

Course Title: Fog Computing

Course Code: CSEC-712
Course Structure: Lectures: 3
Credit Hours: 3
Prerequisite:

Course Objectives:

This course is designed to give a multitude of technologies that comprise the modern concept of Fog and Edge computing, their applications, architectures, and technologies. Fog Computing is an emergent architecture for computing, storage, control, and networking that distributes these services closer to end users along the cloud-to-things continuum. It covers both mobile and wire line scenarios, traverses across hardware and software, resides on network edge but also over access networks and among end users, and includes both data plane and control plane.

Course Syllabus:

This course gives an introduction to Fog Computing, IoT and related techniques, issues, Fog Computing Architectures, Feasible Service Models of Fog Computing Architecture, Fog Computing Applications: Smart city, Smart health, Smart Building, Internet of Energy and Smart Transportation. Other topics of content include Fog/IoT Data storage and Management, Real-time streaming data processing, Data analytics, Resource-constrained devices management and optimization, Scheduling for Fog infrastructures, Reliability, Security and Privacy, privacy challenges and solutions. Students will also learn and understand about Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit, Common Standards in Fog Computing: The Open Fog Consortium, Standards of Application Development, Building and simulating of use-Case Studies in Smart Health / Smart Cities / Smart Government /Smart Industrial Environments/Industry 4.0.

Course Outline:

1. Overview: From Cloud to Fog, Potentials, trends, and prospects in edge technologies: Fog, cloudlet, mobile edge, and micro data centers
2. Overview: From IT to loT to IoE, Basic attributes and challenges for IoE
3. Fog/Edge Computing Computing Architectures, Feasible Service Models of Fog/Edge Computing Architecture
4. Fog/Edge Computing Applications: Smart city, Smart health, Smart Building, Internet of Energy, smart transportation
5. Fog/Edge/IoT Data storage and Management, Real-time streaming data processing, Data analytics
6. Resource-constrained devices management and optimization
7. Scheduling for Fog/Edge infrastructures
8. Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit:
9. Components of iFogsim: physical components and logical components, Module placement

policies,

10. Installation of iFogSim, Building Simulation with iFogSim, Creation of physical and logical components
11. Application Case Studies: a latency-sensitive online game, Intelligent Surveillance through Distributed Camera Networks, Performance Evaluation
12. Example Scenarios: Sensors with different tuple emission rate, Send specific number of tuples from a sensor, Connect lower level Fog devices with nearby gateways, Mobility of a Fog device, Make Cluster of Fog devices, Simulation of a Placement Policy
13. Common Standards in Fog Computing: The Open Fog Consortium, Standards of Application Development
14. Building and simulating a Use-Case Study in Smart Health / Smart Cities / Smart Government / Smart Industrial Environments / Industry 4.0
15. Fog/Edge/IoT Reliability, Security and Privacy, Fog/Edge privacy challenges and solutions

Reference Material:

1. Internet of Things principals and paradigms, edited by Rajkumaar Buyya, AmirVahid, ISBN 978-0-12-805395-9
2. Fog Computing Concepts, Frameworks and Technologies by mahmood Zaigham (Ed. 2018), ISBN 978-3-319-94890-4
3. Fog and Edge Computing: Principles and Paradigms, edited by Rajkumar Buyya, Satish Srirama, Wiley Press
4. The Rise of Fog Computing in the Digital Era, edited by K. G. Srinivasa, Pankaj Lathar, G. M. Siddesh, ISBN 152256070X, 9781522560708
5. https://www.openfogconsortium.org/resources/#use-cases
6. Fog of everything: energy-efficient networked computing architectures, research challenges, and a case study (https://ieeexplore.ieee.org/document/7921687/)
7. FOCAN: A Fog-supported Smart City Network Architecture for Management of Applications in the Internet of Everything Environments (https://arxiv.org/abs/1710.01801)
8. iFogSim: A Toolkit for Modeling and Simulation of Resource Management Techniques in Internet of Things, Edge and Fog Computing Environments (https://arxiv.org/abs/1606.02007)
9. Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit
10. Building a Sustainable Internet of Things: Energy-Efficient Routing Using Low-Power Sensors Will Meet the Need (https://www.researchgate.net/publication/323491668_Building_a_Sustainable_Internet_of_Things_Energy-Efficient_Routing_Using_Low-Power_Sensors_Will_Meet_the_Need)
11. Fog computing job scheduling optimization based on bees swarm (https://www.tandfonline.com/doi/abs/10.1080/17517575.2017.1304579?journalCode=teis20)
12. Priority based scheduling in Fog Computing
13. Mobility aware Application Scheduling in Fog Computing
14. Data Storage and management in fog/edge Computing - webcourse https://webcourse.cs.technion.ac.il/236826/Winter2017-2018/ho/WCFiles/Data%20storage%20and 20management%20in%20Fog%20-%20final%20.pptx

15. https://www.cds.net/blog/2018/03/fog-computing-and-iot/
16. FogStore: Toward a Distributed Data Store for Fog Computing (https://arxiv.org/pdf/1709.07558)
17. An architecture for Load Balancing Techniques for Fog Computing https://pdfs.semanticscholar.org/24e5/022d0b6775f460159dd1a96d63ec4fbb4f68.pdf
18. Multiobjective optimization for computation offloading in Fog Computing https://ieeexplore.ieee.org/document/8168252/\
19. An overview of Fog Computing and its security issues, Security and privacy issues of fog

Revised Curriculum of M. Sc. Information Technology

for

Main Campus, Sub Campuses,

and

Affiliated Colleges



Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall 2013)

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Curriculum
for
M. Sc. in Information Technology Program

Program Rationale

The digital revolution not only affected the way scientists conduct their research but also expedites the pace of inventions. High pace innovations in technologies for communication, computation, interactivity, and delivery of information introduced invention like the Internet, the World Wide Web, email, bulletin board system, virtual communities,E-commerce, and other online technologies which brought a paradigm shift in business world - from data processing to information processing - converting industrial society to an "information society". Such inventions converted computer technology into information technology (IT). While this paradigm shift improved productivity, it also created new workplace challenges regarding the development, operation, maintenance, and up-gradation of organizational IT infrastructure. Twenty-first century organizations use technology to find solutions to all kinds of business challenges. For this, organizations need appropriate systems that work properly and are secured, upgraded, maintained, and replaced as appropriate. In addition, employees of organizations require support from experts who understand computer systems' software and who understand how to use technology to contribute to productivity. Such professionals are valued for their knowledge and skills.

This increasing demand of IT professional has compelled many students who have completed their BA/BSc in non-IT discipline to continue their higher education in IT discipline. The M. Sc. IT program is also a conversion degree programallow such students to fulfill their desires.

The key rationale behind M.Sc. IT program is to develop a programthat really able to meet above discussed challenges of 21st century knowledge driven complex work places. The curriculum of the program provides integration of all components and sound foundations that allow accessing all of the new knowledge and technology to meet the challenges of future. The program prepares students to plan, organize, acquire, install and manage the information technology needs of business, government, health care, schools, and other kinds of organizations.

The program is focused on the acquisition of theory and the applicationof technical competencies associated with the information technology profession. The courses prepare students with fundamental knowledge in core technologies, such as software engineering, programming, database design, network architecture and administration, web technologies and application development, implementation and maintenance.The structure of the program meets the needs of students with formal computing experiences and with established relevant skills. Students are expected to learn theoretical and practical understanding of the entire field of Information Technology. The program structure provides basis for various options including Breadth-Based, Depth-Based, and Integrated Breadth & Depth-Based specializations. Student may choose a particular option, which is the most appropriate to their planned future career.

Program's Aims & Objectives

M. Sc. IT Program is committed to create, expand, disseminate and teach the information technology body of knowledge through academics, applications and research which positively impact society (locally, nationally, and internationally).

The program aims to produce well rounded individuals of great character, competence, vision and drive who are productive and responsible members of society familiar with the technical concepts and practices in the Computing & Information Technology discipline.

The successful graduate shall able to anticipate the changing direction of information technology and evaluate and communicate the likely utility of new technologies to an individual or organization. They should be able to:

- Use and apply current technical concepts and practices in the core information technologies;
- Analyze, identify and define the requirements that must be satisfied to address problems or opportunities faced by organizations or individuals;
- Design effective and usable IT-based solutions and integrate them into the user environment;
- Identify and evaluate current and emerging technologies and assess their applicability to address the users' needs;
- Analyze the impact of technology on individuals, organizations and society, including ethical, legal and policy issues;
- Demonstrate an understanding of best IT practices and standards and their application;
- Demonstrate independent critical thinking and problem solving skills;
- Collaborate in teams to accomplish a common goal by integrating personal initiative and group cooperation;
- Communicate effectively and efficiently with clients, users and peers both verbally and in writing, using appropriate terminology;
- Demonstrate independent, critical thinking and problem solving competencies by being able to analyze, identify and define the requirements that must be satisfied to address problems or opportunities faced by organizations or individuals.
- Anticipate the importance of research by being aware of basic research artifacts such as structure of a research paper, brainstorming.

Program's Outcome

The program will produce entrepreneurs of great character, competence, vision and drive,equipped with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in information technology domain upon graduation.

Program's Curriculum Underlying Principles

Curriculum plays an important role within education as it outlines the planned and structured learning experiences that an academic program provides. For an effective academic program the curriculum must meet the needs of the stakeholders



and face the emerging challenges. The Department of CS & IT (UOS) realizes the rapidly changing needs of today's knowledge intensive technology driven complex work places and the changing patterns of 21st century universities' education which have removed the identity of place, the identity of time, the identity of the scholarly community, and the identity of the student community. To meet these challenges, the Department has revised the existing curriculum. The revised curriculum is based on following underlying principles:

- The curriculum should be a broad based and provides students with the flexibility to work across many disciplines & professions.
- The curriculum should prepare graduates to succeed in a rapidly changing field.
- The curriculum should provide guidance for the expected level of mastery of topics by graduates.
- Should provide realistic, adoptable recommendations that provide guidance and flexibility, allowing curricular designs that are innovative and track recent developments in the field.
- The curriculum contents should be relevant and compatible with a variety of institutions.
- The size of the essential knowledge must be managed.
- The curriculum should identify the fundamental skills and knowledge that all graduates should possess.
- The curriculum should provide the greatest flexibility in organizing topics into courses and curricula.

In the light of these principles, the curriculum of the program has adopted a balanced and multidisciplinary approach and presents a blend of study areas which spread across the boundaries of fundamental knowledge of traditional disciplines to advanced knowledge of the emerging disciplines. Body of knowledge (BOK) of the program covers knowledge areas which are required for the program's accreditation from the Accreditation Council and knowledge area which are required for professional certification and professional development.

It is universally accepted that each profession needs both a specific skill set and an appropriate mindset. Developing an appropriate mindset of the prospective computing graduates requires a body of knowledge which enriches students' experiences, thoughts, beliefs, assumptions, and attitudes about the special characteristics of that specific domain. Therefore, the course contents and related practical experiences are designed to meet the professional requirements of the respective domain. To achieve these objectives the curriculum has focused on following six(6) key areas:

1. Knowledge: Theoretical learning of concepts and principles regarding a particular subject(s).
2. Skills: Capability of using learnt knowledge and applying it according to the context
3. Competencies: The ability to do things satisfactory- not necessarily outstandingly or even well, but rather to a minimum level of acceptable

performance.

4. Expertise: Level of proficiency and innovative ways of applying learnt knowledge. (Competitive edge)
5. Dispositions: Habits of mind or tendencies to respond to certain situations in certain ways. The role of dispositions in computing education is very important. For example, having the disposition to be a programmer is much better that just having programming skills.
6. Values: Moral, ethical and professional practices.

To strengthen the curriculum further, specialization tracks have also been integrated within the curriculum's body of knowledge. These specialization tracks are designed according to what the industry is looking for in an employee and the learning interests of students. Furthermore, life skills including desired dispositions, soft skills, public speaking, critical thinking & reasoning, 21st Century literacy, personal attributes, entrepreneurship, attitude towards lifelong learning, professional practices and other social skills have not considered discrete items, rather threaded into the entire fabric of the curriculum.

Program Structure

The structure of M. Sc. program in Information Technology meets the needs of students with formal computing experience and with established relevant skills. The students are expected to learn theoretical and practical understanding of the entire field of Information Technology. The program structure is dynamic and provides basis for various options including Breadth-Based, Depth-Based, and Integrated Breadth & Depth-Based specializations. Student may choose a particular option, which is the most appropriate to their planned future career. Followings are the program's details:

Specializations

The program offers following specialization tracks. Students can opt any one of them according to their preferences:

- Web Engineering
- Database Management Systems
- Computer Networks

Degree Requirement

Minimum credit hours shall be 74Cr. Hrs. for M.Sc. IT program including a Capstone Project.

Duration

The program shall comprise of 4semester/terms spread over two (2)calendar years with two semesters/terms a year. University Rules and Regulations shall determine the maximum time limit of the Degree.

Eligibility Criteria

The candidates must have graduation or equivalent qualification with at least 2nd division or equivalent.

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Distribution of Courses

Followings are the distribution of total credit hours:

ComputingCore Courses – 35 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
1	CMP-2122	-	Programming Fundamentals	4 (3+1)
2	CMP-2123	CMP-2122	Object Oriented Programming	4 (3+1)
3	CMP-3112	CMP-2123	Data Structures and Algorithms	3 (3+0)
4	CMP-2111	-	Discrete Structures	3 (3+0)
5	CMP-2210	-	Digital Logic and Design	3 (3+0)
6	CMP-3611	-	Operating Systems	3 (3+0)
7	CMP-3440	-	Database Systems	3 (3+0)
8	CMP-3310	-	Software Engineering	3 (3+0)
9	CMP-2540	-	Computer Communication and Networks	3 (3+0)
10	CMP-4970	-	Capstone Project	6 (0+6)

Supporting Elective Courses - 12 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
11	ICT-2011	-	Introduction to ICT	3 (3+0)
12	MATH-2215		Basic Mathematics	3 (3+0)
13	MNG-2210	-	Financial Accounting	3 (3+0)
14	ENG-2413	-	Technical and Report Writing	3 (3+0)

Information Technology Core Courses - 18 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
15	IT-3548	CMP-2122	Web Systems and Technologies	3 (3+0)
16	IT-3743	-	Multimedia Systems and Design	3 (3+0)
17	IT-3441	CMP-3440	Database Administration & Management	3 (3+0)
18	SE-3311	CMP-2123	Object Oriented Analysis & Design	3 (3+0)
19	IT-4511	CMP-2540 CMP-3611	Systemand Network Administration	3 (3+0)
20	IT-4349	CMP-3310	IT Project Management	3 (3+0)

WebEngineering Specialization - 9 Credit Hours (Regular Track)				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
21	IT-4744	IT-3548	Enterprise Application Development	3(3+0)
22	IT-4746	CMP-3110	E-Commerce Applications Development	3(3+0)
23	IT-4545	IT-3548	Mobile Computing	3(3+0)

Computer Networks Specialization - 9 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**

24	IT-3541	CMP-2540	Network Design and Management	3(3+0)
25	IT-4569	CMP-2540	Routing & Switching	3(3+0)
26	IT-4541	IT-4511	Data & Network Security	3(3+0)

Database Management Systems Specializations - 9 Credit Hours				
#	**Code**	**Pre-Req**	**Course Title**	**Cr. Hrs.**
27	IT-4441	CMP-3440	Data Warehousing	3(3+0)
28	IT-4442	CMP-3440	Data Mining	3(3+0)
29	IT-4461	CMP-3440	Enterprise Resource Planning Systems	3(3+0)

Course Coding Scheme

Scheme for Course Code				
Discipline Code	Course Level	Course Category	Course Type	Course Number
2-4 Letters	1 Digit	1 Digit	1 Digit	1 Digits
XX - XXXX	0-9	0-9	0-9	0-9

Course Level		
Level	**Degree**	**Course Type**
1	**UNDER-GRADUATE**	Non-Credited Courses
2		Foundation + Core Level 1 Courses
3		Core Level 2 + Specialization Level 1
4		Specialization Level 2
5	**GRADUATE (MS/M.PHIL)**	Core + Specialization Level 1
6		Specialization Level 2
7	**PHD**	Specified
8		Specified

Course Type	
1	Theory Breadth
2	Theory + Practical (Breadth)
3	Multidisciplinary (Breadth)
4	Theory Depth
5	Theory + Practical (Depth)
6	Multidisciplinary (Depth)
7	Practical
8	Seminar
9	Research

Discipline Code	
CS	Computer Science
IT	Information Technology
SE	Software Engineering
CMP	Computing
SS	Social Studies
MATH	Mathematics
ENG	English
MNG	Management

Course Categories		
0	**Introductory & General Courses**	
1	**Programming Fundamentals & Programming Languages , Discrete Structures, Algorithms and Complexity**	
		Programming Languages
		Discrete Structures
		Algorithms and Complexity
2	**Architecture and Organization**	
		Architecture and Organization
3	**Software Engineering**	
		Software Development Fundamentals
		Software Engineering
		Systems Fundamentals
4	**Information Systems**	
		Information Management
		Information Assurance and Security
5	**Net-Centric Computing**	
		Networking and Communications
		Parallel and Distributed Computing
		Technology Infrastructure
		Platform-based Development
6	**Operating Systems**	
		Operating Systems
7	**Human-Computer Interaction, Graphics and Visual Computing**	
		Human-Computer Interaction
		Graphics and Visual Computing
8	**Intelligent Systems**	
		Intelligent Systems
9	**Computational Science , Capstone Project & Professional Issues**	
		Social Issues and Professional Issues
		Computational Science

Course Matrix forM.Sc. Information Technology Program

(74 Credit Hours)

Semester 1 (19 Cr. Hrs.)	**Semester 2 (19 Cr. Hrs.)**	**Semester 3 (18 Cr. Hrs.)**	**Semester 4 (18 Cr. Hrs.)**
CMP-2210	CMP-3611	CMP-4970	CMP-4970
3 (3+0)	3 (3+0)	3 (0+3)	3(0+3)
Digital Logic and Design	Operating Systems	Capstone Project	Capstone Project
CMP-2122	CMP-2123	IT-3548	IT-4349
4(3+1)	4(3+1)	3(3+0)	3 (3+0)
Programming Fundamentals	Object Oriented Programming	Web Systems and Technologies	IT Project Management
MATH-2215	CMP-3310	CMP-3112	IT-4511
3(3+0)	3 (3+0)	3 (3+0)	3 (3+0)
Basic Mathematics	Software Engineering	Data Structures and Algorithms	System and Network Administration
ICT-2011	IT-3743	CMP-3440	IT-3441
3(3+0)	3(3+0)	3(3+0)	3 (3+0)
Introduction to ICT	Multimedia Systems and Design	Database Systems	Database Administration & Management
MNG-2210	CMP-2540	SE-3311	
3(3+0)	3 (3+0)	3 (3+0)	3 (3+0)
Financial Accounting	Computer Communication and Networks	Object Oriented Analysis & Design	IT Elective II
ENG-2413	CMP-2111		
3(3+0)	3 (3-0)	3 (3+0)	3 (3+0)
Technical and Report Writing	Discrete Structures	IT Elective I	IT Elective III

Course Contents for M.Sc. Information Technology

Contents of Computing Core Courses

Course Title: Programming Fundamentals

Course Code: CMP-2122
Course Structure: **Lectures: 3 / Labs: 1**
Credit Hours: **4**
Prerequisites: **None**

Course Objectives:
The course is designed to familiarize students with the basic structured programming skills. It emphasizes upon problem analysis, algorithm designing, and program development and testing.

Course Syllabus:
Overview of Computer Programming.Principles of Structured and Modular Programming.Overview of Structured Programming Languages.Algorithms and Problem Solving. Program Development: Analyzing Problem, Designing Algorithm/Solution, Testing Designed Solution. Translating Algorithms into Programs.Fundamental Programming Constructs.Data Types.Basics of Input and Output.Selection and Decision (If, If-Else, Nested If-Else, Switch Statement and Condition Operator). Repetition (While and For Loop, Do-While Loops), Break Statement, Continues Statement. Control Structures. Functions.Arrays.Pointers.Records.Files. Testing & Debugging.

Course Outline:

1. Overview of Computer Programming: Machine Languages, Assembly Languages and High-Level Languages, History of C, C Standard Library, Typical C Program Development Environment, Memory Concepts, Arithmetic in C, Decision Making: Equality and Relational Operators. [Ch. 1,2]
2. Principles of Structured and Modular Programming : Algorithms, Pseudocode, Control Structures, The if Selection Statement, The if…else Selection Statement, The while Repetition Statement, Sentinel-Controlled Repetition, Nested Control Structures, Assignment Operators, Increment and Decrement Operators. [Ch. 3]
3. Program Control:Repetition Essentials, Counter-Controlled Repetition, for loop, switch Multiple-Selection Statement, do…while Repetition Statement, break and continue Statements, Logical Operators, Confusing Equality (==) and Assignment (=) Operators. [Ch. 4]
4. Functions:Function Definitions, Function Prototypes, Function Call Stack and Activation Records, Headers, Calling Functions By Value and By Reference, Scope Rules, Recursion, Fibonacci Series, Recursion vs. Iteration [Ch. 5]
5. Arrays:Defining Arrays, Array Examples, Passing Arrays to Functions, Sorting Arrays, Case Study: Computing Mean, Median and Mode Using Arrays, Searching Arrays, Multiple-Subscripted Arrays [Ch. 6]

6. Pointers:Pointer Variable Definitions and Initialization, Pointer Operators, Passing Arguments to Functions by Reference, Using the const Qualifier with Pointers, Bubble Sort Using Call-by-Reference, sizeof Operator, Pointer Expressions and Pointer Arithmetic, Relationship between Pointers and Arrays, Arrays of Pointers, Case Study: Card Shuffling and Dealing Simulation, Pointers to Functions. [Ch. 7]
7. Characters and Strings:Fundamentals of Strings and Characters, Character-Handling Library, String-Conversion Functions, Standard Input/Output Library Functions, String-Manipulation Functions of the String-Handling Library, Comparison Functions of the String-Handling Library, Search Functions of the String-Handling Library, Memory Functions of the String-Handling Library, Other Functions of the String-Handling Library [Ch. 8]
8. Formatted Input/Output:Streams, Formatting Output with printf, Printing Integers, Printing Floating-Point Numbers, Printing Strings and Characters, Other Conversion Specifiers, Printing with Field Widths and Precision, Using Flags in the printf Format Control String, Printing Literals and Escape Sequences, Reading Formatted Input with scanf. [Ch. 9]
9. Structures, Unions, Bit Manipulations and Enumerations:Structure Definitions, Initializing Structures, Accessing Structure Members, Using Structures with Functions, typedef, Example: High-Performance Card Shuffling and Dealing Simulation, Unions, Bitwise Operators, Bit Fields, Enumeration Constants. [Ch. 10]
10. File Processing: Data Hierarchy, Files and Streams, Creating a Sequential-Access File, Reading Data from a Sequential-Access File, Random-Access Files, Creating a Random-Access File, Writing Data Randomly to a Random-Access File, Reading Data from a Random-Access File. [Ch. 11]

Textbook(s):

- C How to Program by Paul Deitel and Harvey Deitel, Prentice Hall; 7th Edition (March 4, 2012)

Reference Material:

- Programming in C by Stephen G. Kochan, Addison-Wesley Professional; 4 edition (September 25, 2013). ISBN-10: 0321776410

Course Title: Object Oriented Programming

Course Code: CMP-2123
Course Structure: Lectures: 3 / Labs: 1
Credit Hours: 4
Prerequisites: CMP-2122(Programming Fundamentals)
Course Objectives:
The course aims to develop students' Object Oriented Programming skills.

Course Syllabus:

1. Objects and Classes, Abstraction, Encapsulation [TB1: Ch9-11]
2. Final Classes, Nested and Inner Classes. [TB2: Ch 5]
3. Inheritance, Abstract Classes, Concrete Classes, Inheritance and Encapsulation.[TB1: Ch12]
4. The is-a Relationship, Inheritance via Abstract Classes, Extending the Hierarchy, Upcasting and Downcasting, Interfaces.[TB1: Ch12]
5. Composition, the has-a Relationship.[TB1: Ch12]
6. Polymorphism.[TB1: Ch 13]

7. Polymorphism, Dynamic (or Late) Binding.[TB1: Ch 13]
8. Interfaces and Polymorphism.[TB1: Ch13]
9. The Wrapper Classes, Boxing and Un-Boxing, Packages.[TB1: Ch14, Ch9.4]
10. Exceptions and Exception Handling.[TB2: Ch 7]
11. File Systems and Paths, File and Directory Handling and Manipulation, Input/Output Streams, Reading Binary Data, Writing binary Data, Writing Text(Characters), Reading Text(Characters), Logging with PrintStream, Random Access Files, Object Serialization. [TB1: Ch 15]
12. Collections, for-each Loop.[TB1: Ch16, 17]
13. GUI Concepts, Components and Containers, Abstract Windows Toolkit and Swing, Windows and Frames, Layout Managers, Panels.[TB1: Ch 18]
14. Event-Driven Programming, The delegation Event Model.[TB1:Ch 19]
15. Event Classes, Mouse Events, Keyboard Events, Using Actions.[TB1: Ch19]
16. Component and JComponent, Buttons, Labels, Text Fields, Text Areas, Dialog Boxes, Checkboxes and Radio Buttons, Menus, JSlider, JTabbedPane.[TB1: Ch 19]

Textbook(s):

- Java Programming: From the Ground Up by Ralph Bravaco and Shai Simonson, McGraw-Hill Higher Education New York, 2010, ISBN 978–0–07–352335–4
- Ivor Horton's Beginning Java by Ivor Horton, John Wiley & Sons, Inc, 7th Edition, 2011, ISBN: 978-0-470-40414-0

Reference Material:

- Java™ Programming by Joyce Farrell, 6th Edition, Cengage Learning, 2012, ISBN-13:978-1-111-52944-4
- Java™ How to Program by Paul Deitel and Harvey Deitel, Pearson, 9th Edition, 2012, ISBN-13:978-0-13-257566-9

Course Title: Discrete Structures

Course Code: CMP-2111
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None
Course Objectives:

The course provides a solid theoretical foundation of discrete structures as they apply to Computer Science problems and structures. The students will learn how to use mathematical notation and solve problems using mathematical tools.

Course Syllabus:

Logic: Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Methods of Proof. Sets & Functions. Algorithms: the Growth of Functions, Complexity of Algorithms, the Integers and Division, Matrices. Number Theory and Cryptography. Mathematical Reasoning: Proof Strategy, Sequences and Summations, Mathematical Induction, Recursive Definitions and Structural Induction, Recursive Algorithms, Program Correctness. The Basics of Counting: The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations. Advanced Counting Techniques: Recurrence Relations, Solving Recurrence Relations, Divide-and-

Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion-Exclusion & its Application. Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings. Graph: Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. Trees: Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees.

Course Outline:

1. Logic: Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Methods of Proof. [TB: Ch. 1]
2. Sets & Functions. [TB: Ch. 2]
3. Algorithms: the Growth of Functions, Complexity of Algorithms, the Integers and Division, Matrices. [TB: Ch. 3]
4. Number Theory and Cryptography. [TB: Ch. 4]
5. Mathematical Reasoning: Proof Strategy, Sequences and Summations, Mathematical Induction, Recursive Definitions and Structural Induction, Recursive Algorithms, Program Correctness. [TB: Ch. 5]
6. The Basics of Counting: The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations. [TB: Ch. 6]
7. Advanced Counting Techniques: Recurrence Relations, Solving Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion-Exclusion & its Application. [TB: Ch. 8]
8. Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings. [TB: Ch. 9]
9. Graph: Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. [TB: Ch. 10]
10. Trees: Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees. [TB: Ch. 11]

Textbook(s):

- Discrete Mathematics and Its Applications by Kenneth H. Rosen, McGraw-Hill Science/Engineering/Math; 7th Edition (2011). ISBN-10: 0073383090

Reference Material:

- Discrete Mathematics by Richard Johnsonbaugh, Pearson; 7th Edition (January 8, 2008). ISBN-10: 0131593188
- Discrete Algorithmic Mathematics by Stephen B. Maurer and Anthony Ralston, A K Peters/CRC Press; 3rd Edition (August 2004). ISBN-10: 1568811667
- Discrete Mathematical Structures by Bernard Kolman, Robert Busby and Sharon C. Ross, Pearson; 6th Edition (2008). ISBN-10: 0132297515
- Discrete Mathematics with Ducks by sarah-marieBelcastro, A K Peters/CRC Press; 1st Edition (June 21, 2012). ISBN-10: 1466504994

Course Title: Data Structures and Algorithms

Course Code: CMP-3112
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3

Prerequisites: CMP-2123 (Object Oriented Programming)

Course Objectives:

This course provides an introduction to the theory, practice and methods of data structures and algorithm design. Students will learn elementary data structures such as stacks, queues, linked lists, sequences, trees and graphs in Java language, and the algorithms designed for manipulating these data structures.

Course Syllabus:

Introduction to Data Structure, primitive Java, Reference Types, Algorithm Analysis.Java collections API (The Java Collections Framework). Recursion, Sorting Algorithms: Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Merge Sort, Quick Sort, Heap Sort, Speed Limit for comparison Sorts, Radix Sort, Bucket Sort.Randomization. Stack and Queue. Linked Lists. Hash Table. Trees.Binary Search Trees.Priority Queue.Binary Heap.Splay Trees.Merging Priority Queues. Graphs: Simple Graphs, Graph Terminology, Paths and Cycles, Isomorphic Graphs, the Adjacency Matrix for a Graph, the Incidence Matrix for a Graph, the Adjacency List for a Graph, Digraphs, Paths in a Digraph, Weighted Digraphs and Graphs, Euler Paths and Hamiltonian Cycles, Dijkstra's Algorithm, Graph Traversal Algorithms. Data Structure Applications: Balanced-Symbol Checker, A simple Calculator, File Compression, A cross-reference generator, Thejosephus problem.Event-Driven Simulation.

Course Outline:

1. Introduction to Data Structure, primitive java, Reference Types, Algorithm Analysis.[TB1:Ch1, 2, 5]
2. Java collections API (The Java Collections Framework). [TB1:Ch 6]
3. Recursion, Sorting Algorithms (Bubble Sort, Selection Sort, Insertion Sort, Shell Sort).[TB1: Ch 6, 7]
4. Sorting Algorithms (Merge Sort, Quick Sort, Heap Sort, Speed Limit for comparison Sorts, Radix Sort, Bucket Sort), Randomization. [TB1: Ch 7, 8]
5. Stack and Queue. [TB1:Ch 16, TB2:Ch 6, 7]
6. Linked Lists. [TB1:Ch 16]
7. Linked Lists. [TB1:Ch 16, TB2:Ch8]
8. Hash Table. [TB1: Ch 20]
9. Trees. [TB1:Ch18]
10. Binary Search Trees, Priority Queue: the Binary Heap. [TB1: Ch 19, Ch 21]
11. Splay Trees, Merging Priority Queues. [TB1:Ch22, Ch23]
12. Graphs (Simple Graphs, Graph Terminology, Paths and Cycles, Isomorphic Graphs, the Adjacency Matrix for a Graph, the Incidence Matrix for a Graph, the Adjacency List for a Graph, Digraphs). [TB1:Ch14, TB2:16]
13. Graphs(Paths in a Digraph, Weighted Digraphs and Graphs, Euler Paths and Hamiltonian Cycles, Dijkstra's Algorithm, Graph Traversal Algorithms) [TB1:Ch14, TB2:16]
14. Data Structure Applications (Balanced-Symbol Checker, A Simple Calculator, File Compression, A Cross-reference Generator, The Josephus problem, Event-Driven Simulation) [TB: Ch 11, 12, 13]

Textbook(s):

- Data Structures & Problem Solving Using Java by Mark Allen Weiss,Addison-Wesley, 4thEdition (October 7, 2009). ISBN-10: 0321541405
- Schaum's Outline of Data Structures with Java by John Hubbard, McGraw-

Hill; 2nd Edition (May 26, 2009). ASIN: B0035X1BQ6

Reference Book(s):

- Data Structures: Abstraction and Design Using Java by Koffman and Wolfgang, Wiley; 2nd Edition (January 26, 2010). ISBN-10: 0470128704
- Data Structures and Algorithm Analysis in Java by Mark Allen Weiss, Prentice Hall; 3rd Edition (November 28, 2011). ISBN-10: 0132576279

Course Title: Digital Logic and Design

Course Code: CMP-2210
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course introduces students with digital circuit of large complexity and how such circuits could be built in a methodological way, starting from Boolean logic and applying a set of rigorous techniques.

Course Syllabus:
Number Systems: Digital Systems, Number Systems and Codes. Unweighted Codes, Binary Storage and Registers, Binary Logic. Boolean Algebra and Logic Gates, Boolean Functions, Canonical and Standard Forms. Digital Logic Gates.Integrated Circuits. Gate-Level Minimization: The Map Method, Product of Sums Simplification, Don't-Care Conditions, NAND and NOR Implementation, Exclusive-OR Function, Karnaugh Maps, QuineMc-Cluskey Method. Combinational Logic: Combinational Circuits, Analysis Procedure, Design Procedure, Binary Adder-Subtractor, Decimal Adder, Binary Multiplier. Magnitude Comparator.Decoders.Encoders.Multiplexers. Synchronous Sequential Logic: Sequential Circuits, Latches, Flip-Flops, Registers and Counters. Memory and Programmable Logic: Random-Access Memory. Memory Decoding.Error Detection and Correction.Read-Only Memory.Programmable Logic Array.Programmable Array Logic.

Course Outline:

1. Number Systems, Operations, and Codes: Decimal Numbers, Binary Numbers, Decimal-to-Binary Conversion, Binary Arithmetic, I's and 2's Complements of Binary, Numbers, Signed Numbers, Arithmetic Operations with Signed Numbers, Hexadecimal Numbers, Octal Numbers, Binary Coded Decimal (BCD), Digital Codes, Error Detection and Correction Codes. [Ch. 2]
2. Logic Gates: The Inverter, The AND Gate, The OR Gate, The NAND Gate, The NOR Gate, The Exclusive-OR and Exclusive-NOR Gates. [Ch. 3]
3. Boolean Algebra and logic Simplification: Boolean Operations and Expressions, Laws and Rules of Boolean Algebra, DeMorgan's Theorem, Boolean Analysis of Logic Circuits, Simplification Using Boolean Algebra, Standard Forms of Boolean Expressions, Boolean Expressions and Truth Tables, The Kamaugh Map, Karnaugh Map SOP Minimization, Karnaugh Map POS Minimization, Five-Variable Karnaugh Maps. [Ch. 4]
4. Combinational logic Analysis: Basic Combinational Logic Circuits, Implementing Combinational Logic, The Universal Property of NAND and

NOR Gates, Combinational Logic Using NAND and NOR Gates. [Ch. 5]

5. Functions of Combinational logic: Basic Adders, Parallel Binary Adders, Ripple Carry versus Look-Ahead Carry Adders, Comparators, Decoders, Encoders. Code Conveners: Multiplexers (Data Selectors), Demultiplexers, Parity Generators/Checkers.[Ch. 6]
6. latches, Flip-Flops, and Timers: Latches, Edge-Triggered Flip-Flops, Flip-Flop Operating Characteristics, Flip-Flop Applications. [Ch. 7]
7. Counters: Asynchronous Counter Operation, Synchronous Counter Operation, Up/Down Synchronous Counters, Design of Synchronous Counters. [Ch. 8]
8. Shift Registers: Basic Shift Register Functions, Serial In/Serial Out Shift Registers, Serial In/Parallel Out Shift Registers, Parallel In/Serial Out Shift Registers, Parallel In/Parallel Out Shift Registers, Bidirectional Shift Registers, Shift Register Counters. [Ch. 9]
9. Memory and Storage: Basics of Semiconductor Memory, Random-Access Memories (RAMs), Read-Only Memories (ROMs), Programmable ROMs (PROMs and EPROMs), Flash Memories. [Ch. 10]
10. Programmable Logic: FPGA [Ch. 11]

Textbook(s):

- Digital Fundamentals by Thomas L. Floyd, Prentice Hall; 9th edition (2007)

Reference Material:

- Digital Fundamentals: A Systems Approach by Thomas L. Floyd, Prentice Hall; 1 edition (July 13, 2012)
- Digital Design, by M. Morris Mano, Michael D. Ciletti, 4th Edition, Prentice Hall (2007). ISBN-10: 0131989243
- Digital Design by Franc Vahid, Wiley; 1st Edition (July 28, 2006). ISBN-10: 0470044373
- Fundamentals of Logic Design by Jr. Charles H. Roth and Larry L Kinney, CL Engineering; 6th Edition (March 13, 2009). ISBN-10: 0495471690

Course Title: Operating Systems

Course Code: CMP-3611
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Objectives:

To help students gain a general understanding of the principles and concepts governing the functions of operating systems and acquaint students with the layered approach that makes design, implementation and operation of the complex OS possible.

Course Syllabus:

Computing Environments.Types and Generation of Operating-System.Key Components. Virtual Machines, System Calls, System Boot, System Programs. Processes, Process Scheduling, Operations on Processes, Inter-process Communication, Communication in Client-Server Systems. Threads: Multithreading Models, Thread Libraries, Threading Issues. CPU Scheduling, Scheduling Criteria, Scheduling Algorithms. Thread Scheduling, Algorithm Evaluation. Process

Synchronization, The Critical-Section Problem, Peterson's Solution, SynchronizationHardware, Semaphores, Classic Problems of Synchronization. Deadlocks Conditions & Handling.Main Memory Management.Virtual Memory Management.File-System and Implementation. I/O Systems: STREAMS, Hardware, Performance, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Bibliographical Notes, Hardware Operations. Case studies: Linux, Windows Operating Systems.

* Labs are preferred in this cours. Lab assignments involving different single and multithreaded OS algorithms.

Course Outline:

1. Introduction: Over view of: Operating Systems, Operating-System Structure, Operating-System Operations, Process management, Memory Management, Storage Management, Protection and Security, Protection and Security, Distributed Systems, Special-Purpose Systems, Computing Environments. [TB: Ch1]
2. Operating-System Structures: Operating-System Services, Operating-System Structure, User Operating-System Interface, Virtual Machines, System Calls, Operating-System Generation, Types of System Calls, System Boot, System Programs. [TB:Ch2].
3. Processes: Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication, Communication in Client- Server Systems. Threads: Multithreading Models, Thread Libraries, Threading Issues. [TB: Ch. 3, 4]
4. CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Thread Scheduling, Algorithm Evaluation. [TB: Ch. 5]
5. Process Synchronization: Background, Monitors, The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classic Problems of Synchronization. [TB: Ch. 6]
6. Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock. [TB: Ch. 7]
7. Main Memory: Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Example: The Intel Pentium. [TB: Ch.8]
8. Virtual Memory: Allocating Kernel Memory, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing. [TB: Ch. 9]
9. File-System Implementation: File-System Structure, Log-Structured File Systems, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery. [TB: Ch. 11]
10. I/O Systems: STREAMS, Hardware, Performance, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Bibliographical Notes, Hardware Operations. [TB: Ch. 13]
11. Security: The Security Problem, Computer-Security, Program Threats, Classifications, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks. [TB: Ch. 15]
12. Case studies: Linux, Windows Operating Systems

Textbook(s):

- Operating System Concepts Essentials by Abraham Silberschatz, Peter B. Galvin and Greg Agne, Wiley; 8th Edition (July 5, 2008). ISBN-10: 0470128720

Reference Material:

- Applied Operating Systems Concepts by Silberschatz A., Peterson, J.L., & Galvin P.C. Wiley; 8th Edition (2011). ISBN-10: 1118112733
- Modern Operating Systems by Tanenmaum A.S., Prentice Hall; 3rd Edition (2007). ISBN-13: 978-0136006633

Course Title: Database Systems

Course Code: CMP-3440
Course Structure: Lectures: 3/ Labs: 0
Credit Hours:3
Prerequisites: None
Course Objectives:
The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts.

Course Syllabus:
Basic Concept: File Processing & Database Approach, Database Applications, Advantages of the DB, Components of the DB Environment, and Evolution of DBs. Database Architecture: DB Development Process, Three Schema Architecture, Data Modeling. Logical Design: E-R Modeling (Entities, Attributes, Relationships; Cardinality Constraints). RDBMS: Logical View of Data, Relational Data Model, Constraints, Transforming ERD/EERD into Relations. The Relational Model: Types, Relations, Relational Algebra, Relational Calculus, Integrity. Normalization. EE-R Diagrams: Development & Constraints, DB Design Life Cycle. DB Development & Management: Introduction to SQL and Basic Commands, SQL Integrity Constraints. Physical DB Design, DB architecture, Query Optimization. SQL Commands: Saving, Listing, Editing, Restoring Table Contents; Logical Operators, Management Commands, Arithmetic Operators, Complex Queries and SQL Functions, Aggregate Function, Grouping Functions, Virtual Tables, Views, Indexes, Joins. Clint-Server & Distributed Environment, ODBC, Bridges, and Connectivity Issues. Concurrency Control with Locking, Serializability, Deadlocks, Database Recovery Management.Distributed Processing and Distributed Databases, DDBMS: Evolution, Architecture, Components, Advantages, Security and Authorization. Physical Design: Storage and File Structure, Efficiency and Tuning.

Course Outline:

1. Databases Overview: Basic Concept; File Processing & Database Approach, Database Applications, Advantages of the DB, Components of the DB Environment, Evolution of DBs.
2. Database Architecture: DB Development Process, Three Schema Architecture, Data Modeling, E-R Modeling (Basic Concepts)
3. Logical Design: E-R Modeling (Entities, Attributes, Relationships; Cardinality Constraints), RDBMS: Logical View of Data; The Relational Data Model
4. Logical Design:Constraints, Transforming ERD/EERD into Relations
5. The Relational Model: Types, Relations, Relational Algebra, Relational

Calculus, Integrity

6. Normalization: First Normal Form, Second Normal Form
7. Normalization: Third Normal Form (3NF), Boyce Codd Normal Form (BCNF)
8. EE-R Diagram**s:** Development & Constraints, DB Design Life Cycle,
9. DB Development & Management: Introduction to SQL and Basic Commands, SQL Integrity Constraints.
10. Physical DB Design, DB architecture, Query Optimization
11. SQL Commands: Saving, Listing, Editing, Restoring Table Contents; Logical Operators, Management Commands
12. Arithmetic Operators, Complex Queries and SQL Functions, Aggregate Function, Grouping Functions
13. Virtual Tables, Views, Indexes, Joins
14. Clint-Server & Distributed Environment, ODBC, Bridges, and Connectivity Issues.
15. Concurrency Control with Locking, Serializability, Deadlocks, Database Recovery Management.
16. Distributed Processing and Distributed Databases,DDBMS: Evolution, Architecture, Components, Advantages, Security and Authorization. Physical Design: Storage and File Structure, Efficiency And Tuning

Textbook(s):

1. Modern Database Management by Fred McFadden, Jeffrey Hoofer, Mary Prescott, Prentice Hall; 11th Edition (July 26, 2012). ISBN-10: 0132662256
2. Database Systems A Practical Approach to Design, Implementation, and Management, 4th Edition, Thomas Connolly, Carolyn Begg, Addison Wesley, 2005.
3. Introduction to Oracle: SQL and PL/SQL ISBN-10: 0131453203

Reference Material:

- Database Design and Relational Theory: Normal Forms and All That Jazz by C. J. Date, O'Reilly Media; 1st Edition (April 24, 2012). ISBN-10: 1449328016
- Fundamentals of Database Systems by R. Elmasri and S. Navathe. 6th Edition, Addison-Wesley (2010). ISBN-10: 0136086209
- Database System Concepts by Abraham Silberschatz, Henry F. Korth and S. Sudarshan. McGraw-Hill; 6th Edition (2010). ASIN: B004Y3YXK2
- Database Systems: a Practical Approach to Design, Implementation and Management by T.Connolly and C.Begg, Addison-Wesley; 5th Edition (2009). ISBN-10: 0321523067
- Modern Database Management System by Fred, Jeffery A. Hoffer and Fred McFadden; Prentice Hall; 7th Edition (April 6, 2004). ISBN-10: 0131453203

Course Title: Software Engineering

Course Code: CMP-3310
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: None
Course Objectives:

To study various software development models and software development life cycles. The concepts of project management, change control, process management, software development and testing are introduced through hands-on team Projects.

Course Syllabus:
The Nature of Software, Nature of WebApps, The Software Process, Software Engineering Practice. Generic Process Models.Specialized Process Models.Systems Analysis and Design.Business Information Systems.Introduction to SDLC, SDLC Phases, System Planning, Preliminary Investigation, SWOT Analysis.Strategic Planning.Information Systems Projects.Requirements Engineering.Data & Process Modeling. Design within the Context of Software Engineering. Design Models. System Architecture.Architectural Styles.User Interface Design.Software Quality Assurance.Validation Testing, System Testing, Internal and External View of Testing.Project Management Concepts.Project Scheduling. Risk Management. Maintenance and Reengineering.

Course Outline:

1. The Nature of Software, Unique Nature of WebApps, Software Engineering, The Software Process, Software Engineering Practice, Software Myths. [TB1: Ch. 1]
2. Generic Process Models: Framework Activity, Task Set, Process Patterns, Process Improvement, CMM, Prescriptive Process Models: Waterfall Model, Incremental Process Model, Evolutionary Process Model. [TB1: Ch. 2]
3. Specialized Process Models: Component Based Development, The Formal Methods Models, Agile Development. [TB1: Ch. 2-3]
4. Introduction to Systems Analysis and Design, Business Information Systems, Information System Components, Types of Information Systems, Evaluating Software, Make or Buy Decision. [TB1: Ch. 1]
5. Introduction to SDLC, SDLC Phases, System Planning, Preliminary Investigation, SWOT Analysis. [TB1: Ch. 2]
6. The Importance of Strategic Planning, Information Systems Projects, Evaluation of Systems Requests, Preliminary Investigation, Systems Analysis, Requirements Modeling, Fact-Finding Techniques. [TB1: Ch. 2-3]
7. Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Requirements Model. [TB1: Ch. 5]
8. Requirements Modelling Strategies, Difference between Structured Analysis and Object Oriented Analysis; Difference between FDD Diagrams & UML Diagrams. [TB2:Ch. 3]
9. Data & Process Modelling, Diagrams: Data Flow, Context, Conventions, Detailed Level DFD's Diagram 0, Levelling, Balancing, Logical Versus Physical Models. [TB2: Ch. 4]
10. Design Within the Context of Software Engineering, The Design Process, Design Concepts, Design Models: Data Design Elements. [TB1: Ch. 8]
11. Architecture Design Elements, Interface Design Elements, Component-Level Design Elements, Deployments Design Elements. [TB: Ch. 8]
12. System Architecture, Architectural Styles, User Interface Design: The Golden Rules, User Interface Analysis and Design, WebApps Interface Design. [TB1: Ch. 9-11]
13. Software Quality Assurance: Background Issues, Elements of Software Quality Assurance, Software Testing Strategies, Strategic Issues, Test Strategies for Conventional Software. [TB1: Ch.16-17]
14. Validation Testing, System Testing, Internal and External View of Testing:

White Box Testing and Black Box Testing Techniques. [TB1: Ch. 17-18)]

15. Introduction to Project Management, Project Scheduling: Gantt Chart, Risk Management: Proactive versus Reactive Risk Strategies, Software Risks, Maintenance and Reengineering: Software Maintenance, Software Reengineering. [TB1: Ch. 28-29]

Textbook(s):

- Software Engineering: A Practitioner's Approach by Roger S. Pressman, McGraw-Hill Science/Engineering/Math; 7th Edition (2009). ISBN-10: 0073375977
- Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225

Reference Material:

- Software Engineering 8E by Ian Sommerville, Addison Wesley; 8th Edition (2006). ISBN-10: 0321313798
- Systems Analysis and Design by Gary B. Shelly, Thomas J. Cashman and Harry J. Rosenblatt, Course Technology; 7th Edition (2007). ISBN-10: 1423912225

Course Title: Computer Communication and Networks

Course Code: CMP-2540
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: None
Course Objectives:

To introduce students with concepts related to computer communication, analogue & digital transmission, network layers, network models (OSI, TCP/IP) and protocol standards. Emphasis is given on the understanding of modern network concepts.

Course Syllabus:

Introduction to Data Communications, Communications Models, Data Networking, and the Internet.Protocol & Architecture.Protocol & Architecture.Data Transmission.Signal Encoding Techniques.Digital Data Communication Techniques.Data Link Control Protocols.Multiplexing.Circuit Switching and Packet Switching.Cellular Wireless Networks Technology & Protocols.Local Area Network Technology & Protocols.Ethernet Technology & Protocols. Wireless LANs: Wireless LAN Technology and Protocols.

Course Outline:

1. Introduction to Data Communications, Communications Models, Data Networking, and the Internet. [TB1: Ch. 1]
2. Protocol & Architecture: The OSI Model, Layered Architecture, Physical, Data Link and Network Layers, Transport, Session, Presentation and Application Layers. [TB1: Ch. 2]
3. Protocol & Architecture: TCP/IP, and Internet-Based Applications. [TB1: Ch. 2]
4. Data Transmission: Concepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments and Channel Capacity, Transmission Media: Guided, Wireless, Line-of-Sight. [TB1: Ch. 3, 4]
5. Signal Encoding Techniques: Digital Data, Digital Signals; Digital Data,

Analog Signals; Analog Data, Digital Signals; Analog Data, Analog Signals. [TB1: Ch. 5]

6. Digital Data Communication Techniques: Asynchronous and Synchronous, Types of Errors, Error Detection, Error Correction, Line Configurations. [TB1: Ch. 6]
7. Data Link Control Protocols: Flow Control, Error Control, High-Level Data Link Control (HDLC). [TB1: Ch. 7]
8. Multiplexing: Frequency-Division, Synchronous Time-Division, Statistical Time-Division, Asymmetric Digital Subscriber Line, xDSL. [TB1: Ch. 8]
9. Circuit Switching, Packet Switching Concepts, Principles and Architecture, Asynchronous Transfer: Role, Architecture and Services. [TB1: Ch. 9]
10. Circuit Switching and Packet Switching: Switched Communication Networks, Circuit-Switching, Circuit-Switching Concepts, Softswitch Architecture, Packet Switching Principles. [TB1: Ch. 11]
11. Cellular Wireless Networks: Principles of Cellular Networks, First-Generation Analog, Second-Generation CDMA, Third-Generation Systems, Fourth-Generation Systems. [TB1: Ch. 13]
12. Local Area Network: Topologies and Transmission Media, LAN Protocol Architecture, Bridges, Hubs and Switches, Virtual LANs. [TB1: Ch. 15]
13. Ethernet: Traditional Ethernet, High-Speed Ethernet, IEEE 802.1Q VLAN Standard. [TB1: Ch. 16]
14. Wireless LANs: Wireless LAN Technology, IEEE 802.11 Architecture and Services, IEEE 802.11 Medium Access Control, IEEE 802.11Physical Layer, IEEE 802.11 Security Considerations. [TB1: Ch. 17]

Textbook(s):

- Data and Computer Communications by William Stallings, Prentice Hall; 9th Edition (August 13, 2010). ISBN-10: 0131392050

Reference Material:

- Data Communications and Networking by BehrouzForouzan, 4th Edition (2007). ISBN 978-007-125442-7
- Computer Networks by Andrew S. Tanenbaum and David J. Wetherall, Prentice Hall; 5th Edition (October 7, 2010). ISBN-10: 0132126958
- Computer Networks and Internets by Douglas E. Comer, Prentice Hall; 5th Edition (April 28, 2008). ISBN-10: 0136066984

Course Title: Capstone Project

Course Code: CMP-4970
Course Structure: Lectures: 0/Labs: 6
Credit Hours: 6
Prerequisites: None
Course Objectives:

The Capstone Project is an opportunity for participants to put their leadership competencies into practice. Capstone Project allows the student to identify and develop a project that puts into practice the leadership skills and competencies learned during the courses of study. Detailed guideline and documentation temples are available with the Department.

Contents of Supporting Elective Courses - 12 Credit Hours

Course Title: Introduction to Information & Communication Technologies

Course Code: ICT-2011
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course introduces students to information and communication technologies and their application in the workplace. Students will get basic understanding of computer software, hardware, and associated technologies. They will also learn how computers are used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace.

Course Syllabus:
Introduction to Computers, The Internet and World Wide Web, Application Software, The System Unit, Input Devices, Output Devices, Storage, System Software, Communications, Databases, Computer Security and Safety, Ethics, and Privacy.

Course Outline:

1. Introduction to Computers: Data and Information, Information Processing Cycle, the Components of a Computer, Advantages and Disadvantages of Using Computers. Networks and the Internet. Computer Software, Categories of Computers, Elements of an Information System, Examples of Computer Usage, Computer Applications in Society [Ch. 1].
2. The Internet and World Wide Web: Key Concepts of the Internet, Evolution of the Internet, The World Wide Web, E-Commerce, Other Internet Services, Netiquette [Ch. 2].
3. Application Software: Business Software, Graphics and Multimedia Software, Software for Home, Personal, and Educational Use, Web Applications, Application Software for Communications. [Ch. 3]
4. The System Unit: Processor, Data Representation, Memory, Expansion Slots and Adapter Cards, Ports and Connectors, Buses, Bays, Power Supply. [Ch. 4]
5. Input Devices:What Is Input? What Are Input Devices? The Keyboard, Pointing Devices, Mouse, Other Pointing Devices, Touch Screens And Touch-Sensitive Pads, Pen Input, Other Input For Smart Phones, Game Controllers, Digital Cameras, Voice Input, Video Input, Scanners And Reading Devices, Biometric Input, Terminals, Putting It All Together, Input Devices For Physically Challenged Users. [Ch. 5]
6. Output Devices: What is Output? Display Devices, Printers, Speakers, Headphones, and Earbuds, Other Output Devices. [Ch. 6]
7. Storage: Hard Disks, Flash Memory Storage, Cloud Storage, Optical Discs, Other Types of Storage. [Ch. 7]

8. System Software: Operating Systems, Operating System Functions, Types Of Operating Systems, Stand-Alone Operating Systems, Server Operating Systems, Embedded Operating Systems, Utility Programs [Ch. 8]
9. Communications: Uses of Computer Communications, Networks, Network Communications Standards, Communications Software, Communications over the Telephone Network, Communications Devices, Home Networks, Communications Channel, Physical Transmission Media, Wireless Transmission Media. [Ch. 9]
10. Databases: Data, and Information, The Hierarchy of Data, Maintaining Data, File Processing Versus Databases, Database Management Systems, Relational, Object-Oriented, and Multidimensional Databases, Web Databases, Database Administration
11. Computer Security and Safety, Ethics, and Privacy:Computer Security Risks, Internet And Network Attacks, Unauthorized Access And Use, Hardware Theft And Vandalism, Software Theft, Information Theft, System Failure, Backing Up, Wireless Security, Health Concerns Of Computer Use, Ethics And Society

Labs:

Lab work should be carried out to develop students' Computer Skills, Operating Systems and Utility Software Skills, E-Mail Skills, Word Processing Skills, Spreadsheet Skills, Electronic Presentation Skills, Web Surfing Skills.

Textbook(s):

- DiscoveringComputers by Gary B. Shelly & Misty E. Vermaat, Course Technology; 1st Edition (January 25, 2011).

Reference Material:

- Computing Essentials 2012 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 22nd Revised Edition (February 1, 2011).
- Computers: Understanding Technology by Fuller, Floyd; Larson, Brian, Fourth Edition, ISBN: 978-0-76383-927-7 (OR Latest Edition.)
- The Concepts of Information Technology by Imran Saeed, AfsanRaza, Tariq Mahmood and ZafarHussain, 6th Edition, IT Series Publications.
- The Essential Guide to Computing: The Story of Information Technology by**by E** Garrison Walters, Prentice Hall PTR (August 11, 2000). ISBN-10: 0130194697
- Computer Applications by Tasleem Mustafa, Tariq Mahmood, Imran Saeed and ZahidJaved, IT Publication Series

Course Title: Basic Mathematics

Course Code:MATH-2215
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course introduces students with key concepts of basic mathematics

Course Syllabus:
Numbers: Integers, Rational and Real number Systems. The Statement Calculus and Logic: Analyzing Arguments Using Truth Tables, Contradiction and Consistency. Mathematical Induction. Sets: Relations and Functions. Counting: Binomial Expansions. Functions: Important Functions, Functions and Angular Measure. Sequences: Limits of Sequences, Series, Infinite Series. Calculus: Continuity and Differentiability, Newton-Raphson Methods, Integrals and Integrations. Algebra: Matrices, Vectors etc.: Equation Solving, More on Matrices, Addition and Subtraction, Determinants, Properties of the Determinant, Cramer's Rule. Probability: Probability - the Rules, Equally Likely Events, Conditional Probability, Bayes, Random Variables and Distributions, Expectation, Moments, Some Discrete Probability Distributions, The Normal Distribution. Looking at Data: Looking at Data, Summary Statistics, Diagrams, Scatter Diagrams.

Course Outline:
1. Numbers: Integers, Rational and Real number Systems. [TB1: 1]
2. The Statement Calculus and Logic: Analyzing Arguments Using Truth Tables, Contradiction and Consistency. [TB1: 2]
3. Mathematical Induction. [TB1: 3]
4. Sets: Relations and Functions. [TB1: 4]
5. Counting: Binomial Expansions. [TB1: 5]
6. Functions: Important Functions, Functions and Angular Measure. [TB1: 6]
7. Sequences: Limits of Sequences, Series, Infinite Series. [TB1: 7]
8. Calculus: Continuity and Differentiability, Newton-Raphson Methods, Integrals and Integrations. [TB1: 8]
9. Algebra: Matrices, Vectors etc.: Equation Solving, More on Matrices, Addition and Subtraction, Determinants, Properties of the Determinant, Cramer's Rule. [TB1: 9]
10. Probability: Probability - the Rules, Equally Likely Events, Conditional Probability, Bayes, Random Variables and Distributions, Expectation, Moments, Some Discrete Probability Distributions, The Normal Distribution. [TB1: 10]
11. Looking at Data: Looking at Data, Summary Statistics, Diagrams, Scatter Diagrams. [TB1: 11]

Textbook(s):
- Mathematics for Computer Scientists by Gareth J. Janacek and Mark Lemmon Close; Ventus Publishing ApS (2009). ISBN-978-87-7681-426-7.

Reference Material:
- Basic Math and Pre-Algebra For Dummies by Mark Zegarelli, For Dummies; 1 edition (October 1, 2007). ISBN-10: 0470135379
- Basic College Mathematics by Elayn Martin-Gay, Pearson; 4 edition (September 23, 2010). ISBN-10: 0321649400

- Basic College Mathematics by Ignacio Bello, McGraw-Hill Science/Engineering/Math; 4 edition (January 4, 2011). ISBN-10: 0073384380.

Course Title: Financial Accounting

Course Code: MNG-2210
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: None
Course Objectives:

Course Objectives:

This course intends to introduce students with knowledge of Financial Accounting required to help them to understand the process of financial management required to develop modern accounting information systems.

Course Syllabus:

Introduction to Accounting, Accounting Principles, Book Keeping, Basics of Financial Statements, Adjustments to Financial Statements, The Cash Book, Bank Reconciliation, Control Accounts, Property, Plant and Equipment (PPE), Accounting Errors, Accounting for Partnerships, Balance Sheet, Financial Asset, Accounting for inventories. Funds flow statement and simple cash flow activities.

Course Outline:

1. Introduction to Accounting: Nature, Purpose and Scope of Accounting, Objectives of Accounting, Users of Accounting Information and Their Respective Needs, Qualities of Useful Accounting Information, Accounting Principles: Going Concern, Accruals, Consistency, Prudence, Business Entity, Duality, Monetary Measurement, Substance Over Form, Realization.
2. Book Keeping: The Accounting Cycle, Double Entry Book-Keeping and Books of Original Entry, The Ledgers, Cash Book and the Trial Balance.
3. Basic Financial Statements: Structure of Financial Statements for a Sole Trader, Statement of Financial Position (The Balance Sheet) for A Sole Trader.
4. Adjustments to Financial Statements: Carriage In and Carriage Out, Bad Debts, Bad and Doubtful Receivables, Bad Debts Recovered, Drawings, Discount Received and Allowed, Accrued and Prepaid Income and Expenses and Depreciation and Disposal of Property, Plant and Equipment.
5. The Cash Book: Two Column Cashbook, Three Column Cashbook, Analytical Cashbook and The Petty Cashbook.
6. Expected Learning Outcomes: Purpose of Bank Reconciliation, Causes of Differences Between Cash and Bank Balances, Bank Reconciliation Process, Bank Overdrafts, and DishonouredCheques.
7. Control Accounts: Uses of Control Accounts, Sales and Purchases Ledger Control Accounts.
8. Property, Plant and Equipment (PPE): Classification of Long-Term Assets, Accounting For PPE, Revenue and Capital Expenditure, Relevant Cost of PPE, Methods of Estimating Depreciation, Revaluation Method, Revaluation of PPE, Exchange of Assets, Disposal of Assets, Schedule of PPE and Presentation and Disclosure of PPE in the Financial Statements.

9. Accounting Errors: Types of Accounting Errors, Errors Not Affecting the Trial Balance and Errors Affecting the Trial Balance.Adjusted Trial Balance, Closing entries and post-closing Trial Balance.
10. Accounting for Partnerships: Introduction to Partnerships, Partnership Agreements, Appropriation of Profit, Personalaccounts, Partners Loan Accounts.

Textbook(s):

- Financial & Managerial Accounting by Jan Williams, Sue Haka, Mark Bettner and Joseph Carcello, McGraw-Hill/Irwin; 16th Edition (2011). ISBN-10: 0078111048

Reference Material:

- Fundamental Accounting Principles with Connect Plus by John Wild, Ken Shaw, and Barbara Chiappetta, McGraw-Hill/Irwin; 20th Edition (December 27, 2010). ISBN-10: 0077505980
- Principles of Managerial Finance by Lawrence J. Gitman and Chad J. Zutter, Prentice Hall; 13th Edition (2011). ISBN-10: 0136119468
- Accounting Principles by Jack L. Smith, Robert M. Keith and William L. Stephens, McGraw-Hill Companies, 3rd Edition (1993). ISBN-10: 0070430748
- Accounting: A Business Perspective (Irwin/Mcgraw-Hill Series in Principles of Accounting) by Roger H. Hermanson, James Don Edwards and Michael W. Maher (1998).ISBN-10: 0075615851

Course Title: Technical and Report Writing

Course Code: ENG-2413
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites:None

Course Objectives:

To effectively plan and structure technical reports and to recognize the various stages in writing a technical report.

Course Syllabus:

Writing for Readers.Academic, Public, and Work Communities.Analyzing Electronic Communities.Discovering and Planning. Purpose, Thesis, and Audience.Drafting. Revising, Editing, and Proofreading. Paragraphs.Clear and Emphatic Sentences.Reasoning Critically.Reading Critically.Arguing Persuasively.Designing Documents.Writing in Online Communities.Speaking Effectively. Academic Writing for Social and Natural Sciences. Public Writing. Researching and Writing.

Course Outline:

1. Writing for Readers: Academic, Public, and Work Communities; Analyzing Electronic Communities; c. Myths and Realities about Writing.
2. Discovering and Planning: Discovering Topics; Generating Ideas; Organizing Information; Planning in Digital Environments.
3. Purpose, Thesis, and Audience: Identifying Your Focus and Purpose; Creating a Thesis; Understanding Your Readers.
4. Drafting: Moving from Planning to Drafting, Drafting Collaboratively,

Drafting in Digital Environments.

5. Revising, Editing, and Proofreading: Making Major Revisions; Making Minor Revisions; Revising Collaboratively; Revising in Digital Environments; Editing; Editing Collaboratively; Proofreading.
6. Paragraphs: Unfocused Paragraphs; Revising for Focus; Incoherent Paragraphs; Revising for Coherence; Poorly Developed Paragraphs; Revising for Development; Using Special-Purpose Paragraphs.
7. Clear and Emphatic Sentences: Unclear Sentences; Revising for Clear Sentences; Revising for Variety and Emphasis.
8. Reasoning Critically: Recognizing Critical Reasoning, Building a Chain of Reasoning, Representing Your Reasoning.
9. Reading Critically: Reading to Understand; Reading to Respond and Evaluate; Using Journals to Turn Reading into Writing.
10. Arguing Persuasively: Recognizing an Issue, Developing Your Stance, Creating an Argumentative Thesis, Developing Reasons and Evidence, Acknowledging Other Perspectives, Arguing Logically, Writing a Position Paper.
11. Designing Documents: Goals of Document Design, Format Choice, Layout, Type Choice, Visuals, Sample Documents. Creating a Visual Argument: Presenting an Issue, Providing Evidence.
12. Writing in Online Communities: Online Expectations, E-mail Conventions, Online Communities, Web Pages, Avoiding Plagiarism and Behaving Ethically Online.
13. Speaking Effectively: Oral Presentations, Preparing an Oral Presentation, Managing Speech Anxiety, Fielding Questions.
14. Academic Writing: Social and Natural Sciences: Goals of Writing in the Social and Natural Sciences, Audiences in the Social and Natural Sciences, Writing Tasks in the Social and Natural Sciences, Types of Writing in the Social and Natural Sciences, Abstract, Informative Report, Lab Report, Research Report,
15. Public Writing: Goals of Public Writing, Public Audiences, Public Writing Tasks, Types of Public Writing, Public Flyer, Letter to the Editor, Oral Presentation.
16. Researching and Writing: Beginning Your Research, Types of Research Writing, Developing a Research Question, Developing a Preliminary Thesis, Creating a Research File and a Timeline, Reading and Notetaking, Summarizing, Paraphrasing, and Synthesizing.

Textbook(s):

- Writer's Companion – The Longman by Chris M. Anson, Robert A. Schwegler and Marcia F. Muth, Pearson Longman, 4th Edition (2007) . ISBN10: 0-20556-252-3

Reference Material:

- Technical English: Writing, Reading, and Speaking by Pickett and Laster. 8th Edition
- The Technical Writer's Companion byAlred, Gerald, Charles T. Brusaw and Walter E. Oliu, 3rd Edition. ISBN 0-312-25978-6.

Contents of IT Core Courses - 18 Credit Hours

Course Title: Web Systems and Technologies

Course Code: IT-3548
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: CMP-2122 (Programming Fundamentals)

Course Objectives:
To introduce students with Web Systems and Technologies.

Course Syllabus:
Introduction: WWW, Web Pages, Web Sites, Web Applications, TCP/IP, TCP/IP Application Services. Web Servers: Basic Operation, Advanced Mechanisms for Dynamic Content Delivery, Advanced Features: Virtual hosting, Chunked transfers, Caching support, Extensibility. HTTP Protocol. SGML, HTML, CSS. XML Languages and Applications: Core XML, XHTML: HTML 5, XHTM MP. Web Service: SOAP, REST, WML, XSL. Web Services: Operations, Processing HTTP Requests, Processing HTTP Responses, Cooki Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery, Advance Functionalities, Server Configuration. Server Security.Web Browsers Architecture and Processes. Active Browser Pages: JavaScript, DHTML, AJAX. Approaches to Web Application Development. Search Technologies. Search Engine Optimization.

Course Outline:

1. Introduction: WWW, Web Pages, Web Sites, Web Applications, TCP/IP, TCP/IP Application Services. Web Servers: Basic Operation, Advanced Mechanisms for Dynamic Content Delivery, Advanced Features: Virtual hosting, Chunked transfers, Caching support, Extensibility. HTTP Protocol [TB1: Ch. 1, 2, 3]
2. Standard Generalized Markup Language, HTML- Structure and syntax, HTML Rendering, Cascading style sheets, Associating styles with HTML documents. [TB1: Ch. 4]
3. XML Languages and Applications, Core XML, XHTML: HTML 5, XHTM MP; Web Service: SOAP, REST, WML, XSL. [TB1: Ch. 5]
4. Web Services: Operations, Processing HTTP Requests, Processing HTTP Responses, Cooki Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery, Advance Functionalities, Server Configuration. Server Security. [TB1: Ch. 6]
5. Web Browsers: Architectural Considerations, Processing Flow, Processing HTTP Requests and Responses, Complex HTTP Interactions. [TB1: Ch. 7]
6. Active Browser Pages: JavaScript, Cascade Style Sheet (CSS), DHTML, AJAX. [TB1: Ch. 8]
7. Approaches to Web Application Development: Programmatic Approaches, Template Approaches, Hybrid Approaches, Separation of Content from Presentation, Frameworks: MVC Approaches, Frameworks. Comparative Survey of Web Applications and Frameworks: [TB1: Ch. 9]
8. Web Application – Struts and JSTL: Virtual Realty Listing Services, The

Textbook: Web Application Architecture: Principles, Protocols and Practices, 2nd Edition, Leon Shklar and Rich Rosen, Copyright © 2009 John Wiley & Sons Ltd
ISBN 978-0-470-51860-1

Structure of the VRLS Application, Design Decisions, Enhancements. [TB1:Ch. 10]

9. Search Technologies: Overview of Algorithm, Searching the Web, Site Search Applications, Search Engine Optimization. [TB1: Ch. 12]

Course Title: Multimedia Systems and Design

Course Code:IT-3743
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites: None
Course Objectives:
The course introduces students with the complete process of multimedia system specifications, formats, design, testing, and prototyping, including the tools and techniques for integrating multimedia content into a product.

Course Syllabus:

What is Multimedia? Text, Multimedia Authoring and Tools, Multimedia Authoring, Multimedia Production, Multimedia Presentation, Automatic Authoring; Editing and Authoring Tools- (Adobe Premiere, Macromedia Director, Macromedia Flash, Dreamweaver), VRML, Handling Images, Sound, Making Animation and Video, Making Multimedia, Multimedia Skills, Planning and Costing, Designing and Producing, Content and Talent, The Internet and Multimedia, Designing for the World Wide Web, Delivering Multimedia Product.

Course Outline:

1. What is Multimedia? Text [TB1. Ch. 1, 2]
2. Multimedia Authoring and Tools: Multimedia Authoring, Multimedia Production, Multimedia Presentation, Automatic Authoring; Editing and Authoring Tools- Adobe Premiere, Macromedia Director, Macromedia Flash, Dreamweaver; VRML. [TB2: Ch. 2]
3. Handling Images. [TB1. Ch. 3]
4. Handling Sound. [TB1. Ch. 4]
5. Handling Animation. [TB1. Ch. 5]
6. Handling Video. [TB1. Ch. 6]
7. Making Multimedia. [TB1. Ch. 7]
8. Multimedia Skills. [TB1. Ch. 8]
9. Planning and Costing. [TB. Ch. 9]
10. Designing and Producing [TB1. Ch. 10]
11. Content and Talent. [TB1. Ch. 11]
12. The Internet and Multimedia [TB1. Ch. 12]
13. Designing for the World Wide Web; [TB1. Ch. 13]
14. Delivering. [TB1. Ch. 14]

[Instructors need to devise a content delivery and Lab work plan using a multimedia Authoring tool in line with the contents of the textbook]

Text book(s):

- Multimedia Making It Work Eighth Edition by Tay Vaughan, McGraw-Hill Osborne Media; 8 Edition (October 29, 2010). ISBN-10: 0071748466
- Fundamentals of Multimedia by Z. M. Li and M. S. Drew, Prentice Hall (2004), ISBN: 0-13-127256-X

Reference Material:

- Digital Multimedia by N. Chapman and J. Chapman. 2nd Edition, Wiley 2004, ISBN: 0-470-85890-7
- The Technology of Video and Audio Streaming by David Austerberry, Focal Press; 2nd Edition (2004). ISBN-10: 0240805801
- Multimedia Security: WaTermarking, Steganography, and Forensics by Frank Y. Shih, CRC Press; 1st Edition (2012), ISBN-10: 1439873313
- Multimedia Computing by Daniel Cunliffe and Geoff Elliott, Lexden Publishing Ltd. (2005). ISBN-10: 1904995055
- Multimedia Foundations: Core Concepts for Digital Design by Vic Costello, Ed Youngblood and Susan Youngblood, Focal Press; 1st Edition (2012). ISBN-10: 0240813944

Course Title: Database Administration & Management

Course Code: IT-3441
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: CMP-3440 (Database Systems)
Course Objectives:

- Make Students fully understand the concepts and technical issues of Database Administration.
- Make Students to have good understanding of internal functionality of Database Management System and can Administrator Huge Database implemented in a DBMS.
- They Should Perform Database Administration tasks i.e. Backup and Recovery and Performance Tuning of Databases.

Course Syllabus:

Installation; SQL* Plus; Oracle Enterprise Manager; DBA Tools. Oracle Architectural Components: Oracle Server. Oracle Instance.Physical Structure.SGA.Shared Pool.Library Cache.Data Dictionary Cache.Large Pool.Processes.Managing Oracle Instances.Startup and Shutdown Database.Managing Files.Creating Database and Data dictionary.Managing Tablespaces.Operations with Tablespaces. Data File Management, Segments, Block. Managing Undo Data, Undo Data Statistics: Managing Tables and Users. Indexes Management, Maintaining Data Integrity, Constraints.Managing Privileges.Basic Oracle Net Architecture.Server Side Configuration.Client Side Configuration. Usage and Configuration of Oracle Shared Server. Backup and Recovery. Sizing Shared Pool, Sizing Buffer Cache, I/O Issues. Tuning Rollback Segments. Tuning Shared Servers, Types of Locks, Block Efficiency, Storage hierarchy, Avoiding Dynamic allocation, Statistics, PCTFREE and PCTUSED, Monitoring Index Usage.

Course Outline:

1. Installation; SQL* Plus; Oracle Enterprise Manager; DBA Tools. Oracle Architectural Components: Oracle Server; Oracle Instance.
2. Physical Structure; SGA; Shared Pool; Library Cache; Data Dictionary Cache; Large Pool; User Process; Server Process; Background Processes.
3. Managing an Oracle Instance: Parameter File; Creating SPFILE; Oracle Managed Files; Startup and Shutdown Database; Alert Log File; Background Trace File; User Trace File.

4. Creating Database and Data dictionary.
5. Managing Control Files and Redo Log Files.
6. Managing Tablespaces, Operations with Tablespaces.
7. Data File Management, Segments, Block.
8. Managing Undo Data, Undo Data Statistics: Managing Tables and Users:
9. Indexes Management, Maintaining Data Integrity, Constraints. Managing Privileges.
10. Basic Oracle Net Architecture: Types of Networks, Oracle Net Services, Oracle Shared Server, Connection Manager, Oracle Net Connections.
11. Server Side Configuration: The Listener Process; Configuring Listener, Sessions, Creating and Managing Listener.
12. Client Side Configuration: Host Naming Method, Local Naming Method, Net Assistant, Configurations. Usage and Configuration of Oracle Shared Server.
13. Backup and Recovery, Instance and Media Recovery, Configuration of Archive log mode, User Managed Complete Recovery, Loading Data into Database, Tuning Tools, Sizing Shared Pool, Sizing Buffer Cache, I/O Issues.
14. Tuning Rollback Segments, Latches, Rollback Segment Tuning Shared Servers, Types of Locks, Block Efficiency, Storage hierarchy, Avoiding Dynamic allocation, Statistics, PCTFREE and PCTUSED, Monitoring Index Usage.

Textbook(s):

- Oracle Database 11g DBA Handbook by Bob Bryla and Kevin Loney, McGraw-Hill Osborne Media; 1st Edition (December 6, 2007). ISBN-10: 0071496637
- Database Administration: The Complete Guide to DBA Practices and Procedures by Craig S. Mullins, Addison-Wesley Professional; 2nd Edition (October 21, 2012). ISBN-10: 0321822943

Reference Material:

- Database Systems: A Practical Approach to Design, Implementation and Management by Thomas M. Connolly and Carolyn E. Begg, Addison-Wesley; 5th Edition (2009). ISBN-10: 0321523067
- Oracle Database 11g The Complete Reference by Kevin Loney, McGraw-Hill Osborne Media; 1st Edition (2008). ISBN-10: 0071598758
- Oracle Database 11g Release 2 Performance Tuning Tips & Techniques (Oracle Press) by Rich Niemiec, McGraw-Hill Osborne Media; 1st Edition (2012). ISBN-10: 0071780262
- Online Material URL http://otn.oracle.com

Course Title: Object-Oriented Analysis and Design

Course Code: IT-3311
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: CMP-2123 (Object Oriented Programming
Course Objectives:

In this course, the students will learn how to produce detailed object models and designs from system requirements; use the modeling concepts provided by UML; identify use cases and expand into full behavioral designs; expand the analysis into a design ready for implementation and construct designs that are reliable.

Course Syllabus:

Principles of Object Technology. UML Unification, UML Diagrams, Unified Process & Rational Unified Process, RUP Disciplines, Requirements Types, Use Case Modeling. EBP Guidelines.System Use Case Diagram, Use Case Table, Activity Diagram, Supplementary Specifications, Vision Document, Glossary, Rational Rose Overview.Elaboration Phase of RUP; Configuration Management; System Sequence Diagram, Domain Model.Implementation of System Sequence & Domain Model. Use Case Dependencies. Analysis Use Case Diagram, Implementation of Sequence, Collaboration, Analysis Use Case Diagram.State Chart Diagrams and Implementation. Design Patterns. Use Case Realization Using GRASP Patterns, Design Model. Modeling Generalization, Creating Design Class Diagram, Mapping Data Model to Domain Model.Implementation of Design Class Diagram, Coding patterns, Mapping Design to Code.Patterns for Assigning Responsibilities, Polymorphism, Pure Fabrication, Indirection, Protected Variation.GoF Design Patterns. [Students must be introduced with Object Diagram, Component Diagram, Package Diagram, Deployment Diagram, Network Diagram.]

Course Syllabus:

1. Principles of Object Technology: Introduction to Object Technology, Principles of Modeling, and Principles of Object Orientation [TB: Ch. 1.1-5]
2. Introduction to UML, Unification, UML Diagrams, Unified Process & Rational Unified Process, RUP Disciplines, Case Study Analysis and Basics, Case Study, About Inception, Feasibility and Risk Analysis [TB: Ch. 1.6, 2.1-6, 3.1-2,4.1-3]
3. Understanding Requirements, Requirements Types, Use Case Modeling: Use Case Writing Styles, EBP Guidelines [TB: Ch. 5.1, 6.1-8]
4. System Use Case Diagram, Use Case Table, Activity Diagram, Supplementary Specifications, Vision Document, Glossary, Rational Rose Overview, Use Case & Activity Diagram Modeling in Rational Rose [TB: Ch. 6.9, 6.12-17, 7.2-4 & 7]
5. Elaboration Phase of RUP; Configuration Management; System Sequence Diagram, Domain Model : Identifying Business Classes, Associations, Attributes [TB: Ch.8.2-5,9.2-4,10.1-4,11.1-7,12.1-4]
6. Implementation of System Sequence & Domain Model: Use Case Operational Contracts, Business Sequence, Analysis Sequence & Collaboration Diagrams [TB: Ch. 11.10, 12.9, 13.1-2, 13.9, 15.1-7]
7. Use Case Dependencies. Analysis Use Case Diagram, Implementation of Sequence, Collaboration, Analysis Use Case Diagram [TB: Ch. 25.1-5, 15.6-7]
8. State Chart Diagrams and Implementation [TB: Ch. 29.1-5, 29.8, Ch. 1-13, 25, 29]
9. Design Patterns: GRASP: Information Expert, Creator, Cohesion & Coupling, Controller [Ch. 16.1-10]
10. Use Case Realization Using GRASP Patterns, Design Model: DeTermining Visibility
    [TB: Ch. 17.1-9, 18.1-3]
11. Modeling Generalization, Creating Design Class Diagram, Mapping Data Model to Domain Model [TB: Ch. 26.1-7, 27.1-10, 19.1-6, 34.5-9]
12. Implementation of Design Class Diagram, Coding patterns, Mapping Design to Code [TB: Ch. 19.6, 20.1-11]

13. More Patterns for Assigning Responsibilities, Polymorphism, Pure Fabrication, Indirection, Protected Variation. GoF Design Patterns: Adapter, Factory [TB: Ch. 22.1-4, 23.1-2]
14. Gof: Singleton, Strategy, Composition, Façade and Discuss Remaining Patterns [TB: Ch. 23.4-8]

Note: [Students must be introduced with Object Diagram, Component Diagram, Package Diagram, Deployment Diagram, Network Diagram.]

Textbook(s):

- Applying UML and patterns: An introduction to Object-Oriented Analysis and Design and Iterative Development by Craig Larman, Prentice Hall; 3rd Edition (October 30, 2004). ISBN-10: 0131489062

Reference Material:

- Fundamental of Object-Oriented Design in UML by Meiler Page-Jones, Addison Wesley, 2000. ISBN: 020169946X.
- The Unified Modeling Language User Guide by G. Booch, J. Rambaugh and I. Jakobson, Addison-Wesley Professional; 2nd Edition (2005). ISBN-10: 0321267974.
- The Unified Modeling Language Reference Manual by James Rumbaugh, Ivar Jacobson and Grady Booch, Addison-Wesley Professional; 2nd Edition (2004). ISBN-10: 032171895X.
- The Unified Modeling Language User Guide by Grady Booch, James Rumbaugh and Ivar Jacobson, Addison-Wesley Professional; (2005). ISBN-10: 0321267974.
- Visual Modeling with Rational Rose 2000 and UML by Terry Quatrani, Addison Wesley, 2000. ISBN: 0201699613.
- The Rational Unified Process Made Easy: A Practitioner's Guide to the RUP: A Practitioner's Guide to the RUP by Per Kroll, Philippe Kruchten and Grady Booch, Addison-Wesley Professional (2003). ISBN-10: 0321166094.
- The Rational Unified Process: An Introduction by Philippe B. Kruchten, Addison-Wesley Professional; 3rd Edition (2003). ISBN-10: 0321197704.

Course Title: Systems and Network Administration

Course Code: IT-4511
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: CMP-2540(Computer Communication and Networks), CMP-3611 (Operating Systems)

Course Objectives:

This course will give an overview of systems and network administration based on both Windows and Linux environments. The objective are common system administration tasks and practices and how to implement and maintain standard services like email, file sharing, DNS and similar.

Course Syllabus:

Introduction to System Administration (SA).SA Components.Server Environment (Microsoft and Linux). Reliable Products, Understand the Cost of Server Hardware,

Consider Maintenance Contracts and Spare Parts, Maintaining Data Integrity, Put Servers in the Data Center, Client Server OS Configuration, Providing Remote Console Access. Comparative Analysis of OS.Important Attributes, Key Features, Pros and Cons. Linux Installation and verification. Configuring Local services and managing basic system issues. Administer users and groups. Software Management.Managing Network Services and Network monitoring tools. Boot Management and Process Management. IP Tables and filtering.Securing network traffic. Advance File systems and logs. Bash Shell Scripting. Configuring Servers (FTP, NFS, Samba, DHCP, DNS and Apache).Configuring LYNC and Sharepoint 2010 on Windows Server 2008.

Course Outline:

1. Introduction to System Administration: Systems, SA Components, Building a Site from Scratch, Growing a Small Site, Going Global, Replacing Services, Moving a Data Center, Handling a High Rate of Office Moves, Assessing a Site (Due Diligence)
2. Server Environment (Microsoft and Linux): Known for Reliable Products, Understand the Cost of Server Hardware, Consider Maintenance Contracts and Spare Parts, Maintaining Data Integrity, Put Servers in the Data Center, Client Server OS Configuration, Provide Remote Console Access
3. Comparative Analysis of most demanded OS: Important Attributes, Key Features, Pros and Cons
4. Linux Installation and verification
5. Configuring Local services and managing basic system issues
6. Administer users and groups
7. Software Management
8. Managing Network Services and Network monitoring tools
9. Boot Management and Process Management
10. IP Tables and filtering
11. Securing network traffic
12. Advance File systems and logs
13. Bash Shell Scripting
14. Configuring Servers (FTP, NFS, Samba) LAB
15. Configuring Servers Cont. (DHCP, DNS and Apache) LAB
16. Configuring LYNC and Sharepoint 2010 on Windows Server 2008 LAB

Textbook(s):

1. The Practice of System and Network Administration, Second Edition by Thomas Limoncelli, Christina Hogan and Strata Chalup, Addison-Wesley Professional; 2nd Edition (2007). ISBN-10: 0321492668
2. Red Hat Enterprise Linux 6 Bible: Administering Enterprise Linux Systems by William vonHagen, 2011

Reference Material:

3. Studyguide for Practice of System and Network Administration by Thomas A. Limoncelli, Cram101; 2nd Edition (2011). ISBN-10: 1428851755
4. Microsoft Windows Server 2008 R2 Administration Instant Reference by Matthew Hester and Chris Henley, ISBN-10: 0470525398.
5. Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009). ISBN-10: 142009159X (TB2)
6. Windows Administration Latest Edition, Microsoft Press

7. Linux Administration Guide Latest Edition

Course Title: IT Project Management

Course Code: IT-4349
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: CMP-3310 (Software Engineering)
Course Objectives:
To develop students' ability to plan and manage software development projects successfully, maximizing the return from each stage of the software development life cycle.

Course Syllabus:
Introduction to Software Project Management, PM Tools, PMI's Knowledge Areas, PMI Framework, PMI Process Groups. Understanding Organizations.Project Planning.Project Evaluation.Selection of an Appropriate Approach in Project.Software Effort Estimation.Activity Planning. Risk Management. Evaluating the Risks to the Schedule. Risk Control, RMMM, Configuration Management & Maintenance, Environment for Configuration Control. Resource Allocation.Monitoring & Control.Review and Evaluation.Challenges of Outsourcing in Project Management, Presentations.

Course Outline:

1. Introduction: Software Project Versus Other Type of Projects Dimensions of a Software Project, Activities in SPM, Setting Goals & Objectives, Business Case, Significance of Processes, Project Vs. Program Management, [TB1: Ch. 1, Handouts]
2. Introduction of PM Tools, PMI's Knowledge Areas, Technical Fundamentals in SPM, Lifecycle Relationships, Classic Mistakes Product-Process-Peoples-Technology Mistakes [TB2, Handouts]
3. PMI Framework, PMI Process Groups: Process Initiating Process Group, Planning Process Process Group, Executing Process, Process Monitoring and controlling, Closing Process Group, Project Charter, Statement of Work.[TB2, Handouts]
4. Understanding Organizations, Organizational Structures, Functional -Project – Matrix, Organizational Impact on Projects, Identifying stakeholders: Define Responsibilities, Authority Relationships, Position Qualifications [TB2, Handouts]
5. Project Planning: Project Selection, Project Scope, Project Infrastructure, Analyze Project Characteristics, Identify Project & Product Activities, Work Break Down Structure [TB1: Ch. 3]
6. Project Evaluation: Strategic Assessment, Technical Assessment, Economic Assessment, Project Portfolio Management, Cost-Benefit Analysis, Cash Flow Forecasting, Cost-Benefit Evaluation Techniques, Procurement Management, Procurement Tools &Techniques, Types of Contracts [TB1: Ch. 2]
7. Selection of an Appropriate Approach in Project: Choosing Technologies, Technical Plan, Waterfall Model, V-Model, Spiral Model, Software Prototyping, Incremental Delivery, Agile Process Model: Dynamic Systems Development Method, Extreme Programming, Selection of Most Appropriate Process Model [TB1: Ch. 4]

8. Software Effort Estimation: Work Breakdown Structure (WBS) and Its Types, Estimation Problems, Software Estimation Techniques: Expert Judgment, Estimating By Analogy, LOC, Function Point Estimation, and COCOMO [TB1: Ch. 5]
9. Activity Planning: Project and Activities, Sequencings and Scheduling Activities, Network Planning Models, Formulation of Network Model, Adding the Time Dimensions, The Forward Pass, The Backward Pass, Identifying the Critical Path, Identifying the Critical Activities Project, AOA, GanttChart, (Installation & Configuration of Software Tools like MS-Project).[TB1: Ch. 6]
10. Risk Management: Categories of Risks, A Framework for Dealing with Risks, Evaluating the Risks to the Schedule: PERT, Importance of Risk, Types Of Risk, Risk Identification Techniques, Project Risk and Change Management [TB1: Ch. 7]
11. Risk Control, RMMM, Configuration Management & Maintenance, Environment for Configuration Control, Configuration Control vs. Version Control [TB1: Ch. 7, OLM]
12. Resource Allocation: Nature of Resources, Identifying Resource Requirements, Scheduling Resources, Resource Scheduling Techniques[TB1: Ch. 8]
13. Monitoring & Control: Creating Framework, Collecting Data, Visualizing Progress, Cost Monitoring, Earned Value, Change Control [TB1: Ch. 9]
14. Review and Evaluation: DeTermining Satisfaction of Requirements, Reviewing And Evaluating Performance, Project Closure: Project Documentation, Cutover/Migration, Quality Standards, Project Closing. [TB2]
15. Challenges of Outsourcing in Project Management, Presentations

Textbook(s):

- Software Project Management by Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009). ISBN-10: 0077122798
- A Guide to the Project Management Body of Knowledge, 3rd Edition (PMBOK Guides), ISBN-13: 978-1930699458

Reference Material:

- Applied Software Project Management by Andrew Stellman and Jennifer Greene, O'Reilly Media; 1st Edition (2005). ISBN-10: 0596009488
- Software Project Survival Guide (Pro -- Best Practices) by Steve McConnell, Microsoft Press; 1stEdition (1997), ISBN-10: 1572316217
- Mastering Software Project Management: Best Practices, Tools and Techniques by Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing (2010). ISBN-10: 1604270349
- Effective Project Management: Traditional, Agile, Extreme by Robert K. Wysocki, Wiley; 6th Edition (2011). ISBN-10: 111801619X
- The Software Project Manager's Handbook - Principles that work at work by Dwayne Phillips, 2nd Edition, IEEE Computer Society Press and Wiley Inter-science, 2004. ISBN 0-471-67420-6

WebEngineering Specialization - 9 Credit Hours (Regular Track)

Course Title: Enterprise Application Development

Course Code: IT-4744
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: IT-3548 (Web Systems and Technologies)
Course Objectives:
The course is aimed at creating robust enterprise applications using J2EE technologies that allow for rapid change and growth.

Course Syllabus:
Object-Oriented Programming Review, Software Architectures Overview, Challenges and Platform of Enterprise Application Development, J2EE Scenarios, J2EE Platform Technologies, The Client Tier, The Web Tier, The Enterprise JavaBeans Tier, Integrating with the Enterprise Information System Tier, Packaging and Deployment, Transaction Management, Security, J2EE Internationalization and Localization, Architecture of the Sample Application.

Course Outline:
1. Object-Oriented Programming Review, Software Architectures Overview: Desktop, File/Server, 2-Tier Client/Server, Multi-Tier Client/Server. [TB: Ch. 1]
2. Challenges of Enterprise Application Development, the Platform for Enterprise Solutions, J2EE Scenarios. [TB: Ch. 2]
3. J2EE Platform Technologies: Component Technologies, Platform Roles, Platform Services, Service Technologies, Communication Technologies. [TB: Ch. 3]
4. The Client Tier: Client Considerations, General Design Issues and Guidelines, Design Issues and Guidelines for Browser Clients, Design Issues and Guidelines for Java Clients. [TB: Ch. 4]
5. The Web Tier: The Purpose of the Web Tier, Web-Tier Technologies, Web-Tier Application Structure, Web-Tier Application Framework Design. [TB: Ch. 5]
6. The Enterprise JavaBeans Tier: Business Logic and Business Objects, Enterprise Beans as J2EE Business Objects, Remote and Local Client Views, Entity Beans, Session Beans, Message-Driven Beans, Design Guidelines, Portability Guidelines. [TB: Ch. 6]
7. Integrating with the Enterprise Information System Tier: Integration Scenarios, J2EE Integration Technologies, Application Integration Design Approaches, Developing an Integration Layer. [TB: Ch. 7]
8. Packaging and Deployment: Packaging Components, Roles and Tasks, Packaging J2EE Applications, Deployment Descriptors, Deployment Tools. [TB: Ch. 8]
9. Transaction Management: Transactional Concepts, J2EE Platform Transactions, J2EE Transaction Technologies, Client Tier Transactions, Web Tier Transaction Guidelines, Enterprise JavaBeans Tier Transactions, EIS Tier Transactions, J2EE Resource Manager Types. [TB: Ch. 9]
10. Security: Security Threats and Mechanisms, Authentication, Authorization, Protecting Messages, Auditing. [TB: Ch. 10]
11. J2EE Internationalization and Localization: Internationalization Concepts and Terminology, Using J2SE Internationalization APIs in J2EE Applications,

Web Tier Internationalization, EIS Tier Internationalization, Internationalized Application Design, Internationalizing Applications with XML, Logging Messages. [TB: Ch. 11]

12. Architecture of the Sample Application: J2EE Architecture Approaches, Sample Application Overview, Designing the Sample Application, Architecture of the Sample Application. [TB: Ch. 12]

Textbook(s):

- Designing Enterprise Applications with the J2EE™ Platform by Inderjeet Singh; Beth Stearns; Mark Johnson; 2nd Edition, Prentice Hall (March 25, 2002). Print ISBN-10: 0-201-78790-3

Reference Material:

- Mastering Enterprise JavaBeans 3.0 bySriganesh, R.P., Brose, G., And Silverman, M. Wiley Publishing, Indianapolis, (2006). ISBN 0-471-78541-5.
- Core J2EE Patterns: Best Practices and Design Strategies by Deepak Alur, Dan Malksand JohnCrupi, Prentice Hall; 2nd Edition (May 10, 2003). ISBN-10: 0131422464
- Sun Certified Enterprise Architect for Java EE Study Guide by Mark Cade and Humphrey Sheil, Prentice Hall; 2nd Edition (February 8, 2010). ISBN-10: 0131482033

Course Title: E-Commerce Applications Development

Course Code: IT-4746
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites:CMP-3110 (Software Engineering)
Course Objectives:

This course focuses on electronic commerce applications, technologies, and tools which are used to conduct business on the World Wide Web.

Course Syllabus:

An overview of e-Commerce & Models, Planning an e-Commerce Framework, Managing Products and Categories, Product Variations and User Uploads, Enhancing the User Experience, The Shopping Basket, The Checkout and Order Process, Shipping and Tax, Discounts, Vouchers, and Referrals, Checkout, Taking Payment for Orders, User Account Management, Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping, Deploying, Security, and Maintenance, SEO.

Course Outline:

1. e-Commerce: An overview of e-Commerce, Brick 'N Mortar stores vs Service-based companies , e-Commerce Models, e-Commerce popular sites: iStockphoto, WooThemes, eBay, Amazon, Play.com. [TB: Ch.1]
2. Planning an e-Commerce Framework: Designing a framework, Patterns, Model-View-Controller, Registry , Singleton, Structure, Building a framework, Routing requests. [TB: Ch.2]
3. Products and Categories: Product information, Category information, Structuring Content, Versioning, Building products, categories, and content functionality, Routing products and categories. [TB: Ch.3]
4. Product Variations and User Uploads: Giving users choice, Giving users control, Shopping. [TB: Ch.4]

5. Enhancing the User Experience: The importance of user experience, Search, Providing wish lists, Making Recommendations, Stock Checking, Customer's Feed Back, Processing reviews/comments. [TB: Ch.5]
6. The Shopping Basket: Creating A Basket, Basket Contents, Managing the Basket, Cleaning the Basket. [TB: Ch.6]
7. The Checkout and Order Process: The Process, Authentication, Payment Method, Order Processed. [TB: Ch.7]
8. Shipping and Tax: Shipping Methods, Shipping Costs, Shipping Rules, Tracking, Tax
   Calculation. [TB: Ch.8]
9. Discounts, Vouchers, and Referrals: Discount codes, Purchasable Voucher Codes, Referrals. [TB: Ch.9]
10. Checkout: Checkout process consideration, Order process review, Authentication & Confirmation. [TB: Ch.10]
11. Taking Payment for Orders: Taking payment, Payment System, Payment gateway, Taking Payment Online, Taking payment offline. [TB: Ch.11]
12. User Account Features: User Account Area, Changing Details, Viewing & Managing Orders. [TB: Ch.12]
13. Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping , etc. [TB: Ch.3]
14. Deploying, Security, and Maintenance, SEO. [TB: Ch.14, 15]

Textbook(s):

- PHP 5 E-commerce Development by Michael Peacock, Packt Publishing (January 20, 2010). ISBN-10: 184719964X

Reference Material:

- Introduction to E-Commerce by Jeffrey F. Rayport, McGraw-Hill, 2nd Edition (2007). ISBN-10: 0071232664
- E-Commerce by Kenneth Laudon and Carol GuercioTraver, Prentice Hall; 8th Edition (2011). ISBN-10: 0138018812
- The Legal Environment of Business: Text and Cases - Ethical, Regulatory, Global, and Corporate Issues by Frank B. Cross and Roger LeRoy Miller, South-Western College/West; 8th Edition (2011). ISBN-10: 0538453990
- e-Business and e-Commerce How to Program by Harvey M. Deitel, Paul J. Deitel and Tem R. Nieto, Prentice Hall; 1st Edition (2000). ISBN-10: 013028419X
- The Complete E-Commerce Book:Design, Build & Maintain a Successful Web-based Business by Janice Reynolds, Cmp Books (2000). ISBN-10: 157820061X
- Effortless E-Commerce with PHP and MySQL by Larry E. Ullman, New Riders; 1st Edition (2010). ISBN-10: 0321656229

Course Title: Mobile Computing

Course Code: IT-4545
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites:IT-3548 (Web Systems and Technologies)
Course Objectives:

The course is aimed to prepare students to grasp the concepts and features of mobile computing technologies and applications.

Course Syllabus:

Introduction to Mobile Computing, Architecture of Mobile Software Applications, Mobile Development Frameworks and Tools.Creating Consumable Web Services for Mobile Devices.Memory Management.Mobile Applications.Mobile User-Interface Design.Dynamic Linking.Concurrency.Managing Resources. Introduction to Mobile Application Development with Andriod. Introduction to Mobile Application Development with IOS. Introduction to Mobile Application Development with Windows Phone. Introduction to Mobile Application Development with Blackberry.

Course Outline:

1. Introduction to Mobile Computing, Architecture of Mobile Software Applications, Introduction to Mobile Development Frameworks and Tools. [TB2: Ch. 1,2]
2. Creating Consumable Web Services for Mobile Devices: Intro to Web Services, Web Services Languages (Formats), Creating and Debugging Web Services [TB2: Ch. 3].
3. Memory Management: Design Patterns for Limited Memory, Strategies for Allocating Variable to Memory, Memory Management in Mobile Java, Symbian OS Memeory Management.[TB1] Ch. 2
4. Mobile Applications: Components of Mobile Application, Workflow for Application Development, Techniques for Composing Application, Application Models in Mobile Java, Symbian OS Application Infrastructure. [TB1] Ch. 3
5. Mobile User-Interface Design: Effective Use of Screen, Understanding Mobile Application Users, Understanding Mobile Information Design, Understanding Mobile Platforms, Using the Tools of Mobile Interface Design. [TB 2: Ch. 4]
6. Dynamic Linking: Introduction to DLL, Implementation Techniques & Plugins, Managing Memory in DLL, Rules of Thumb for Using DLL, Mobile Java and Dynamic Linking, Symbian OS Dynamic Libraries. [TB1]Ch. 4
7. Concurrency: Introduction, Infrastructure for Concurrent Programming, Faking Concurrency, MIDP Java and Concurrency, Symbian OS and Concurrency. [TB1]Ch. 5
8. Managing Resources: Resource-Related Concerns in Mobile Devices, Common Concerns, MIDP Java, Symbian OS. [TB1] Ch. 6
9. Security: Secure Coding and Design, Infrastructure for Enabling Secure Execution, Security Features in MIDP Java, Symbian OS Security. [TB1] Ch. 8
10. Introduction to Mobile Application Development with Andriod [TB2: Ch. 6]
11. Introduction to Mobile Application Development with IOS [TB2: Ch. 7]
12. Introduction to Mobile Application Development with Windows Phone [TB2: Ch. 8]
13. Introduction to Mobile Application Development with Blackberry [TB2: Ch. 9]

Textbook(s):

1. Programming Mobile Devices: An Introduction for Practitioners by TommiMikkonen, Wiley; 1st Edition (March 19, 2007). ISBN-10: 0470057386.
2. Professional Mobile Application Development by Jeff McWherter& ScottGowell, Wrox; 1st Edition (September 4, 2012). ISBN-10: 1118203909

Reference Material:

- Mobile Computing Principles: Designing and Developing Mobile

Applications with UML and XML by Reza B'Far and Roy T. Fielding, Cambridge University Press (2004). ISBN-10: 0521817331.

- Mobile Design and Development: Practical concepts and techniques for creating mobile sites and web apps (Animal Guide) by Brian Fling, O'Reilly Media; 1st Edition (2009). ISBN-10: 0596155441.
- Fundamentals of Mobile and Pervasive Computing by Frank Adelstein, Sandeep KS Gupta, Golden Richard III and Loren Schwiebert, McGraw-Hill Professional; 1st Edition (2004). ISBN-10: 0071412379.
- Mobile Design Pattern Gallery: UI Patterns for Mobile Applications by Theresa Neil, O'Reilly Media (2012). ISBN-10: 1449314325.
- Programming Android: Java Programming for the New Generation of Mobile Devices by ZigurdMednieks, Laird Dornin, G. Blake Meike and Masumi Nakamura, O'Reilly Media; 2nd Edition (2012). ISBN-10: 1449316646.
- Beginning Android 4 Application Development by Wei-Meng Lee, Wrox; 1st Edition (March 6, 2012). ISBN-10: 1118199545

Computer Networks Specialization - 9 Credit Hours

Course Title: Network Design and Management

Course Code:IT-3541
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: CMP-2540 (Computer Communication and Networks)
Course Objectives:
This course is aimed to prepare students to design and manage various aspects of organizational network.

Course Syllabus:
Analyzing Business Goals and Constraints.Top-Down Network Design Methodology.Characterizing the Existing Internetwork.Designing a Network Topology.Designing Models for Addressing and Numbering.Selecting Switching and Routing Protocols.Developing Network Security Strategies.Developing Network Management Strategies.Physical Network Design.Selecting Technologies and Devices for Enterprise Networks.Testing Network Design.Optimizing Network Design.Documenting Network Design. Network Management Standards & Models. SNMP Management.SNMP Management.Broadband Network Management.

Course Outline:

1. Analyzing Business Goals and Constraints: Using a Top-Down Network Design Methodology, Analyzing Business Goals, Analyzing Business Constraints. Analyzing Technical Goals and Tradeoffs: Scalability, Availability, Network Performance, Security, Manageability, Usability, Adaptability, Affordability, Making Network Design Tradeoffs. [TB1: Ch. 1, 2]
2. Characterizing the Existing Internetwork: Characterizing the Network Infrastructure, Checking the Health of the Existing Internetwork. Characterizing Network Traffic: Characterizing Traffic Flow, Characterizing Traffic Load, Characterizing Traffic Behavior, Characterizing Quality of Service Requirements. [TB1: Ch. 3, 4]

3. Designing a Network Topology: Hierarchical Network Design, Redundant Network Design Topologies, Modular Network Design, Designing a Campus Network Design Topology, Virtual LANs, Wireless LANs, Redundancy and Load Sharing in Wired LANs, Server Redundancy, Workstation-to-Router Redundancy, Designing the Enterprise Edge Topology, Secure Network Design Topologies. [TB1: Ch. 5]
4. Designing Models for Addressing and Numbering: Guidelines for Assigning Network Layer Addresses, Designing a Model for Naming. [TB1: Ch. 6]
5. Selecting Switching and Routing Protocols: Making Decisions as Part of the Top-Down Network Design Process, Selecting Switching Protocols, Selecting Routing Protocols, IP Routing. [TB1: Ch. 7]
6. Developing Network Security Strategies: Network Security Design, Security Mechanisms, Modularizing Security Design, [TB1: Ch. 8]
7. Developing Network Management Strategies: Network Management Design, Network Management Architectures, Selecting Network Management Tools and Protocols. [TB1: Ch. 9]
8. Physical Network Design: Selecting Technologies and Devices for Campus Networks: LAN Cabling Plant Design, LAN Technologies, Selecting Internetworking Devices for a Campus Network Design, Example of a Campus Network Design. [TB1: Ch. 10]
9. Selecting Technologies and Devices for Enterprise Networks: Remote-Access Technologies, Selecting Remote-Access Devices for an Enterprise, WAN Technologies, Example of a WAN Design. [TB1: Ch. 11]
10. Testing Network Design: Using Industry Tests, Building and Testing a Prototype Network System, Writing and Implementing a Test Plan for Network Design, Tools for Testing a Network Design. [TB1: Ch. 12]
11. Optimizing Network Design: Optimizing Bandwidth Usage with IP Multicast Technologies, Reducing Serialization Delay, Optimizing Network Performance to Meet Quality of Service Requirements, Cisco IOS Features for Optimizing Network Performance. Documenting Network Design: Responding to a Customer's Request for Proposal, Contents of a Network Design Document [TB1: Ch. 13, 14].
12. Network Management Standards & Models; SNMPv1 Network Management: Organization, Information, Communication and Functional Models. [TB2: Ch 3,4, 5]
13. SNMP Management: SNMPv2 & SNMPv3 [TB2: Ch 6,7]
14. SNMP Management: RMON; Network Management Tools, Systems, and Engineering. [TB2: Ch 8,9]
15. Broadband Network Management: WAN (Wired and Optical Access Networks). [TB2: Ch 12,13]

Textbook(s):

- Top-Down Network Design by Priscilla Oppenheimer, Cisco Press; 3 Edition (September 3, 2010). ISBN-10: 1587202832 (TB1)
- Network Management: Principles and Practice by Mani Subramanian; Timothy A. Gonsalves; N. Usha Rani, Pearson Education India (2010). ISBN-10: 81-3172-759-9

Reference Material:

- Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009). ISBN-10: 142009159X (TB2)

- Networks: Design and Management by Steven Karris, Orchard Publications (August 2002). ISBN-10: 0970951140
- Network Design: Management and Technical Perspectives by Teresa C. Piliourasand KornelTerplan, CRC Press (August 19, 1998). ISBN-10: 0849334047
- Network Warrior by Gary A. Donahue, O'Reilly Media; 2nd Edition (May 13, 2011). ASIN: B004W8ZL3W
- Modeling and Tools for Network Simulation by Klaus Wehrle, MesutGünes, and James Gross, Springer (September 23, 2010). ISBN-10: 3642123309
- The Practice of System and Network Administration by Thomas Limoncelli, Christina Hogan, and Strata Chalup, Addison-Wesley Professional; 2nd Edition (July 15, 2007). ISBN-10: 0321492668
- Network Management: Principles and Practice by Mani Subramanian; Timothy A. Gonsalves and N. Usha Rani, Pearson Education India (2010). ISBN-10: 81-3172-759-9

Course Title: Routing & Switching

Course Code: IT-4569
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: CMP-2540 (Computer Communication and Networks)
Course Objectives: This course focuses on advanced IP addressing techniques, in Termediate routing protocols, command-line interface configuration of switches, Ethernet switching, VLANs, STP, and VTP. Emphasis will be placed on application and demonstration of skills acquired in pre-requisite courses. Upon completion, students should be able to perform tasks related to VLSM, routing protocols, switching concepts and configuration, STP, VLANs, and VTP.

Course Syllabus:
Ethernet Basic: Ethernet Layer 1, Ethernet Layer 2, Switching and Bridging Logic, SPAN and RSPAN.: VLANs, VLAN TrunkingPrortocols, VLAN Trunking: ISL and 802.1Q, Configuring PPPoE. Spanning Tree Protocol: 802.1d Spanning Tree Protocol, Optimizing Spanning Tree, Protecting STP, Troubleshooting Complex Layer 2 Issues.IP Addressing.IP Services.IP Forwarding (Routing).EIGRP.OSPF.IGP Routing.Fundamentals of BGP Operations.BGP Routing Policies.Wide Area Network.IP Multicasting. IP Multicast Routing.

Course Outline:

1. Ethernet Basic: Ethernet Layer 1, Ethernet Layer 2, Switching and Bridging Logic, SPAN and RSPAN. [TB: Ch. 1]
2. Virtual LANs and VLAN Trunking: VLANs, VLAN TrunkingPrortocols, VLANTrunking: ISL and 802.1Q, Configuring PPPoE. [TB: Ch. 2]
3. Spanning Tree Protocol: 802.1d Spanning Tree Protocol, Optimizing Spanning Tree, Protecting STP, Troubleshooting Complex Layer 2 Issues. [TB: Ch. 3]
4. IP Addressing: IP Addressing &Subnetting, CIDR, Private Addressing, and NAT. [TB: Ch. 4]
5. IP Services: ARP, Proxy ARP, Reverse ARP, BOOTP, and DGCP; HSRP, VRRP,and GLBP; Syslog, Web Cache Communication Protocol,

Implementing and Using: IPSLA, NetFlow, Router IP Trafic Export, FTP, Embedded Event Manager, Remote Monitoring, TFTP Server, Secure Copy Protocol, HTTP and HTTPs Access, Telnet Access, SSH Access. [TB: Ch. 5]

6. IP Forwarding (Routing): IP Forwarding, Mutilayer Switching, Policy Routing, Optimized Edge Routing and Performance Routing. [TB: Ch. 6]
7. EIGRP: Basic States, EIGRP Convergence, EIGRP Configuration, [TB: Ch. 7]
8. OSPF: OSPF Database Exchange, OSPF Design and LSAs, OSPF Configurations, Virtual Link Configuration, Configuring OSPF Authentication, OSPF Stub Router Configuration. [TB: Ch. 8]
9. IGP Routing: Routing Map, Prefix Lists, and Administrative Distance; Router Redistribution, Router Summarization, Default Routes, Troubshooting Complex Layer 3 Issues. [TB: Ch. 9]
10. Fundamentals of BGP Operations: Building BGP Neighbor Relationships, Building the BGP Table, Building the IP Routing Table. [TB: Ch. 10]
11. BGP Routing Policies: Routing Filtering and Routers Summarization, BGP Pathe Attributes and the BGP Decision Processes, Configuring BGP Policies. [TB: Ch. 11]
12. Wide Area Network: Point-to-Point Protocol, Frame Relay Concepts, Frame Relay Configuration. [TB: Ch. 15]
13. IP Multicasting: Need of Multicasting, Multicasting IP Addresses, Managing Distribution of Multicast Trafic with IGMP, LAN Multicast Optimizations. [TB: Ch. 16]
14. IP Multicast Routing: Basic, Dense-Mode Routing Protocols, LAN- Specific Issues with PIM-DM and PIM-SM, Sparse-Mode Routing Protocols. [TB: Ch. 17]

Textbook(s):

- CCIE Routing and Switching Certification Guide (4th Edition) by Wendell Odom, Rus Healy and Denise Donohue, Cisco Press; 4th Edition (December 18, 2009). ISBN-10: 1587059800

Reference Material:

- Packet Guide to Routing and Switching by Bruce Hartpence, O'Reilly Media (September 3, 2011). ISBN-10: 1449306551
- CCIE Routing and Switching v4.0 Quick Reference by Brad Ellis, Jacob Uecker and Steven Means, Cisco Press (October 4, 2010). ASIN: B00452V45O

Course Title: Data & Network Security

Course Code: IT-4541
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: IT-4511(System and Network Administration)
Course Syllabus:
Network Security Overview, Understanding Defenses, Cryptography, Security Policies, Secure Design, Web Security, Router Security, Firewalls, Intrusion Detection System, Remote Access, Virtual Private Networks, Public Key Infrastructure, Wireless Security, Logging and Auditing, Case Studies.

Course Outline:

1. Network Security Overview: Defining Trust, Weaknesses and Vulnerabilities, Responsibilities for Network Security, Security Objectives, the Need for Security, Risk and Vulnerability, TCP/IP Suite Weaknesses, Buffer Overflows, Spoofing Techniques, Social Engineering. [TB1: Ch. 1,2]
2. Understanding Defenses: Digital IDs, Intrusion Detection System, PC Card-Based Solutions, Physical Security, Encrypted Login, Firewalls, Reusable Passwords, Antivirus Software, Encrypted Files, Biometrics. [TB1: Ch. 3]
3. Cryptography: Introduction, Cryptography versus Cryptanalysis, Modern-Day Techniques. [TB1: Ch. 4]
4. Security Policies: Defining a Security Policy, Importance of a Security Policy, Development Process, Incident Handling Process, Security Wheel, Sample Security Policy. [TB1: Ch. 5]
5. Secure Design: Network Design-Principles, Network Design-Methodology, Return on Investment, Physical Security Issues, Switches and Hubs. [TB1: Ch. 6]
6. Web Security: Hardening, Case Study. [TB1: Ch. 7]
7. Router Security: Basic Router Security, Router Security to Protect the Network, CBAC, Case Study. [TB1: Ch. 8]
8. Firewalls: Firewall Basics, Different Types of Firewalls, Enhancements for Firewalls, Placing Filtering Routers and Firewalls. [TB1: Ch. 9]
9. Intrusion Detection System: Introduction to Intrusion Detection, Host-Based IDSs, Network-Based IDSs, IDS Management Communications-Monitoring the Network, Sensor Maintenance, Case Study: Deployment of IDS Sensors in the Organization and Their Typical Placement. [TB1: Ch. 10]
10. Remote Access: AAA Model, AAA Servers, Lock-and-Key Feature, Two-Factor Identification, Case Study: Configuring Secure Remote Access. [TB1: Ch. 11]
11. Virtual Private Networks: Generic Routing Encapsulation Tunnels, IP Security, VPNs with IPSec, Case Study: Remote Access VPN. [TB1: Ch. 12]
12. Public Key Infrastructure: Public Key Distribution, Trusted Third Party, PKI Topology, Enrollment Procedure, Revocation Procedure, Case Study: Creating Your Own CA. [TB1: Ch. 13]
13. Wireless Security: Different WLAN Configurations, What Is a WLAN? How Wireless Works, Risks of Open Wireless Ports, War-Driving and War-Chalking, SAFE WLAN Design Techniques and Considerations, Case Study: Adding Wireless Solutions to a Secure Network. [TB1: Ch. 14]
14. Logging and Auditing: Logging, SYSLOG, Simple Network Management Protocol, Remote Monitoring, Service Assurance Agent, Case Study. [TB1: Ch. 15]

Textbook(s):

- Network Security Fundamentals by GertDeLaetand GertSchauwers, Cisco Press; 1st Edition (September 18, 2004). ISBN-10: 1587051672

Reference Material:

- Network Security Bible by Eric Cole, Wiley; 2nd Edition (September 8, 2009). ISBN-10: 0470502495
- Network Security Essentials: Applications and Standards by William Stallings, Prentice Hall; 4th Edition (March 22, 2010). ISBN-10: 0136108059
- Security in Computing by Charles P. Pfleeger and Shari Lawrence Pfleeger, Prentice Hall; 4th Edition (2006). ISBN-10: 0132390779
- CISSP All-in-One Exam Guide, 6th Edition by Shon Harris, McGraw-Hill

Osborne Media; 6th Edition (2012). ISBN-10: 0071781749

- Hacking Exposed 7: Network Security Secrets & Solutions, Seventh Edition by Stuart McClure, Joel Scambray and George Kurtz, McGraw-Hill Osborne Media; 7th Edition (2012). ISBN-10: 0071780289

Course Title: Data Warehousing

Course Code: IT-4441
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: CMP-3440 (Database Systems)
Course Syllabus:

Introduction to Data Warehousing, Data Warehouse System Lifecycle, Analysis and Reconciliation of Data Sources, User Requirement Analysis, Conceptual Modeling, Conceptual Design, Workload and Data Volume, Logical Modeling, Logical Design, Data-staging Design, Indexes for the Data Warehouse, Physical Design, Data Warehouse Project Documentation, Case Studies, Tools for Data Warehousing: MS SQL and Teradata.

Course Outline:

1. Introduction to Data Warehousing: Brief History, Characteristics, Architecture, Data Staging and ETL, Multidimentional Model, Meta-data, Accessing Data Warehouse, ROLAP, MOLAP, and HOLAP. [TB1: Ch. 1]
2. Data Warehouse System Lifecycle: Risk Factors, Top-Down vs Bottom-Up, Data Mart Design Phases, Methodological Framework – Data-Driven, Requirement-Driven; Testing Data Marts. [TB1: Ch. 2]
3. Analysis and Reconciliation of Data Sources: Inspecting and Normalization Schemata, Integration Problems, Integration Phases, Defining Mapping. [TB: Ch. 3]
4. User Requirement Analysis: Interviews, Glossary-based Requirement Analysis, Additional Requirements. [TB: Ch. 4]
5. Conceptual Modeling: Dimensional Fact Model, Events and Aggregation, Temporal Aspects, Overlapping Fact Shcemata, Formalizing the Dimensional Fact Model. [TB: Ch. 6]
6. Conceptual Design: ER Schema-based Design, Relational Schema-based Design, XML Schema-based Design, Mixed-approach Design. Requirement-driven Approach Design. [TB: Ch. 6]
7. Workload and Data Volume [TB1: Ch. 7]
8. Logical Modeling: MOLAP and HOLAP Systems, ROLAP Systems, Views, Temporal Scenarios. [TB1: Ch. 8]
9. Logical Design: From Fact Schemata to Start Schemata, View Materialization, View Fragmentation. [TB1: Ch. 9]
10. Data-staging Design: Population Reconciled Databases, Cleansing Data, Populating Dimensional Tables, Populating Fact Tables, Populating Materialized View
11. Indexes for the Data Warehouse: B*-Tree Indexes, Bitmap Indexes, Projection Indexes, Join & Star Indexes, Spatial Indexes, Join-Algorithm. [TB1: Ch. 11]
12. Physical Design: Optimizers, Index Selection, Splitting a Database into Tablespaces, Allocating Data Files, Disk Block Size. [TB1: Ch. 12]
13. Data Warehouse Project Documentation: Data Warehouse Levels, Data Mart Level, Fact Level

14. Case Studies, Tools for Data Warehousing: MS SQL and Teradata

Textbook(s):

- Data Warehouse Design: Modern Principles and Methodologies by MatteoGolfarelli and Stefano Rizzi, McGraw-Hill Osborne Media; 1st Edition (May 26, 2009). ISBN-10: 0071610391

Reference Material:

- Building the Data Warehouse by William H. Inmon, Wiley; 4th Edition (2005). ISBN-10: 0764599445
- The Data Warehouse Lifecycle Toolkit : Expert Methods for Designing, Developing, and Deploying Data Warehouses by Ralph Kimball, Laura Reeves, Margy Ross and Warren Thornthwaite, Wiley (August 13, 1998). ISBN-10: 0471255475
- Data Warehousing Fundamentals for IT Professionals by PaulrajPonniah, Wiley; 2nd Edition (2010). ISBN-10: 0470462078
- Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and AmitAsthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419

Course Title: Data Mining

Course Code: IT-4442
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: CMP-3440 (Database Systems)

Course Objectives:

The course introduces students with basic applications, concepts, and techniques of data mining and to develop their skills for using recent data mining software to solve practical problems in a variety of disciplines.

Course Syllabus:

Data-Mining Concepts, Preparing the Data, Data Reduction, Learning From Data, Statistical Methods, Decision Trees and Decision Rules, Artificial Neural Networks, Ensemble Learning, Cluster Analysis, Association Rules, Web Mining and Text Mining, Genetic Algorithms, Fuzzy Sets and Fuzzy Logic, Visualization Methods, Data Mining Tools: Weka, CBA and Yale, etc.

Course Outline:

1. Data-Mining Concepts: Introduction, Data-Mining Process, Large Data Sets, Data Warehouses for Data Mining, Business Aspects Data Mining. [TB1: Ch. 1]
2. Preparing the Data: Raw Data- Representation, Characteristics, Transformation; Missing Data, Time-Dependent Data, Outlier Analysis. [TB1: Ch. 2]
3. Data Reduction: Dimensions of Large Data Sets, Feature Reduction, Relief Algorithm, Entropy Measure for Ranking Features, PCA, Value Reduction, Feature Discretization: ChiMerge Technique, Case Reduction. [TB1: Ch. 3]
4. Learning From Data: Learning Machine, SLT, Types of Learning Methods, Common Learning Tasks, SVMs, kNN: Nearest Neighbor Classifier, Model Selection versus Generalization, Model Estimation. [TB1: Ch. 4]
5. Statistical Methods: Statistical Inference, Assessing Differences in Data Sets, Bayesian Inference, Predictive Regression, ANOVA, Logistic Regression,

Log-Linear Models, LDA. [TB1: Ch. 5]

6. Decision Trees and Decision Rules: Decision Trees, Generating & Pruning Decision Tree, CART Algorithm &Gini Index, Limitations of Decision Trees and Decision Rules. TB1: Ch. 6]
7. Artificial Neural Networks: Model of an Artificial Neuron, Architectures of ANNs, Learning Process, Learning Tasks Using ANNs, Multilayer Perceptrons, Competitive Networks and Competitive Learning, SOMs. [TB1: Ch.7]
8. Ensemble Learning: Ensemble-Learning Methodologies, Combination Schemes for Multiple Learners, Bagging and Boosting, AdaBoost. [TB: Ch. 8]
9. Cluster Analysis: Clustering, Similarity Measures, Agglomerative Hierarchical Clustering, Partitional Clustering, Incremental Clustering, DBSCAN Algorithm. BIRCH Algorithm, Agglomerative Hierarchal and Partition Clustering Algorithms, Clustering Validation. [TB: Ch. 9]
10. Association Rules: Market-Basket Analysis, Algorithm Apriori, From Frequent Itemsets to Association Rules, Improving the Efficiency of the Apriori Algorithm, FP Growth Method, Associative-Classification Method, Multidimensional Association–Rules Mining. [TB: Ch. 10]
11. Web Mining and Text Mining: Web Mining, Web Content, Structure, and Usage Mining, HITS and LOGSOM Algorithms, Mining Path–Traversal Patterns, PageRank Algorithm, Text Mining, Latent Semantic Analysis. [TB: Ch. 11]
12. Genetic Algorithms: Fundamentals of GAs, Optimization Using GAs, Schemata, TSP, Machine Learning Using GAs, GAs for Clustering. [TB: Ch. 13]
13. Fuzzy Sets and Fuzzy Logic: Fuzzy Sets, Fuzzy-Set Operations, Extension Principle and Fuzzy Relations, Fuzzy Logic and Fuzzy Inference Systems, Multifactorial Evaluation, Extracting Fuzzy Models from Data, Data Mining and Fuzzy Sets
14. Visualization Methods: Perception and Visualization, Scientific Visualization and Information Visualization, Parallel Coordinates, Radial Visualization, Visualization Using Self-Organizing Maps, Visualization Systems for Data Mining
15. Data Mining Tools: Weka, CBA and Yale, etc.

Textbook(s):

- Data Mining: Concepts, Models, Methods, and Algorithms by MehmedKantardzic, Wiley-IEEE Press; 2nd Edition (August 16, 2011). ISBN-10: 0470890452

Reference Material:

- Data Mining: Concepts and Techniques, Third Edition (The Morgan Kaufmann Series in Data Management Systems) by Jiawei Han, MichelineKamber and Jian Pei, Morgan Kaufmann; 3rd Edition (2011). ISBN-10: 0123814790
- Principles of Data Mining (Adaptive Computation and Machine Learning) by David J. Hand, HeikkiMannila and Padhraic Smyth, A Bradford Book (August 1, 2001). ISBN-10: 026208290X
- Data Mining and Data Warehousing: Practical Machine Learning Tools Techniques by Ram Kumar Singh and AmitAsthana, LAP LAMBERT Academic Publishing (2012). ISBN-10: 3659118419
- Information-Statistical Data Mining: Warehouse Integration with Examples of

Oracle Basics (The Springer International Series in Engineering and Computer Science) by Bon K. Sy and Arjun K., Springer; 1st Edition (2003). ISBN-10: 1402076509

- Building the Data Warehouse by William H. Inmon, Wiley; 4th Edition (2005). ISBN-10: 0764599445

Course Title: Enterprise Resource Planning Systems

Course Code: IT-4461
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: CMP-3440 (Database Systems)
Course Objectives:

An ERP system is software that runs all areas of an organization including accounting and finance, HR, sales and distribution, production, purchasing and inventory. This course covers ERP theory and practice. Course content includes evolution of ERP systems, business process reengineering, process mapping, ERP life cycle, ERP functionality, ERP bolt-ons and security and risk issues.

Course Syllabus:

Introduction to Enterprise Resource Planning Systems.ERP Technology.ERP and Business Process Reengineering.Systems Diagramming and the Process Map. ERP Life Cycle: Planning and Package Selection. ERP Life Cycle: Implementation and Operation and Maintenance. ERP Sales, CRM and Knowledge Management.ERP Financials.Human Capital Management, Self-Service and Outsourcing.Manufacturing Systems and Supply Chain.Auditing ERP.Business Intelligence and Performance Management.

Course Outline:

1. Introduction to Enterprise Resource Planning Systems. [TB. Ch. 1]
2. ERP Technology. [TB. Ch. 2]
3. ERP and Business Process Reengineering. [TB. Ch. 3
4. Systems Diagramming and the Process Map. [TB. Ch. 41]
5. ERP Life Cycle: Planning and Package Selection. [TB. Ch. 5]
6. ERP Life Cycle: Implementation and Operation and Maintenance. [TB. Ch. 6]
7. ERP Sales, CRM and Knowledge Management. [TB. Ch. 7
8. ERP Financials. [TB. Ch. 8]
9. Human Capital Management, Self-Service and Outsourcing. [TB. Ch. 9]
10. Manufacturing Systems and Supply Chain. [TB. Ch. 10]
11. Auditing ERP . [TB. Ch. 11]
12. Business Intelligence and Performance Management. [TB. Ch. 12]

Textbook(s):

- Modern ERP: Select, Implement & Use Today's Advanced Business Systems by Marianne Bradford, lulu.com (October 19, 2009). ISBN-10: 0557012910.

Reference Materials:

- Managerial Issues of Enterprise Resource Planning Systems by David Olson, McGraw-Hill/Irwin; 1st Edition (September 10, 2003). ISBN-10: 0072861126
- Enterprise Resource Planning by Bret Wagner by Ellen Monk, Course Technology; 3rd Edition (February 4, 2008). ISBN-10: 1423901797

- ERP Systems byDimpiSrivastava by AartiBatra, I K International Publishing House (February 15, 2010). ISBN-10: 9380578148

Curriculum
of
MS Information Technology
for
Main Campus, Sub Campuses,
and
Affiliated Colleges



Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall 2018)

Curriculum for MS Information Technology

Program's Rationale

A high pace of innovations in technologies for communication, computation, interactivity, and delivery of information introduced invention like *the Internet, the World Wide Web, email, bulletin board system, virtual communities, E-commerce*, and other online technologies. These inventions brought a paradigm shift in business world - from data processing to information processing - converting industrial society to an "information society." This paradigm shift not only affected the way scientists conduct their research but also expedite the pace of inventions. As a result Computing becomes a rapidly progressing domain. In recent years, many significant developments have been made and many new concepts have been introduced. For example, "Computational Lens" which articulates a new relationship between computer science and other sciences, "Ternary Computing" dealing with computing for the masses, "e-Science" managing massive experimental data and collaborating via the Net, "Computational Thinking", "Cloud Computing", "Biological Computing", etc. In parallel, the integration of computing in other disciplines introduces new disciplines such as "Computational-x" (e.g., computational mathematics, computational physics, computational finance, etc.) and "x- Informatics" (e.g., bio-informatics, dental-informatics, clinical-informatics, health-informatics, etc.). Many such developments compel IT graduates to update their knowledge to meet the needs of the time. One of the key rationales behind MS(IT) program is the development of a dynamic curricula structure that allows IT graduates to gain a broad technical understanding of current and evolving technologies in the IT field with an emphasis on moving technology from the laboratory to the realm of business development through offering Breadth-Based, Depth-Based, and Integrated Breadth & Depth-Based courses. Students may choose a particular option, which is the most appropriate to their planned future career. Through offering these options, the program develops technically competent, highly productive, and self-motivated professionals in tune with the demands of an ever changing market. The program will groom not only IT professionals, but also experts from other domains offering a unique and comprehensive body of knowledge that exposes the learners to a practical application of information technology within an area of specialization.

Program Structure

The Program is designed for full-time students. The program comprises of 30 Cr. Hrs. with 3 core courses, 6 elective courses, and a research thesis of 6 Cr. Hrs. The dynamic structure of the program allows students to choose a particular option, which is the most appropriate for planned future career. Followings are the program details:

Program Aim & Objectives

MS(IT) Program is aimed to create, expand, disseminate and teach the information technology body of knowledge through academics, applications and research which positively impact society locally, nationally, and internationally.

One of the key objectives of the program is to produce well rounded individuals who are productive and responsible members of society familiar with the technical concepts and practices in the computing & information technology domains. The program provides graduates with competency and knowledge to take on appropriate professional roles in information technology industry or to pursue further education. Following are the key objectives of the program:

- Use and apply current technical concepts and practices in the core information technologies.
- Analyze, identify and define the requirements that must be satisfied to address problems or opportunities faced by individuals or organizations.
- Identify and evaluate current and emerging technologies and assess their impact on individuals, organizations and society; including ethical, legal and policy issues.
- Demonstrate independent critical thinking and problem solving skills.
- Collaborate in teams to accomplish a common goal by integrating personal initiative and group cooperation.
- Communicate effectively and efficiently with clients, users and peers both verbally and in writing, using appropriate terminology.
- Recognize the need for continued learning throughout career.

Duration

The **minimum duration** for completion of MS degree is two years. The HEC allows a **maximum period of four years** to complete MS degree requirements.

Eligibility:

16-years of education with 2.5 CGPA or equivalent in science/engineering discipline preferably with 4 years degree program of BS (SE/CS/IT/EE/CE) or equivalent from HEC recognized university or degree awarding institute.

Degree Requirements

For the award of MS degree, a student must have:

a. Passed courses totalling at least 30 credit hours, including three core courses.
b. Obtained a CGPA of 2.5 or more.

Distribution of Courses:

Followings are the distribution of total credit hours:

Category or Area	Credit Hours
Core	12
Elective	12
Thesis/Project/Course work	6
Total Credit Hours	30

List of Core Courses

S. No	Course Code	Pre-Req	Course Title	Credit Hours
1	ITCC-701	Analysis of Algorithms	Advanced Analysis of Algorithms	3 (3+0)
2	ITCC-702	None	Information Privacy and Security	3 (3+0)
3	ITCC-703	None	Cryptography	3 (3+0)
4	ITCC-704	DBMS	Advanced Database Management Systems	3 (3+0)

-* Students must have studied Information Technology Infrastructure course

List of Elective Courses

#	Code	Pre-req	Course	Cr. Hrs
5	ITEC-707	Computer Networks	Advanced Topics in Wireless Networks	3(3+0)
6	CSEC-717	Artificial Intelligence	Advanced Artificial Intelligence	3 (3+0)
7	CSEC-713	Human Computer Interaction	Advanced Human Computer Interaction	3(3+0)
8	CSEC-707	Web system and technology	Advanced Web development	3(3+0)
9	CSEC-731	None	Advanced Web Engineering	3 (3+0)
10	CSEC-708	None	Agent Based Modeling	3(3+0)
11	CSEC-714	None	Big Data Analysis	3(3+0)
12	CSEC-724	None	Bioinformatics	3(3+0)
13	ITEC-710	None	Business Process Management Trends & Technologies	3 (3+0)
14	CSEC-715	Computer Networks	Cloud Computing	3(3+0)
15	CSEC-711	None	Computational Intelligence	3(3+0)
16	CSEC-722	Linear Algebra	Computer Vision	
17	CSEC-718	None	Digital Image Processing	3(3+0)
18	CSEC-706	DBMS	Distributed Computing	3(3+0)
19	ITEC-703	DBMS	Distributed Database Systems	3(3+0)
20	CSEC-730	OS	Distributed System	3(3+0)
21	ITEC-705	None	Enterprise Data Center Design and Methodology	3 (3+0)
22	CSEC-721	None	Expert Systems	3(3+0)
23	CSEC-704	None	Formal Methods	3(3+0)
24	CSEC-702	None	Functional Programming	3(3+0)
25	CSEC-719	None	Fuzzy Logic	3(3+0)
26	CSEC-703	Linear Algebra	Game Theory	3(3+0)
27	CSEC-733	None	Grammar Engineering	4(3+1)
28	CSEC-727	Design and Analysis of Algorithms	Graph Theory & Algorithms	3(3+0)
29	CSEC-728	None	Information Retrieval	3(3+0)
30	ITEC-702	None	Information Security	3 (3+0)
31	CSEC-725	Probability & Statistics	Information Theory	3(3+0)

32	CSEC-736	None	Intelligent Multi Agent systems	3(3+0)
33	CSEC-723	None	Intelligent Agents Technology	3(3+0)
34	ITEC-708	None	Knowledge Management Systems & Technologies	3 (3+0)
35	CSEC-701	None	Machine Learning	3(3+0)
36	ITEC-701	None	Multimedia Databases	3(3+0)
37	CSEC-716	None	Multimedia Systems Theory & Principles	3(3+0)
38	CSEC-720	None	Natural Language Processing	3(3+0)
39	CSEC-705	None	Parallel Processing: Algorithms and Architectures-I	3(3+0)
40	CSEC-729	Parallel Processing: Algorithms Architectures-I	Parallel Processing: Algorithms and Architectures-II	3(3+0)
41	SEEC-701	Software Engineering	Reliability Engineering	3(3+0)
42	SEEC-705	None	Research Methodology	3(3+0)
43	ITEC-709	None	Service-Oriented Architecture	3(3+0)
44	CSEC-732	None	Soft Computing	3(3+0)
45	SEEC-702	Software Engineering	Software Configuration Management	3(3+0)
46	SEEC-703	Software Engineering	Software Measurement and Metrics	3(3+0)
47	SEEC-704	Software Engineering	Software Risk Management	3(3+0)
48	CSEC-735	None	Speech Recognition and Synthesis	3(3+0)
49	CSEC-737	Probability & Statistics	Stochastic Processes	3(3+0)
50	CSEC-726	Probability & Statistics	Stochastic Systems	3(3+0)
51	ITEC-706	Computer Networks	Telecom Management	3 (3+0)
52	ITEC-704	Computer Networks	Telecommunication Systems	3 (3+0)
53	CSEC-734	None	Text Processing and Data Analysis	4(3+1)
54	ITEC-711	None	Virtualization in Cloud Computing	3 (3+0)
55	SECC-701	None	Advanced Requirements Engineering	3(3+0)
56	SECC-702	None	Advanced Software System Architecture	3(3+0)
57	SECC-703	None	Software Testing and Quality Assurance	3(3+0)
58	SECC-704	None	Advance Software Project Management	3(3+0)
59	CSCC-701	None	Advanced Theory of Computation	3(3+0)
60	CSCC-703	Operating	Advanced Operating Systems	3(3+0)

		Systems		
61	CSCC-704	Computer Architecture	Advanced Computer Architecture	3(3+0)
62	CSEC-709	None	Swarm Intelligence	3(3+0)
63	CSEC-710	None	Evolutionary Computation	3(3+0)
64	CSEC-712	None	Fog Computing	3(3+0)

Scheme of Study for MSIT Program

2–year Program (4 Semesters/Terms): (30 Credit Hours)

Semester/Term 1			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	ITCC-701	Advanced Analysis of Algorithms	3(3+0)
2	ITCC-702	Information Privacy and Security	3(3+0)
3	ITCC-703	Cryptography	3(3+0)
Total			9

Semester/Term 2			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	ITCC-704	Advanced Database Management System	3(3+0)
2		Elective I	3(3+0)
3		Elective II	3(3+0)
Total			9

Semester/Term 3			
#	**Code**	**Course Title**	**Cr. Hrs.**
1		Elective III	3(0+3)
2		Elective V	3(3+0)
3	ITCC-700	Thesis-I	3(3+0)
Total			6

Semester/Term 4			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	ITCC-700	Thesis-II	3(3+0)
Total			06
Total Credit Hrs.			30

Contents of MSIT Core Courses

Course Title: Advanced Algorithm Analysis

Course Code: ITCC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
This is an advanced course in design and analysis of algorithms covering topics typically not covered in undergraduate algorithms. In this course the students will learn how to : (i) design and implement 'new' algorithms in the real world. (ii) map problems to algorithmic problems. (iii) read and understand algorithms published in journals. (iv) develop writing skills to present your own algorithms (v) collaborate and work together with other people to design new algorithms.

Course Syllabus:
Dynamic Programming, Greedy Algorithms, Amortized Analysis, Fibonacci Heaps, van Emde Boas Trees, Single-Source Shortest Paths, All-Pairs Shortest Paths, Maximum Flow, Multithreaded Algorithms, String Matching Algorithms, Approximation Algorithms, and Parallelism Parallel Graph Algorithms.

Course Outline:
1. Dynamic Programming: Rod Cutting, Matrix-Chain Multiplication, Elements of Dynamic Programming, Longest Common Subsequence, Optimal Binary Search Trees. [TB1: Ch. 15]
2. Greedy Algorithms: An Activity-Selection Problem, Elements of the Greedy Strategy, Huffman Codes, Matroids and Greedy Methods, A Task-Scheduling Problem as A Matroid. [TB1: Ch. 16]
3. Amortized Analysis: Aggregate Analysis, The Accounting Method, The Potential Method, Dynamic Tables. [TB1: Ch. 17]
4. Fibonacci Heaps: Structure Of Fibonacci Heaps, Mergeable-Heap Operations, Decreasing a Key and Deleting a Node, Bounding the Maximum Degree. [TB1: Ch. 19]
5. vanEmde Boas Trees: Preliminary Approaches, A Recursive Structure, The Van Emde Boas Tree. [TB1: Ch. 20]
6. Single-Source Shortest Paths: The Bellman-Ford Algorithm, Single-Source Shortest Paths In Directed Acyclic Graphs, Dijkstra's Algorithm, Difference Constraints and Shortest Paths, Proofs of Shortest-Paths Properties. [TB1: Ch. 24]
7. All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication, The Floyd-Warshall Algorithm, Johnson's Algorithm for Sparse Graphs. [TB1: Ch. 25]
8. Maximum Flow: Flow Networks, The Ford-Fulkerson Method, Maximum Bipartite Matching, Push-Relabel Algorithms, The Relabel-To-Front Algorithm. [TB1: Ch. 26]
9. Multithreaded Algorithms: The Basics Of Dynamic Multithreading, Multithreaded Matrix Multiplication, Multithreaded Merge Sort. [TB1: Ch. 27]
10. String Matching: The Naive String-Matching Algorithm, The Rabin-Karp Algorithm, String Matching With Finite Automata, The Knuth-Morris-Pratt Algorithm. [TB1: Ch. 32]
11. Approximation Algorithms: The Vertex-Cover Problem, The Traveling-Salesman Problem, The Set-Covering Problem, Randomization And Linear Programming, The Subset-Sum Problem. [TB1: Ch. 35]
12. Parallel Algorithms: Parallelism, The PRAM Model, Simple Parallel Operations, Parallel Searching, Parallel Sorting, Parallel Numerical Algorithms, Parallel Graph Algorithms. [TB2: Ch. 9]

Reference Material:
1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, The MIT Press; 3rd Edition (2009). ISBN-10: 0262033844
2. Analysis of Algorithms: an active learning approach by Jeffrey J. McConnell, Jones &

Bartlett Pub; 2nd Edition (November 2, 2007). ISBN-10: 0763707821
3. Approximation Algorithms by Vijay V. Vazirani, Springer (December 1, 2010). ISBN-10: 3642084699
4. Algorithms and Theory of Computation Handbook, Second Edition, Volume 2: Special Topics and Techniques, Chapman and Hall/CRC; 2nd Edition (November 20, 2009). ISBN-10: 1584888202

Course Title: Information Privacy and Security

Course Code: ITCC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Overview of e-security: Threats, risks, consequences, Sources of threats, Attacks classification, Preventive measures, remedial measures, Cryptography for e-security: Historical perspective, Confusion vs. diffusion, Stream ciphers vs. block ciphers, Keys and key management, Key exchange (peer to peer, peer - key server - peer), Diffie Helman key sharing scheme, Symmetric key cryptography vs asymmetric key cryptography, Trapdoor functions, GPG: Overview of GPG, Commands and CLI, GPG trust model, GUI – KGPG, Seahorse, Frontends – Kleopatra, enigmail 2, Practical applications: PKI, CA. X509 certificates, SSL/TLS, HTTPS, IPV6 and IPSEC, Proxies and Firewalls, Misc. techniques: Encryption using non-cryptographic tools (vi, zip), Authentication principles and methods, Passwords, two-factor authentication, One-way encryption, Steganography, Hamming, Chaffing and Winnowing, Management aspects: System Administration policies, Security audit, Penetration testing and ethical hacking, Mandatory Access control, Discretionary Access Control, Monitoring and logging tools

Reference Materials:
1. William Stallings, Cryptography and network security, Pearson Education.
2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone , Handbook of Applied Cryptography, CRC Press.
3. Margaret Cozzens, Steven J Miller, The mathematics of encryption, American Mathematical Society

Course Title: Cryptography

Course Code: ITCC-703
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Elementary number theory: Prime numbers, Factoring, Modular arithmetic, Fermat's & Euler's theorems, gcd, Euclid's algorithm, Discrete logarithm problem, Public key encryption: Public key crypto systems, RSA algorithm, Elliptic Curve cryptography, Hash digests: Properties of cryptographic hash functions, Merkle Damgard construction, md family, sha family, Digital signatures, sha3, Block ciphers: Block cipher principles, Feistel networks, S boxes and P boxes, Block cipher modes of operation, DES, 3DES, AES, Interactive Proofs, Zero-Knowledge Proofs, Zero-Knowledge Proofs of Knowledge, Non-

Interactive Zero-Knowledge Proofs, Secure Protocols, Two-Party Secure Computation, Multiparty Secure Computation, Chosen Ciphertext Security

Reference Materials:
The course materials will consist of research papers related to each topic

Course Title: Advanced Database Management Systems

Course Code: ITCC-704
Course Structure: **Lectures: 3/ Labs: 0**
Credit Hours: **3**
Pre-requisites: **None**
Course Objectives:
Make Students fully understand the concepts and technical issues of Database Administration, Management System and can Administrator Huge Database implemented in a DBMS.

Course Syllabus:
Overview Of Database Systems, The Relational Model, Relational Algebra, Evaluating Relational Operators, A Typical Relational Query Optimizer, Overview Of Transaction Management, Parallel And Distributed Databases, Object-Database Systems, Deductive Databases, Data Warehousing And Decision Support, Data Mining, Information Retrieval And Xml Data, Spatial Data Management, Advanced Topics: Advanced Transaction Processing, Data Integration, Mobile Databases, Main Memory Databases, Multimedia Databases, Geographic Information Systems, Temporal Databases, Biological Databases, Information Visualization ..

Course Outline:

1. Overview of Database Systems: A Historical Perspective, File Systems versus a DBMS, Advantages of a DBMS, Levels of Abstraction in a DBMS, Queries in a DBMS, Transaction Management, Structure of a DBMS. [Ch. 1]
2. The Relational Model: Introduction to the Relational Model, Integrity Constraints over Relations, Enforcing Integrity Constraints, Querying Relational Data, Logical Database Design: ER to Relational, Introduction to Views [Ch. 3]
3. Relational Algebra: Introduction to Relational Algebra, Introduction to Relational Calculus [Ch. 4]
4. Evaluating Relational Operators: The' Selection Operation, General Selection Conditions, The Projection Operation, The Join Operation, The Set Operations, Aggregate Operations, The Impact of Buffering [Ch. 14]
5. A Typical Relational Query Optimizer: Translating SQL Queries into Algebra, Estimating the Cost of a Plan, Relational Algebra Equivalences, Enumeration of Alternative Plans, Nested Subqueries, The System R Optimizer, Other Approaches to Query Optimization [Ch. 15]
6. Overview Of Transaction Management: The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock-Based Concurrency Control, Performance of Locking, Transaction Support in SQL, Introduction to Crash Recovery.[Ch. 16]
7. Parallel And Distributed Databases: Introduction, Architectures for Parallel Databases, Parallel Query Evaluation, Parallelizing Individual Operations, Parallel Query Optimiza-

tion, Introduction to Distributed Databases, Types of Distributed Databases, Distributed DBMS Architectures, Storing Data in a Distributed DBMS, Distributed Catalog Management, Distributed Query Processing, Updating Distributed Data, Distributed Transactions, Distributed Concurrency Control, Distributed Recovery [Ch. 22]

8. Object-Database Systems: Introduction, Structured Data Types, Operations on Structured Data, Encapsulation and ADTs, Inheritance, Objects, aIDs, and Reference Types, Database Design for an ORDBMS, ORDBMS Implementation Challenges, OODBMS, Comparing RDBMS, OODBMS, and ORDBMS [Ch. 23]
9. Deductive Databases: Introduction to Recursive Queries, Datalog, Theoretical Foundations, Recursive Queries with Negation, From Datalog to SQL, Evaluating Recursive Queries [Ch. 24]
10. Data Warehousing And Decision Support: Introduction to Decision Support, OLAP: Multidimensional Data Model, Multidimensional Aggregation Queries, Implementation Techniques for OLAP, Data 'Warehousing, Views and Decision Support, View Materialization, Maintaining Materialized Views. [Ch. 25]
11. Data Mining: Introduction to Data Mining, Counting Co-occurrences, Mining for Rules, Tree-Structured Rules, Clustering, Similarity Search over Sequences, Incremental Mining and Data Streams, Additional Data Mining Tasks.
12. Information Retrieval and Xml Data: Colliding Worlds: Databases, IR, and XML, DBMS versus IR Systems, Introduction to Information Retrieval, Indexing for Text Search, Web Search Engines, Managing Text in a DBMS, A Data Model for XML, XQuery: Querying XML Data, Efficient Evaluation of XML Queries. [Ch. 27]
13. Spatial Data Management: Types of Spatial Data and Queries, Applications Involving Spatial Data, Introduction to Spatial Indexes, Indexing Based on Space-Filling Curves, Region Quad Trees and Z-Ordering: Region Data, Grid Files, R Trees: Point and Region Data, Issues in High-Dimensional Indexing [Ch. 28]
14. Advanced Topics: Advanced Transaction Processing, Data Integration, Mobile Databases, Main Memory Databases, Multimedia Databases, Geographic Information Systems, Temporal Databases, Biological Databases, Information Visualization [Ch. 29]

Reference Material:

1. Database Management Systems, 3rd Edition by Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill; 3rd edition (August 14, 2002). ISBN-10: 0072465638
2. Advanced Database Systems by Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T. Snodgrass, V.S. Subrahmanian, Roberto Zicari, Morgan Kaufmann; 1st Edition (May 15, 1997). ISBN-10: 155860443X
3. XQuery by Priscilla Walmsley ISBN: 0596006349 (Chapter 1-8)
4. Spatial Databases: With Application to GIS by Hilippe Rigaux. ISBN: 1558605886 (Chapter 2, 6)
5. Advanced Database Systems by Carlo Zaniolo, Stefano Ceri (Chapter 5, 6)
6. Foundations of Semantic Web Technologies by Pascal Hitzler. ISBN: 142009050X (Chapter 5, 6)
7. Principles of Distributed Database Systems by Ozsu, M. Tamer. ISBN: 0136597076 (Chapter "Introduction", "Architecture" and "Parallel Databases")
8. Hadoop: The Definitive Guide byTom White. ISBN: 1449389732 (Chapter 1, 2, 5, 6)
9. An Advanced Course in Database Systems: Beyond Relational Databases by S. W. Dietrich and S. D. Urban, Prentice Hall, 2005. ISBN-10: 0130428981
10. Database Systems: A Practical Approach to Design, Implementation and Management by Thomas M. Connolly and Carolyn E. Begg, Addison-Wesley; 5th Edition (2009). ISBN-

10: 0321523067
11. Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber and Jian Pei, Morgan Kaufmann; 3rd Edition (2011). ISBN-10: 0123814790
12. Data Mining: Concepts, Models, Methods, and Algorithms by Mehmed Kantardzic, Wiley-IEEE Press; 2nd Edition (2011). ISBN-10: 0470890452
13. Data Warehousing Fundamentals for IT Professionals by Paulraj Ponniah, Wiley; 2nd Edition (2010). ISBN-10: 0470462078

Contents of MSIT Elective Courses

Course Title: Advanced Theory of Computation

Course Code: CSCC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course aims to teach the basic methods and conclusions of the Theory of Computation. Students learn to apply these methods to problems from different fields and be guided by the results in searching for computational solutions to the problems.

Course Syllabus:
Mathematical Tools and Techniques; Proofs, Principle of Mathematical Induction, Recursive Definitions, Structural Induction. Regular Languages and Regular Expression, Finite Automata. Nondeterministic Finite Automata; Regular & Non-regular Languages; Context-Free Grammars, Regular Grammars, Derivation Tree and Ambiguity, An Unambiguous CFG for Algebraic Expression, Simplified Forms and Normal Forms. Pushdown Automata; Context-Free and Non-Context-Free Languages. Detailed Investigation: Turing Machines, Recursively Enumerable and Languages. Unsolvable Problems, Computable Functions, Measuring and Classifying Complexity, Traceable and Possibly Intractable Problems. P and NP, Polynomial-Time Reduction and NP-Completeness, Cook's Theorem, NP-Complete Problems.

Course Outline:
1. Mathematical Tools and Techniques: Logic and Proofs, Sets, Functions and Equivalence Relations, Languages. [TB: Ch. 1]
2. Proofs, Principle of Mathematical Induction, Recursive Definitions, Structural Induction. [TB: Ch. 2]
3. Regular Languages and Regular Expression, Finite Automata: Finite Automata: Examples and Definitions. Distinguishing One String from Another, Union, Intersection, and Complements. [TB: Ch. 3]
4. Nondeterministic Finite Automata, Nondeterministic Finite Automata with A-Transitions, Kleene's Theorem. [TB: Ch. 4]
5. Regular & Non-regular Languages, The Criteria for Regularity, Minimal Finite Automata, The Pumping Lemma for Regular Languages, Decision Problems, Regular Languages and Computers. [TB: Ch. 5]
6. Context-Free Grammars, Regular Grammars, Derivation Tree and Ambiguity, An Un-

ambiguous CFG for Algebraic Expression, Simplified Forms and Normal Forms. [TB: Ch. 6]

7. Pushdown Automata: Definitions and Examples, Deterministic Pushdown Automata, A PDA corresponding to a Given CFG, A CFG corresponding to a Given PDA, Parsing. [TB: Ch. 7]
8. Context-Free and Non-Context-Free Languages: The Pumping Lemma for Context-Free Languages, Intersections and Complements of CFLs, Decision Problems Involving Context-Free Languages. [TB: Ch. 8]

Detailed Investigation

9. Turing Machines: Definitions and Examples, Computing Partial Functions with a TM, Combining TMs, Variations of TM, Non-deterministic TM, Universal TM, Models of Computation and the Church-Turing Thesis. [TB: Ch. 9]
10. Recursively Enumerable and Languages: Recursively Enumerable and Recursive, Enumerating a Language, More General Grammars, Context-Sensitive Languages and the Chomsky Hierarchy, Not All Languages are Recursively Enumerable. [TB: Ch. 10]
11. Unsolvable Problems: A No-recursive Language and an Unsolvable Problem, The Halting Problem, Unsolvable Problems Involving TMs, Rice's Theorem, Post's Correspondence Problem, Unsolvable Problems Involving CFG. [TB: Ch. 11]
12. Computable Functions: Primitive Recursive Functions, PRF and Bounded Operations, Unbounded Minimalization and ų-Recursive Functions, Godel Numbering, All Computable Function Are ų-Recursive. [TB: Ch. 12]
13. Measuring and Classifying Complexity: Growth Rates of Function, Time and Space Complexity of a TM, Complexity Classes. [TB: Ch. 13]
14. Traceable and Possibly Intractable Problems: P and NP, Polynomial-Time Reduction and NP-Completeness, Cook's Theorem, NP-Complete Problems. [TB: Ch. 14]

Reference Material:

1. Introduction to Languages and the Theory of Computation by John Martin, McGraw-Hill Science/Engineering/Math; 4th Edition (February 2, 2010). ISBN-10: 0073191469
2. Theory of Computation by George Tourlakis, Wiley; 1st Edition (April 17, 2012). ISBN-10: 1118014782
3. Introducing the Theory of Computation by Wayne Goddard, Jones & Bartlett Publishers; 1st Edition (January 18, 2008). ISBN-10: 0763741256
4. Theory of Computation by Dexter C. Kozen, Springer; 1st Edition (December 15, 2010). ISBN-10: 1849965714
5. Introduction to the Theory of Computation by Michael Sipser, Course Technology; 3rd Edition (June 27, 2012). ISBN-10: 113318779X

Course Title: Advanced Operating Systems

Course Code: CSCC-703
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisite: Operating Systems

Course Objectives:

The students will learn about advanced OS concepts, design and internal processes

Course Syllabus:

Operating System Architecture, Multitasking, Multiuser, Multiprocessing, Multi- Threading OS, Operating System Services For Process Management, Process Scheduling Concepts, System Calls For Process Management, Process Communication And Synchronization Concepts, Memory And I/O Management Overview, UNIX Commands For System Administration. Multitasking OS. Multiprocessor Systems. Memory Management. Unit V I/O Systems. File System.

Course Outline:

1. Introduction: Operating System Architecture, Multitasking, Multiuser, Multiprocessing, Multi- Threading OS, Operating System Services for Process Management, Process Scheduling Concepts, System Calls for Process Management, Process Communication And Synchronization Concepts, Memory and I/O Management Overview, UNIX Commands for System Administration.
2. Multitasking OS :Design and Implementation Kernel Of Multitasking OS :Services, Process State Transitions, Functional Specification, Implementation Considerations, System List, Ready List And Its Manipulation, IPC and Synchronization, Process Management , Interrupt Management
3. Multiprocessor Systems: Introduction, Parallel Hardware And Interconnections, Types of Multiprocessor OS, Sharaing OS, Mutiprocesor OS Design Considerations, Threads, Thread Scheduling, Kernel Mode Processes, Multiprocessor Synchronization, Implementation of Mutual Exclusion.
4. Memory Management: Overview, Pages, Zones, Kmalloc, Vmalloc, Slab Layer, Slab Layer Allocator, Deallocator, Statically Allocating on The Stack, High Memory Mapping. Non Contiguous Memory Management.
5. Unit V I/O Systems: I/O Device Types, I/O Structure, Driver Interfaces, Disk Device Driver Access Strategies, Unification Of Files And I/O Devices, Generalized Disk Device Drivers, Disk Caching, I/O Scheduler.
6. File System: File System Organization, Operations, Implementation, File Descriptors, File Blocks Allocaton, Mapping of File Blocks, System Calls For The File System: Open, Read, Write, Lseek, Close. Mounting and Un Mounting File Systems, Link, Unlink, File System Abstractions, VFS, File System Maintenance, File Security.

Reference Material:

1. Stallings, William, and Goutam Kumar Paul. Operating systems: internals and design principles. Pearson, 2012. ISBN-10: 0024154938;ISBN-13: 978-0024154934
1. Operating systems a design oriented approach by charlescrowly, Irwin Professional Publishing (November 1, 1996). ISBN-10: 0256151512
2. The design of the UNIX Operating System by Maurice J. Bach, Prentice Hall; 1st Edition (June 6, 1986). ISBN-10: 0132017997
3. Understanding the Linux kernel Daniel Bovet and Marco Cesati, 3 O'Reilly Media; 3rd Edition (November 2005). ISBN-10: 0596005652
4. Modern Operating Systems by Andrew S. Tanenbaum, Prentice Hall; 3rd Edition (December 21, 2007). ISBN-10: 0136006639
5. Operating Systems Design and Implementation by Andrew S Tanenbaum and Albert S Woodhull, Prentice Hall; 3rd Edition (January 14, 2006)
6. Unix Network Programming, Volume 1: The Sockets Networking API W. Richard Stevens, BillFenner, and Andrew M. Rudoff, ISBN-978-81-203-0749-0, PHI.
7. Linux Kernel Development by Robert Love, Addison-Wesley Professional; 3rd Edition (July 2, 2010). ISBN-10: 0672329468

8. UNIX Systems Programming: Communication, Concurrency and Threads by Kay A. Robbins and Steve Robbins, Prentice Hall; 2nd Edition (June 27, 2003). ISBN-10: 0130424110

Course Title: Advanced Computer Architecture

Course Code: CSCC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Architecture

Course Objectives:
To develop an understanding of high-performance computer architecture, as a foundation for advanced work in computer architecture.

Course Syllabus:
Introduction to Advanced Computer Architecture and Parallel Processing, Multiprocessors Interconnection Networks, Performance Analysis of Multiprocessor Architecture, Shared Memory Architecture, Message Passing Architecture, Abstract Models, Network Computing, Parallel Programming in the Parallel Virtual Machine, Message Passing Interface (MPI), Scheduling and Task Allocation.

Course Outline:
1. Introduction to Advanced Computer Architecture and Parallel Processing: History, Flynn's Taxonomy of Computer Architecture, SIMD Architecture, MIMD Architecture, Interconnection Networks. [TB: Ch. 1]
2. Multiprocessors Interconnection Networks: Interconnection Networks Taxonomy, Bus-Based Dynamic Interconnection Networks, Switch-Based Interconnection Networks, Static Interconnection Networks, Analysis and Performance Metrics. [TB: Ch. 2]
3. Performance Analysis of Multiprocessor Architecture: Computational Models, An Argument for Parallel Architectures, Interconnection Networks Performance Issues, Scalability of Parallel Architectures, Benchmark Performance. [TB: Ch. 3]
4. Shared Memory Architecture: Classification of Shared Memory Systems, Bus-Based Symmetric Multiprocessors, Basic Cache Coherency Methods, Snooping Protocols, Directory Based Protocols, Shared Memory Programming. [TB: Ch. 4]
5. Message Passing Architecture: Introduction to Message Passing, Routing in Message Passing Networks, Switching Mechanisms in Message Passing, Message Passing Programming Models, Processor Support for Message Passing, Example Message Passing Architectures, Message Passing Versus Shared Memory Architectures. [TB: Ch. 5]
6. Abstract Models: The PRAM Model and Its Variations, Simulating Multiple Accesses on an EREW PRAM, Analysis of Parallel Algorithms, Computing Sum and All Sums, Matrix Multiplication, Sorting, Message Passing Model, Leader Election Problem, Leader Election in Synchronous Rings. [TB: Ch. 6]
7. Network Computing: Computer Networks Basics, Client/Server Systems, Clusters, Interconnection Networks, Cluster Examples, Grid Computing. [TB: Ch. 7]
8. Parallel Programming in the Parallel Virtual Machine: PVM Environment and Application Structure, Task Creation, Task Groups, Communication among Tasks, Task Synchronization, Reduction Operations, Work Assignment. [TB: Ch. 8]
9. Message Passing Interface (MPI): Communicators, Virtual Topologies, Task Communi-

cation, Synchronization, Collective Operations, Task Creation, One-Sided Communication. [TB: Ch. 9]

10. Scheduling and Task Allocation: The Scheduling Problem, Scheduling DAGs without Considering, Communication, Communication Models, Scheduling DAGs with Communication, The NP-Completeness of the Scheduling Problem, Heuristic Algorithms, Task Allocation, Scheduling in Heterogeneous Environments. [TB: Ch. 10]
    [Instructors need to devise a contents delivery plan]

Reference Material:

1. Advanced Computer Architecture and Parallel Processing by Hesham El-Rewini, MostafaAbd-El-Barr, Wiley-Interscience; 1st Edition (January 18, 2005). ISBN-10: 012383872X
2. Advanced Computer Architectures by Sajjan G. Shiva, CRC Press (2005). ISBN-10: 0849337585
3. Advanced Computer Architecture by By Amit Kumar Mishra, S K Kataria & Sons (2010). ISBN-10: 9380027494
4. Advanced Computer Architecture: A Design Space Approach by DezsoSima, Terence Fountain, Peter Kacsuk, Addison-Wesley; 1st Edition (July 7, 1997). ISBN-10: 0201422913
5. Scalable Parallel Computing Technology, Architecture, Programming by Kai Hwang, Zhiwei Xu, McGraw-Hill Science/Engineering/Math; 1st Edition (February 1, 1998). ISBN-10: 0070317984

Course Title: Functional Programming

Course Code: CSEC-702
Course Structure: Lectures: 3 / Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The students will gain an applied understanding of the concepts and practice of functional programming. The will be:

- to use the language to implement algorithms and data types to solve problems.
- to explain common errors in sample programs and offer corrections.
- to discuss functional programming and functional programs more generally:

Course Syllabus:

Computers and modeling, Pictures and functions, Types, The Haskell programming language, Haskell Interpreter, Implementing a Prime Number Test, Haskell Type Declarations, Identifiers in Haskell, Haskell Types, The Prime Factorization Algorithm, The map and filter Functions, Haskell Equations and Equational Reasoning. Mathematical Objects: Logical Connectives and their Meanings, Logical Validity and Related Notions, Making Symbolic Form Explicit. Lambda Algebra. The Use of Logical Proof. Sets, Types and Lists Operations. Relations. Functions. Induction and Recursion. Induction and Recursion over Trees. Induction and Recursion over Lists. Polynomials. Corecursion.

Course Outline:

1. Introducing functional programming: Computers and modeling, Pictures and functions, Types, The Haskell programming language, Haskell Interpreter, Implementing a Prime Number Test, Haskell Type Declarations, Identifiers in Haskell, Haskell Types, The

Prime Factorization Algorithm, The map and filter Functions, Haskell Equations and Equational Reasoning.

2. Mathematical Objects: Logical Connectives and their Meanings, Logical Validity and Related Notions, Making Symbolic Form Explicit.
3. Lambda Abstraction, Definitions and Implementations, Abstract Formulas and Concrete Structures, Logical Handling of the Quantifiers, Quantifiers as Procedures.
4. The Use of Logical Proof: Proof Style, Proof Recipes, Rules for the Connectives, Rules for the Quantifiers, Strategic Guidelines, Reasoning and Computation with Primes.
5. Sets, Types and Lists: Sets, Paradoxes, Types and Type Classes, Special Sets, Algebra of Sets, Pairs and Products, Lists and List Operations.
6. Comprehension and Database Query, Using Lists to Represent Sets, A Data Type for Sets.
7. Relations: The Notion of a Relation, Properties of Relations, Implementing Relations as Sets of Pairs.
8. Implementing Relations as Characteristic Functions, Equivalence Relations, Equivalence Classes and Partitions, Integer Partitions.
9. Functions: Basic Notions, Surjections, Injections, Bijections, Function Composition, Inverse Function, Partial Functions, Functions as Partitions, Products, Congruences.
10. Induction and Recursion: Mathematical Induction, Recursion over the Natural Numbers, The Nature of Recursive Definitions.
11. Induction and Recursion over Trees, Induction and Recursion over Lists, Some Variations on the Tower of Hanoi, Induction and Recursion over Other Data Structures.
12. Polynomials: Difference Analysis of Polynomial Sequences, Gaussian Elimination, Polynomials and the Binomial Theorem, Polynomials for Combinatorial Reasoning.
13. Corecursion: Corecursive Definitions, Processes and Labeled Transition Systems, Proof by Approximation, Proof by Coinduction, Power Series and Generating Functions, Exponential Generating Functions.

Reference Material:

1. The Haskell Road to Logic, Maths and Programming by Kees Doets and Jan van Eijck, College Publications (May 7, 2004). ISBN-10: 0954300696
2. Functional Programming: Practice and Theory by Bruce J. MacLennan Addison-Wesley Professional; 1st Edition (January 11, 1990). ISBN-10: 0201137445
3. Haskell: The Craft of Functional Programming by Simon Thompson, Haskell, Addison-Wesley Professional; 3rd Edition (October 2, 2011). ISBN-10: 0201882957

Course Title: Game Theory

Course Code: CSEC-703
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: Linear Algebra

Course Syllabus:

Introduction To Game Theory, The Two-Person, Zero-Sum Game With Equilibrium Points, The General, Two-Person, Zero-Sum Game. Utility Theory, The Two Person, Non-Zero-Sum Game, The N-Person Game. Strategic Games. Infinite Games and Automata Theory. Back and Forth between Logic and Games. Graph Searching Games. Beyond Nash Equilibrium.

Course Outline:

1. Introduction To Game Theory, The Two-Person, Zero-Sum Game With Equilibrium Points, The General, Two-Person, Zero-Sum Game.
2. Utility Theory, The Two Person, Non-Zero-Sum Game.
3. The N-Person Game
4. Strategic Games: Basic Concepts, Iterated Elimination Of Strategies, Mixed Extension, Variations on the Definition of Strategic Games, Mechanism Design, Pre-Bayesian Games
5. Infinite Games and Automata Theory: Basic Notations And Definitions, Transformation of Winning Conditions, Tree Automata, Beyond Finite Automata.
6. Algorithms for Solving Parity Games: Games on Graphs, Solving Repeated Reachability and Eventual Safety Games, Solving Parity Games.
7. Back and Forth Between Logic and Games: Introduction, Reachability Games and Parity Games, Reachability Games And Logic, Logics With Least And Greatest Fixed-Points, Definability Of Winning Regions in Parity Games, Inflationary Fixed-Point Logic and Backtracking Games.
8. Graph Searching Games: Introduction, Classifying Graph Searching Games, Variants Of Graph Searching Games, Monotonicity of Graph Searching, Obstructions, An Application to Graph-Decompositions, Complexity of Graph Searching.
9. Beyond Nash Equilibrium: Solution Concepts for The 21st Century: Robust and Resilient Equilibrium, Taking Computation into Account, Taking (Lack Of) Awareness into Account, Iterated Regret Minimization.

Reference Material:

1. Davis, Morton D. Game theory: A nontechnical introduction. Courier Corporation, 2012.. ISBN-10: 0486135152
1. Lectures in Game Theory for Computer Scientists by Krzysztof R. Apt (Ed) and Erich Grädel (Ed), Cambridge University Press; 1st Edition (February 14, 2011).
2. Games, Puzzles, and Computation by Robert A. Hearn and Erik D. Demaine, ISBN-10: 1568813228
3. Game Theory by Drew Fudenberg and Jean Tirole, The MIT Press (August 29, 1991). ISBN-10: 0262061414

Course Title: Graph Theory & Algorithms

Course Code: CSEC-727
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Design and Analysis of Algorithms

Course Objectives:

The course is aimed to develop students' understanding of various techniques of graph theory and its applications.

Course Syllabus:

Fundamental Concepts of Graphs, Sub-Graphs, Connected Graphs, Trees, Non-separable Graphs, Connectivity, Planar Graphs, Vertex Colorings, Edge Colourings, Hamilton Cycles, Eigenvalues of Graph, Coverings and Packings in Directed Graphs. Integer Flows and Coverings.

Course Outline:

1. Fundamental Concepts of Graphs: What is A Graph, Simple Graphs, Graph and Their Representations, Isomorphism and Automorrphisms, Labelled Graphs, Graphs Arising From Other Structures, Incidents Graphs, Union and Intersection Graphs ,Cartesian Product, Directed Graphs.
2. Sub-Graphs: Sub-Graphs and Super graphs, Spanning and Induced Sub-Graphs, Decomposition and Coverings, Edge Cuts and Bonds, Even Sub-Graphs, Graph Reconstruction.
3. Connected Graphs: Walks and Connection, Cut Edges, Connection to Diagraphs, Cycle Double Covers.
4. Trees: Forests and Trees, Spanning Tree, Calay's Formula, Fundamental Cycles And-Bonds, Co-Tree, Trees And Distance. Applications of Tree.
5. Non-separable Graphs: Cut Vertices, Separations and Blocks, Ear Decompositions, Strong Orientations, Directed Ear Decompositions, Even Cycles Decompositions.
6. Connectivity: Vertex Connectivity, Fan Lemma, Edge Connectivity, Three-Connected Graphs, Submodularity, Determining, ChordalGraphs, Simplicial vertices.
7. Planar Graphs: Plane and Planar Graphs, Duality, Euler's Formula, Bridges, Kuratowski'sTheorem.
8. Vertex Colorings: Chromatic Numbers, Critical Graphs, Girthand Chromatic Number, Perfect Graphs, List Colourings, The Adjacency Polynomial, Chromatic Polynomial. Applications of Vertex Colourings.
9. Edge Colourings: Edge Colouring Number, Vizing's Theorem, Snarks, Covering By Perfect Matchings, List Edge Colouring, Applications of Edge Colourings.
10. Hamilton Cycles: Hamiltonian and non-Hamiltonian graphs, Non-Hamiltonian Planar Graphs, Path Exchanges parity, Hamilton Cycles in Graphs.
11. Eigenvalues of Graph,
12. Coverings and Packings in Directed Graphs.
13. Integer Flows and Coverings.

Reference Material:

1. Graph Theory by J.A Bondy and U.S.R Murty, Springer; 1st Edition (2008). Corr. 3rd printing 2008 Edition (August 14, 2008). ISBN-10: 1846289696
2. A First Course in Graph Theory by Gary Chartrand and Ping Zhang, Dover Publications (February 15, 2012). ISBN-10: 0486483681
3. Graph Theory and Complex Networks: An Introduction by Maarten van Steen, Maarten van Steen (April 5, 2010). ISBN-10: 9081540610
4. Graphs & Digraphs by Gary Chartrand , Linda Lesniak, and Ping Zhang, Chapman and Hall/CRC; 5th Edition (October 19, 2010). ISBN-10: 1439826277

Course Title: Information Retrieval

Course Code: CSEC-728
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Objectives:

The deals with IR representation, storage, organization & access to information items

Course Syllabus:

Basic Concepts of IR, IR System Block, Diagram. Automatic Text Analysis, Indexing and Classification. Measures of Association. Clustering Algorithms. File Structures. IR Models.

Search Strategies. Performance Evaluation. Online IR Systems & Interfaces Standards. Taxonomy and Ontology. Distributed and Parallel IR. Query Processing. Multimedia IR Models & Languages- Data Modeling Techniques to Represent Audio and Visual Document, Query Languages Indexing & Searching- Generic Multimedia Indexing Approach, Query Databases of Multimedia Documents, Display the Results of Multimedia Searches, One Dimensional Time Series, Two Dimensional Color Images, Automatic Feature Extraction. Searching the Web, Challenges, Characterizing the Web, Search Engines, Browsing, Mata Searchers, Web Crawlers, Robot Exclusion, Web Data Mining, Metacrawler, Collaborative Filtering, Web Agents (Web Shopping, Bargain Finder,..), Economic, Ethical, Legal and Political Issues.

Course Outline:

1. Introduction: Basic Concepts of IR, Data Retrieval & Information Retrieval, IR System Block, Diagram. Automatic Text Analysis, Luhn's Ideas, Conflation Algorithm, Indexing and Index Term Weighing, Probabilistic Indexing, Automatic, Classification. Measures of Association, Different Matching Coefficient, Classification Methods, Cluster Hypothesis. Clustering Algorithms, Single Pass Algorithm, Single Link Algorithm, Rochhio's Algorithm and Dendograms.
2. File Structures, Inverted File, Suffix Trees & Suffix Arrays, Signature Files, Ring Structure, IR Models, Basic Concepts, Boolean Model, Vector Model, and Fuzzy Set Model. Search Strategies, Boolean Search, Serial Search, and Cluster based Retrieval, Matching Function
3. Performance Evaluation- Precision and Recall, Alternative Measures Reference Collection (TREC Collection), Libraries & Ibliographical System- Online IR System, Opacs, Digital Libraries - Architecture Issues, Document Models, Representation & Access, Prototypes, Projects & Interfaces, Standards.
4. Taxonomy and Ontology: Creating Domain Specific Ontology, Ontology Life Cycle, Distributed and Parallel IR: Relationships Between Documents, Identify Appropriate Networked Collections, Multiple Distributed Collections Simultaneously, Parallel IR – MIMD, Architectures, Distributed IR – Collection, Partitioning, Source Selection, Query Processing.
5. Multimedia IR Models & Languages- Data Modeling, Techniques to Represent Audio and Visual Document, Query Languages Indexing & Searching- Generic Multimedia Indexing Approach, Query Databases of Multimedia Documents, Display the Results of Multimedia Searches, One Dimensional Time Series, Two Dimensional Color Images, Automatic Feature Extraction.
6. Searching the Web, Challenges, Characterizing the Web, Search Engines, Browsing, Mata Searchers, Web Crawlers, Robot Exclusion, Web Data Mining, Metacrawler, Collaborative Filtering, Web Agents (Web Shopping, Bargain Finder,..), Economic, Ethical, Legal and Political Issues.

Reference Material:

1. Modern Information Retrieval: The Concepts and Technology behind Search by Ricardo Baeza-Yates and BerthierRibeiro-Neto, Addison-Wesley Professional; 2nd Edition (February 10, 2011). ISBN-10: 0321416910
2. The Geometry of Information Retrieval by C. J. van Rijsbergen, Cambridge University Press (September 13, 2004). ISBN-10: 0521838053
3. Managing Gigabytes: Compressing and Indexing Documents and Images by Ian H. Witten, Alistair Moffat, & Timothy C. Bell, Morgan Kaufmann; 1st Edition (May 17, 1999)
4. Information Retrieval: Algorithms and Heuristics by D. Grossman and O. Frieder,

Springer; 2nd Edition (December 20, 2004). ISBN-10: 1402030045
5. An Introduction to Search Engines and Web Navigation by Mark Levene, Wiley; 2nd Edition (October 18, 2010). ISBN-10: 047052684X
6. Multimedia information System by V. S. Subrahamanian, Satish K. Tripathi, Springer, (December 3, 2010). ISBN-10: 1441950427
7. Multimedia mining A highway to intelligent multimedia documents by Chabane Djeraba, Springer; 1st Edition (November 30, 2002). ISBN-10: 1402072473
8. Introduction to Information Retrieval by Christopher D. Manning, Prabhakar Raghavan, &Hinrich Schütze, Cambridge University Press; 1st Edition (July 7, 2008). ISBN-10: 0521865719
9. Search Engines: Information Retrieval in Practice by Bruce Croft, Donald Metzler, & Trevor Strohman, Addison-Wesley; 1st Edition (February 16, 2009). ISBN-10: 0136072240
10. Information Retrieval: Data Structures and Algorithms by William B. Frakesand Ricardo Baeza-Yates, Prentice Hall; 1st Edition (June 22, 1992). ISBN-10: 0134638379

Course Title: Distributed Computing

Course Code: CSEC-706
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: DBMS

Course Objectives:
This course covers the architecture and enabling technologies of Peer-2-Peer and distributed computing systems and their innovative applications.

Course Syllabus:
Centralized and Decentralized Systems, Taxonomy Dependency Considerations. Discovery Protocols. Structured Document Types. Distributed Security Techniques. Hash Functions. Digital Signature, Secure Channels, Secure Mobile Code. The Web as Distributed Environment: URI Templates, HTTP and Security, Representational State Transfer, the Semantic Web. Peer-2-Peer Environments. Volunteer Computing. Web Services: Architecture and Development, Service-Oriented Architecture. Distributed Objects and Agent Technologies. Grid Computing. P2P Applications Protocols and Architectures. Freenet. Middleware Protocols and Architectures. Web Services Protocols. Distributed Object Deployment Using Jini. P2P Deployment Using Jxta. Web Services Deployment.

Course Outline:
1. Introduction to Distributed Systems: Centralized and Decentralized Systems, Taxonomy Dependency Considerations, Examples of Distributed Applications, and Examples of Middleware. Discovery Protocols: Service and Directory Discovery, Unicast Addressing, UDP, IP Multicast Addressing, Service Location Protocol.
2. Structured Document Types: HTML, XML, XHTML, Document Modelling and Validation. Distributed Security Techniques: Introduction, Design Issues, Hash Functions, Signing Messages with a Digital Signature, Secure Channels, Secure Mobile Code: Creating a Sandbox.
3. The Web - Distributed Environment -, Naming Things in a Uniform Way, URI Templates, Shared Representation of Things, Hypertext Transfer Protocol, HTTP and Security, Representational State Transfer, The Semantic Web. Peer-2-Peer Environments: Introduction, Historical Peer to Peer, The Shift to New Internet Users, Modern

Definition of Peer to Peer, Social Impacts of P2P, The P2P Environment, P2P Example Applications, True P2P and Good Distributed Design, Related Projects: Volunteer Computing.

4. Web Services: Introduction, Web Services Architecture and Development, Service-Oriented Architecture. Distributed Objects and Agent Technologies: What Are Distributed Objects? CORBA, Mobile Agents, Objects, Services and Resources, Distributing Objects Using Java, Remote Method Invocation.
5. Grid Computing: Introduction, Social Perspective, History of the Grid, The Grid Computing Architecture, The Criteria for a Grid, Types of Grid, Grid Computing Toolkit.
6. P2P Applications Protocols and Architectures: Gnutella: History of Gnutella, What Is Gnutella? A Gnutella Scenario: Discovering Peers, Gnutella in Operation, Searching Within Gnutella, Gnutella 0.6 Protocol Description, File Downloads, Gnutella Implementations. Scalability: Performance in P2P Networks, Unstructured P2P, Social Networks, Combining Network Topologies, The Convergence of the Napster and Gnutella Approaches, The Structured P2P Approach, New Trends.
7. Freenet: Introduction, Freenet Routing, Freenet Keys, Joining the Network, Current Developments. BitTorrent: What Is BitTorrent? The BitTorrent Protocol, BitTorrent, Inc., New Developments.
8. Middleware Protocols and Architectures: Jini: Introdcution, Jini Architecture, Registering and Using Jini Services, Jini: Tying Things Together, Organization of Jini Services & Events. Jxta : Background, Jxta Overview and Architecture, Jxta Network Overlay, The Jxta Protocols, Jxta Environment Considerations, Security, NAT and Firewalls.
9. Web Services Protocols: SOAP, WSDL, UDDI, WS-Extensions. OGSA: Overview, OGSI, WS-RF, Higher Level Interfaces. Web 2.0: The Web as Platform, Technologies and APIs, Computing in the Cloud, Ubiquitous Computing.
10. Distributed Object Deployment Using Jini: RMI Security, An RMI Application, A Jini Application, Running Jini Applications.
11. P2P Deployment Using Jxta: Starting the Jxta Platform, Peer Con_guration Using Jxta, Using the Jxta Con_gurator; Example Two: Using Jxta Pipes, P2P Environment: The Jxta Approac.
12. Web Services Deployment: Data Binding, Setup, Container Classes, Server Implementation, Service WSDL, Client Implementation.

Reference Material:

1. From P2P and Grids to Services on the Web: Evolving Distributed Communities by Ian J. Taylor Ian J. Taylor and Andrew Harrison, Springer; 2nd Edition (November 14, 2008). ISBN-10: 1848001223.
2. Peer-to-Peer : Harnessing the Power of Disruptive Technologies by Andy Oram, O'Reilly Media; 1st Edition (March 15, 2001)
3. Structured Peer-to-Peer Systems: Fundamentals of Hierarchical Organization, Routing, Scaling, and Security by Dmitry Korzun and Andrei Gurtov, Springer, (November 12, 2012).
4. K. Hwang and Z. Xu, Scalable Parallel Computing, McGraw-Hill, (1998). ISBN 0-07-031798-4.
5. Ian Taylor: From P2P to Web Services and Grids, Springer-Verlag, (2005). ISBN: 1-85233-869-5.
6. F. Berman, G. Fox, and T. Hey (Editors), Grid Computing, Wiley, (2003). ISBN: 0-470-85319-0.

Course Title: Distributed System

Course Code: CSEC-730
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: OS

Course Objectives:
To help students gain a general understanding of the principles and concepts governing distributed environment in complex applications.

Course Syllabus:
Goals, Architecture, Examples of Distributed Systems, Characteristics, Hardware and Software Concepts, Design Issues, Challenges. System Models. Inter-process Communication and Coordination. Remote Procedural Call. Synchronization and Election. Distributed File Systems. Distributed Shared Memory. Fault Tolerant and Recovery.

Course Outline:
1. Introduction: Introduction to Distributed Systems: Goals, Architecture, Examples of Distributed Systems, Characteristics, Hardware and Software Concepts, Design Issues, Challenges. System Models: Architectural models, fundamental models and Failure Model.
2. Inter-Process Communication and Coordination: Message Passing Communication: Communication Primitives, Message Synchronization and Buffering, Pipe, Pipe and Socket APIs, Group Communication, Multicasting, Remote Procedural Call: Basic Operation, Implementation and Call Semantics, Failure Handling, LRPC Object Oriented Distributed Computing Technologies – Basics, Design Issues of Various Technologies Like RMI and CORBA With Semantics and Executions.
3. Synchronization and Election: Clock Synchronization: Logical and Physical Clocks, Algorithms and Uses, Mutual Exclusion: Centralize, Distributed and Token Ring Algorithms, Comparison. Logical Clocks: Lamport's Logical Clock, Vector Clocks, Global State: Needs, Properties and Various Global States Election Algorithm: Bully and Ring Algorithm.
4. Distributed File Systems: Introduction, Characteristics, File Service Architecture, Sun Network and Coda File System: Overview of NFS, Communication, Processes, Naming, Synchronization, Consistency and Replication, Fault Tolerance and Security, Naming Services: Case Study of Global Name Service and X.500 Directory Service.
5. Distributed Shared Memory: Replication: Introduction, Reasons for Replication, Object Replication and Scaling Technique, Distributed Shared Memory: Design and Implementation Issue; Data Centric Consistency Models - Strict, Sequential, Casual, Pram, Weak, Release, Entry Client-Centric Consistency Models: Eventual, Monotonic Reads, Monotonic Writes, Read Your Writes, Writes Follow Reads
6. Fault Tolerant and Recovery: Fault Tolerance: Concepts, Failure Models, Failure Masking by Redundancy, Process Resilience: Design Issues, Failure Masking and Replication, Agreement in Faulty Systems, Recovery: Introduction, Check-Pointing, Message Logging – Synchronous and Asynchronous, Adaptive Logging

Reference Material:
1. Distributed Systems – Concept and Design by George Coulouris, Jean Dollimore& Tim

Kindberg, 4th Edition, Pearson (LPE). ISBN – 978-81-317-1840-7
2. Distributed Systems – Principles and Paradigms by Andrew S. Tanenbaum & Maarten van Steen, Prentice Hall; 2nd Edition (October 12, 2006) . ISBN-10: 0132392275
3. Distributed Computing: Principles, Algorithms, and Systems by Ajay D. Kshemkalyani and MukeshS inghal, Cambridge University Press; (March 3, 2011). ISBN-10: 0521189845
4. Distributed Operating System and Algorithm Analysis by Randay Chow and Theodore Johnson, Pearson (LPE). ISBN – 978-81-317-2859-8
5. Distributed Algorithms by Nancy A. Lynch, Morgan Kaufmann; 1st Edition (March 15, 1996). ISBN-10: 1558603484
6. Distributed Systems: An Algorithmic Approach by Sukumar Ghosh, Chapman and Hall/CRC; 1st Edition (November 22, 2006). ISBN-10: 1584885645

Course Title: Digital Image Processing

Course Code: CSEC-718
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
This course provides an introduction to basic concepts, methodologies and algorithms of digital image processing.

Course Syllabus:
Introduction to Digital Image Processing. Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition. Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing. Intensity Transformations and Spatial Filtering. Spatial Frequency, Fourier Theory, The Discrete Fourier Transform, Investigating Spectra. Filtering of Images, Deconvolution. Color Fundamentals, Color Models. Storage Media, File Formats. Segmentation Fundamentals, Point Line and Edge Detection. Non-contextual techniques. Morphological Image Processing Introduction. Compound Operations, Morphological Filtering, Greyscale Morphology. Image Compression. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Course Outline:
1. What Is Digital Image Processing? The Origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing.
2. Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition.
3. Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing.
4. Intensity Transformations and Spatial Filtering Background, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering.
5. Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods, Using Fuzzy Techniques for Intensity Transformations and Spatial Filtering.
6. Spatial Frequency, Fourier Theory, the Discrete Fourier Transform, Investigating Spectra.
7. Filtering of Images, Deconvolution.
8. Color Fundamentals, Color Models.

9. Storage Media, File Formats, The PBM, PGM, PPM Formats, The Portable Network Graphics (PNG) Format.
10. Segmentation Fundamentals, Point Line and Edge Detection.
11. A Simple Non-contextual Technique: Thresholding, Contextual Techniques, Segmentation using Other Image Properties.
12. Morphological Image Processing Introduction, Basic Concepts, Fundamental Operations.
13. Compound Operations, Morphological Filtering, Greyscale Morphology.
14. Image Compression Introduction, Redundancy, Performance Characterisation, Lossless Compression Techniques, Lossy Compression Techniques, Compression of Moving Images.
15. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Reference Book(s)

1. Digital Image Processing by Rafael C. Gonzalez, Prentice Hall, 3rd Edition, (2008), ISBN 0-13-168728-x
2. Digital Image Processing a practical Introduction using Java by Nick Efford, Addison Wesley, (2000).
3. The Image Processing Handbook by John C. Russ, Taylor & Fransic, 5th Edition, (2007). ISBN 13: 978‐0‐8493‐7254‐4

Course Title: Fuzzy Logic

Course Code: CSEC-719
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: None

Course Objectives:

Fuzzy Logic is an important area having multiple applications in Computing. The course will introduce students with key concepts of Fuzzy Logic.

Course Syllabus:

Introduction Fuzziness, Examples of Fuzziness, Modeling of Fuzziness, Operations on Fuzzy Sets, Fuzziness as Uncertainty. Algebra of Fuzzy Sets. Fuzzy Quantities, Fuzzy Numbers, Fuzzy Intervals. t – Norms, Generators of t – Norms, Isomorphisms of t – Norms, Negations, t – Conorms, Strict De – Morgan Systems, Nilpotent De Morgan Systems, Non-uniqueness of Negations In Strict De Morgan Systems. Fuzzy Implications, Averaging Operators and Negations, Averaging Operators and Nilpotent t-Norms, De Morgan Systems With Averaging Operators, Power of t-Norms, Sensitivity of Connectives. Fuzzy Relations: Binary Fuzzy Relations, Operations On Fuzzy Relations, Approximate Reasoning, Approximate Reasoning In Expert Systems, Modulus Ponens. Universal Approximations: Fuzzy Rule Bases,Desing Methodologies, Approximation Capabilities. Partial Knowledge: Belief Functions, Indicence Algebras, Monotonicity, Beliefs, Densities and Allocations, Möbius Transform, Reasoning with Belief Functions, Decision Making With Belief Functions.

Course Outline:

1. Fuzziness: Introduction, Examples of Fuzziness, Modeling of Fuzziness, Operations on Fuzzy Sets, Fuzziness as Uncertainty
2. Algebra of Fuzzy Sets: Boolean Algebra and Lattices, Equivalence Relations and Partitions, Composing Mappings, Isomorphism, and Homomorphisms, Alpha Cuts, Images of

Alpha Level Sets.
3. Fuzzy Quantities, Fuzzy Numbers, Fuzzy Intervals.
4. Basic Connectives: t – Norms, Generators of t – Norms, Isomorphisms of t – Norms, Negations, t – Conorms, Strict De – Morgan Systems, Nilpotent De Morgan Systems, Non-uniqueness of Negations In Strict De Morgan Systems.
5. Fuzzy Implications, Averaging Operators and Negations, Averaging Operators and Nilpotent t-Norms, De Morgan Systems With Averaging Operators, Power of t-Norms, Sensitivity of Connectives.
6. Fuzzy Relations: Binary Fuzzy Relations, Operations On Fuzzy Relations, Approximate Reasoning, Approximate Reasoning In Expert Systems, Modulus Ponens.
7. Universal Approximations: Fuzzy Rule Bases, Desing Methodologies, Approximation Capabilities
8. Partial Knowledge: Belief Functions, Indicence Algebras, Monotonicity, Beliefs, Densities and Allocations, Möbius Transform, Reasoning with Belief Functions, Decision Making With Belief Functions.

References Material:
1. A First Course in Fuzzy Logic by Hung T. Nguyen and Elbert A. Walker, Chapman and Hall/CRC; 3rd Edition (October 6, 2005).ISBN-10: 1584885262
2. Introduction to the Basic Principles of Fuzzy Set Theory and some of its Applications Communication and Cognition, Gent, 1991
3. Fuzzy Set Theory and its Applications by H. J. Zimmermann, Springer; 4th Edition (October 15, 2001). ISBN-10: 0792374355
4. Fundamentals of Fuzzy Sets by Didier Dubois and HenriPrade, Springer; 1st Edition (January 1, 2000). ISBN-10: 079237732X

Course Title: Expert Systems

Course Code: CSEC-721
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course concentrates on an analysis of the architecture, knowledge and problem-solving style of expert system.

Course Syllabus:
Introduction to Expert Systems. Major Characteristics of Expert Systems. Knowledge Representation. Prolog Programming. Developing Meta Interpreters in Prolog. Inference Techniques. MYCIN. Rule-Based Expert Systems. Backward-Chaining Rule-Based Systems. Designing Backward-Chaining Rule-Based Systems. Forward-Chaining Rule-Based Systems. Designing Forward-Chaining Rule-Based Systems. Frame-Based Expert Systems. Designing a Frame-Based Expert Systems.

Course Outline:
1. Introduction to Expert Systems.
2. Major Characteristics of Expert Systems.
3. Knowledge Representation.
4. Prolog Programming.
5. Developing Meta Interpreters in Prolog.

6. Inference Techniques.
7. MYCIN.
8. Rule-Based Expert Systems.
9. Backward-Chaining Rule-Based Systems.
10. Designing Backward-Chaining Rule-Based Systems.
11. Forward-Chaining Rule-Based Systems.
12. Designing Forward-Chaining Rule-Based Systems.
13. Frame-Based Expert Systems.
14. Designing a Frame-Based Expert Systems.

Reference Material:

1. Expert Systems: Design and Development by Durkin, J., Prentice Hall, New York, NY, 1994 or Latest Edition.
2. Introduction To Expert Systems by Peter Jackson, Addison-Wesley; 3rd Edition (December 23, 1998). ISBN-10: 0201876868
3. Expert Systems Programming: Practical Techniques for Rule-Based Systems by Ken Pedersen, Wiley; 1st Edition (May 8, 1989). ISBN-10: 0471600695
4. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Prentice Hall (April 1990). ISBN-10: 0134771001
5. An Introduction To Expert Systems by James P. Ignizio, Mcgraw-Hill College; (January 1, 1991). ISBN-10: 0079097855
6. Expert Systems by Nikolopoulos, CRC Press; 1st Edition (January 10, 1997). ISBN-10: 0824799275

Course Title: Intelligent Agents Technology

Course Code: CSEC-723
Course Structure: Lectures:3 / Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

After passing this course students will be able to understand about software agent technology including:

- What is agent technology?
- Technological contexts.
- Trends and drivers.
- Agent technologies and tools.
- Applications.
- Challenges.
- Technology roadmaps.

Course Syllabus:

Basics of Intelligent Agents. Intelligent Agents Application. Desktop Agents. Internet Agents. Web search Agents, Information Filtering Agents, Personalized Newspaper, Offline Delivery Agents, URL-minder, Bargain Finder. Intranet Agents. Mobile Agents. Technology of Intelligent Agents. Agent Machinery. Agent Content. Agent Access. Agent Security. Developing Agent Applications.

Course Outline:

1. Intelligent Agents: Attributes of Intelligent Agents, Task level Skills, Knowledge, Communication Skills, End user Taxonomy of Agents, Types of Agents: Desktop Agents, Internet Agents. Mobile agents, Intranet Agents.
2. Desktop Agents: Operating System Agents - An Intelligent Utility System Agent, Interface Agent, Application Agents, Email Agent, Search Agent, Application Suite Agents, Benefits of Desktop Agents.
3. Internet Agents: Web search Agents, Benefits of Search Agents, Information Filtering Agents, Benefits of Information Filtering Agents, Offline Delievery Agents, Benefits of offline Delivery Agents, Notification Agents, URL-minder, Benefits of Notification Agent.
4. Intranet Agents: Intranet Search Agents, Informational Filtering Agents, Collaboration Agents, Lotus Notes Agents, Process Automation Agents – Edify work force; A Process Automation Agent, Database Agents DSS Agent – A Database Agent, Mobile Agents – Cyber Agent; A Java based mobile Agent System, Tabriz AgentWare.
5. Technology of Intelligent Agents: the historical view, technical view, Intelligence & Agency, Machinery, Content, Access & Security, Development Model, Steps towards Automation, Steps Towards Agent-based Application.
6. Agent Machinery: Principles of Reasoning – Inferencing Systems, Rules of Inferencing, Sensors & Actors, RAISE: An Inferencing System for Agents, The Trouble with Rules, Adaptive Inferencing, Learning for Intelligent Agents –Sources of Data for Learning.
7. Agent Content: Knowledge Representation, Agent Communication, World Views –World views for Agents, Classes of World-Views, World Views Models for your business, Knowledge Representation & Agent Access, Intelligent Databases, An Agent Content Framework, Agent Communication Languages, The Knowledge Sharing Effort, Knowledge sharing & Manipulation Language (KQML), Agent Content Creation, Sources of Content in your Business.
8. Agent Access: A Framework for Intelligent Agent Access, Agent Access for Existing Applications –Wrappering, Client/Server Applications, Database & File System Interfaces, User Interface, User Access –Conversational User Interfaces, User Events & Actions, Mobile Agents, Mobile Agent Languages, Mobile Agent Principles, Motivations for Using Mobile Agents, Mobile Agent Scenario, Languages for Mobile Agents, Mobile Agent Issues, Internet Access, Access in your Business.
9. Agent Security: What does Security Do? Security for Agents, Security Basics, Delegation for Agents –Controlled Delegation, Limiting Resource Consumption, Security Issues for Mobile Agents –Delegation & Authentication, Agent Privacy, Security Minded Languages for Agents, Security for Mobile Agents, Trusting Agents – Testing & Training, Training Human Agents, Verification, Reputation.
10. Developing Agent Applications: Learning Interface Agents, Learning Agent Functional Architecture, Event Modeling, Learning Engine, Fact Interpretation, Observations, Instructions, Inference.

Reference Material:

1. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
2. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence by Gerhard Weiss, The MIT Press (July 31, 2000). ISBN-10: 0262731312
3. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
4. Intelligent Software Agents: Foundations and Applications by Walter Brenner, Rüdiger-

Zarnekow, Hartmut Wittig and A.S. Rudd, Springer, (July 31, 2012). ISBN-10: 3642804861
5. Agent Technology for E-Commerce by Maria Fasli, Wiley; 1st Edition (March 6, 2007). ISBN-10: 0470030305

Course Title: Stochastic Systems

Course Code: CSEC-726
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:
The course will introduce students with key concepts of Stochastic Systems.

Course Syllabus:
Overview of Probability. The Axioms of Probability. Repeated Trials. Random Variable. Distribution and Density Functions, Specific Random Variables, Conditional Distributions, Asymptotic Approximations for Binomial Random Variable. Functions of One Random Variable. Two Random Variables. Sequences of Random Variables. Stochastic Convergence and Limit Theorems, Random Numbers, Meaning and Generation. Statistics.

Course Outline:
1. Overview of Probability: Introduction, Definitions, Probability and Induction, Causality Versus Randomness.
2. The Axioms of Probability: Set Theory, Probability Space, Conditional Probability.
3. Repeated Trials: Combined Experiments, Bernoulli Trials, Bernoulli's Theorem and Games of Chance.
4. The Concept of a Random Variable: Introduction, Distribution and Density Functions, Specific Random Variables, Conditional Distributions, Asymptotic Approximations for Binomial Random Variable.
5. Functions of One Random Variable: The Random Variable g(x), The Distribution of g(x), Mean and Variance, Moments, Characteristic Functions.
6. Two Random Variables: Bivariate Distributions, One Function of Two Random Variables, Two Functions of Two Random Variables, Joint Moments, Joint Characteristic Functions, Conditional Distributions, Conditional Expected Values.
7. Sequences of Random Variables: General Concepts, Conditional Densities, Characteristic Functions, and Normality, Mean Square Estimation, Stochastic Convergence and Limit Theorems, Random Numbers: Meaning and Generation.
8. Statistics: Introduction, Estimation, Parameter Estimation, Hypothesis Testing.

Reference Material:
1. Dynamics of Stochastic Systems by V. I. Klyatskin, Elsevier Science; 1st Edition (December 15, 2005). ISBN-10: 0444517960
2. Probability, Random Variables and Stochastic Processes by Athanasios Papoulis and S. Unnikrishna Pillai, McGraw-Hill Europe; 4th Edition (January 1, 2002). ISBN-10: 0071226613
3. Stochastic systems by George Adomian, Academic Press (May 28, 1983). ISBN-10: 012410956X

Course Title: Stochastic Processes

Course Code: CSEC-737
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:
The course will introduce students with key concepts of Stochastic Processes.

Course Syllabus:
Review of basic probability. Systems with Stochastic Inputs, The Power Spectrum, Discrete-Time Processes, Continuity, Differentiation, Integration, Shift Operators and Stationary Processes. Finite Markov Chains. Branching Processes. Renewal Theory. Markov Processes. Brownian Motion. Random Walks and Other Applications. Mean Square Estimation.

Course outline:
1. Review of basic probability: Sample space, event, conditional probability, independent events, Baye's formula, random variable, distribution, cumulative distribution, Bernoulli distribution, binomial distribution, Poisson distribution, geometric distribution, density function, exponential distribution, gamma distribution, expectation, variance, standard deviation, joint distribution, covariance, correlation, mean, moment generating function, Chebyshev's inequality, Law of large numbers, central limit theorem.
2. General Concepts: Definitions, Systems with Stochastic Inputs, The Power Spectrum, Discrete-Time Processes, Continuity, Differentiation, Integration, Shift Operators and Stationary Processes.
3. Finite Markov chains: basics, examples, 1-step and n-step transition probabilities, stationary distributions, classifying states, periodicity of classes, absorption of transient states, reversibility, ruin problem.
4. Branching processes: probability generating function, compound distribution, generations of offspring, extinction, total progeny, generalizations.
5. Renewal theory: sequence generating function, pattern generation, consecutive successes, mean number of trials, breaking even, mean number of occurrences, comparison of patterns, probability of winning, expected duration.
6. Markov processes: Poisson processes, extensions, pure birth processes, Yule process, pure death processes, birth and death processes, linear case, linear growth with immigration, M/M/infinity queue, power supply problem, stationary distributions, examples, absorption, continuous time Markov chains, n-state case.
7. Brownian motion: definition, no drift case, reaching a point, avoiding zero, returning to zero, drift.
8. Random Walks and Other Applications: Random Walks, Cyclostationary Processes, The Poisson Sum Formula, The Schwarz Inequality.
9. Mean Square Estimation: Introduction, Prediction.

Reference Material:
1. Stochastic Processes with Applications by Rabi N. Bhattacharya and Edward C. Waymire, Society for Industrial & Applied (August 5, 2009).ISBN-10: 0898716896
2. Classical and Spatial Stochastic Processes by Rinaldo B. Schinazi, Birkhäuser; 1999 Edition (May 1, 1999). ISBN-10: 1461272033.
3. Probability, Random Variables and Stochastic Processes by Athanasios Papoulis and S. UnnikrishnaPillai, McGraw-Hill Europe; 4th Edition (January 1, 2002). ISBN-10:

0071226613
4. Basic Stochastic Processes: A Course Through Exercises by ZdzislawBrzezniak, Tomasz Zastawniak, Springer (September 6, 2000). ISBN-10: 3540761756
5. Stochastic Processes: with Applications to Reliability Theory by Toshio Nakagawa, Springer; 1st Edition (June 9, 2011). ISBN-10: 0857292730

Course Title: Multimedia Databases

Course Code: ITEC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Introduction to Multimedia Databases, Multimedia Data, The Human Sensory System and Multimedia, Introduction to SQL and Multimedia, Querying Multimedia Data, Modeling Multimedia Databases, Using Multimedia Metadata, Multimedia Database Architecture and Performance, Multimedia and the Internet, Quality-of-service Issues, Dealing with Text Databases, Content-dependent Metadata, Dealing with Image Databases, Dealing with Video Databases.

Course Outline:
1. Introduction to Multimedia Databases: Introduction, Essential of Database Systems, Multimedia Data, Multimedia Applications.
2. Multimedia Data: Multimedia Data Size, Real-time Nature of Multimedia, Problems with Semantic Nature of Multimedia Data.
3. The Human Sensory System and Multimedia: Human Information Processing, Human Brain and Multimedia Information, The Senses, Converting Data into Sensory Perception.
4. An Introduction to SQL and Multimedia: Introduction to SQL, Methods Using PL/SQL Stored Procedures, Manipulating Large Objects.
5. Querying Multimedia Data: Manipulating Multimedia Data, Classification Problem.
6. Modeling Multimedia Databases: Issues of Designing Multimedia Database Management Systems, Semantic Data Modeling, Object-oriented Design, Object Methods, Object-relational Approach.
7. Using Multimedia Metadata: Classifying Metadata, Generating and Extracting Metadata, The Role of Metadata Standards, Digital Rights Management, Domain-dependent Metadata, Developing Ontologies.
8. Multimedia Database Architecture and Performance: Introduction to Multimedia Architecture Requirements, Performance Issues in Specific Implementations, Content Management.
9. Multimedia and the Internet: The Internet, Delivery of Multimedia Data, Media Streams, Network Protocols, User Datagram Protocol.
10. Quality-of-service Issues - Internet Service Models, Packets and Datagrams - Sequence and Loss, Network Architecture, Requirements of Applications Involving Multicasting and Interactivity.
11. Dealing with Text Databases: Querying Character Data Using SQL, Statistical Methods for Text Analysis, Querying Multimedia Text.
12. Content-dependent Metadata, Metadata Standards, Indexing Technologies for Text.
13. Dealing with Image Databases: Technologies for Image Processing, The Role of Feature Extraction, Retrieval Methods, Image Analysis and Object Recognition, Image Classification, Image Database Software, Developing Image Media Databases.

14. Dealing with Video Databases: Video Analysis and Segmentation, Storage of Video Objects, Disk Scheduling, Dealing with Moving Images, Metadata for Speech, Metadata for Video, Manipulating Video Data, Video Query Process, Video Applications.

Reference Material:

1. Multimedia Databases: An Object-Relational Approach by Lynne Dunckley, Pearson Education (January 31, 2003). ISBN-10: 0201788993
2. Multimedia Database Systems: Design and Implementation Strategies by Kingsley C. Nwosu, B. Thuraisingham and P. Bruce Berra, Springer; (October 28, 2011). ISBN-10: 146138060X
3. Principles of Multimedia Database Systems by V.S. Subrahmanian, Morgan Kaufmann Publishing Company, San Fransisco, CA. 1998. ISBN: 1558604669.
4. Distributed Multimedia Database Technologies Supported by MPEG-7 and MPEG-21 by HaraldKosch, CRC Press; 1st Edition (November 24, 2003). ISBN-10: 0849318548
5. Multimedia Data Mining: A Systematic Introduction to Concepts and Theory by Zhongfei Zhang and Ruofei Zhang, Chapman and Hall/CRC; 1st Edition (December 2, 2008). ISBN-10: 1584889667

Course Title: Distributed Database Systems

Course Code: ITEC-703
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: DBMS

Course Syllabus:

Distributed Data Processing, Distributed Database Systems, Design Issues, Distributed DBMS Architecture. Distributed Database Design. Database Integration. Data and Access Control. Query Processing. Query Decomposition and Data Localization. Optimization of Distributed Queries. Multidatabase Query Processing. Transaction Management. Distributed Concurrency Control. Distributed DBMS Reliability. Data Replication.

Course Outline:

1. Distributed Data Processing, Distributed Database Systems, Data Delivery Alternatives, Promises of DDBSs, Complications Introduced by Distribution, Design Issues, Distributed DBMS Architecture.
2. Distributed Database Design: Top-Down Design Process, Fragmentation, Allocation, Data Directory.
3. Database Integration: Bottom-Up Design Methodology, Schema Matching, Schema Integration, Schema Mapping, Data Cleaning.
4. Data and Access Control: View Management, Data Security, Semantic Integrity Control.
5. Overview of Query Processing: Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing.
6. Query Decomposition and Data Localization: Query Decomposition, Localization of Distributed Data.
7. Optimization of Distributed Queries: Query Optimization, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization.
8. Multidatabase Query Processing: Issues in Multidatabase Query Processing, Multidatabase Query Processing Architecture, Query Rewriting Using Views, Query Optimization and Execution, Query Translation and Execution.

9. Transaction Management: Definition of a Transaction, Properties of Transactions, Types of Transactions.
10. Distributed Concurrency Control: Serializability Theory, Taxonomy of Concurrency Control Mechanisms, Locking-Based Concurrency Control Algorithms, Timestamp-Based Concurrency Control Algorithms, Optimistic Concurrency Control Algorithms, "Relaxed" Concurrency Control.
11. Distributed DBMS Reliability: Reliability Concepts and Measures, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols, Dealing with Site Failures, Network Partitioning, Architectural Considerations.
12. Data Replication: Consistency of Replicated Databases, Update Management Strategies, Replication Protocols, Group Communication, Replication and Failures, Replication Mediator Service.

Reference Material:

1. Principles of Distributed Database Systems by M. Tamer Özsu and Patrick Valduriez, Springer, 3rd Edition, (March 2, 2011). ISBN-10: 1441988335
2. Distributed Database Management Systems: A Practical Approach by Saeed K. Rahimi, and Frank S. Haug, Wiley-IEEE Computer Society Pr; 1st Edition (May 23, 2011). ASIN: B005CDYQSC
3. Distributed Systems: Principles and Paradigms by Andrew S. Tanenbaum and Maarten van Steen, Prentice Hall; US Edition (January 15, 2002). ISBN-10: 0130888931
4. Distributed Systems: Concepts and Design by Jean Dollimore, Tim Kindberg and George Coulouris, Addison Wesley; 4th Edition (May 20, 2005). ISBN-10: 0321263545
5. Distributed Database Systems by Chhanda Ray, Pearson (October 3, 2012). ASIN: B009NEMZ0W

Course Title: Formal Methods

Course Code: CSEC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Modern software development inevitably requires the design and analysis of a number of different artifacts. Formal methods allow the mathematically precise formulation of some of these artifacts. This course is an introduction to the use of formal methods for the specification, design, and automatic analysis of software systems.

Course Syllabus:

Introduction to Formal methods, Introducing Z, Elements of Z, Logic, Using Predicates in Z, Schemas and Schema Calculus, Formal Reasoning, Rule-Based Programming, Graphical User Interface, Safety-Critical Protection System, Modeling Large Systems, Converting Z into Code.

Course Outline:

1. Formal methods: What are FM? What FM are not, When, How, and Why use FM? Popular Fallacies and Alternatives. Formal Methods and Project Management: Gathering Requirement, From Information Requirement to Formal Specifications, Validating Formal Specifications. [TB: Ch. 1,2,3]
2. Introducing Z: What is Z? Informal Requirements, Data Flow Diagrams, State Transi-

tion Diagram, State Transition Diagram, State Transition tables. Introducing schemas: Basic Types and Abbreviations, Axiomatic Descriptions, State Schemas, Operation Schemas, Implicit preconditions, Schema Calculus. [TB: Ch. 4,5, 6, 7]

3. Elements of Z: Sets and Types, Declarations, Variables, Expressions, Operators, Predicates, Equations and Laws. Structure: Tuple, Records, Relations, Tables, Databases, Pairs and Binary Relations, Functions, Sequences, Operators. [TB: Ch. 8,9]
4. Logic: Basic Predicates, Using Predicates in Z, Relations as Predicates, Logical Connectives, Logic and Natural Language, Quantifiers, Z and Boolean Types, Predicates and undefined Expressions. Synthesis: Set Comprehensives, Lambda Expressions, Formal Specifications, Conveniences and shortcuts, Modeling Systems and Change. [TB: Ch. 10, 11]
5. Schemas and schema calculus: Conjunctions and Disjunctions, Other Schema Operators. Schema types and Bindings: Generics & Free Types [TB: Ch. 12, 13,14]
6. Formal Reasoning: Calculation and proof, Laws, Checking Specifications, Preconditions, Formal Reasoning and Intuition, Machine-Checked proof. [TB: Ch.15]
7. Graphical User Interface: Events, Display and Dialogs, Selecting a Display, Changing Setting Value, Z and State Transition Systems, Changing the Machine State. [TB: Ch. 21]
8. Safety-Critical Protection System: Partition, Refinement, Enforcing the Safety Requirements. [TB: Ch. 22]
9. Modeling Large Systems: A Single Subsystem, Many Subsystems, Useful Idioms, Subsystems, Conditions, and Modes. [TB: Ch. 23].
10. Converting Z Specification into Code.

Reference Material:

1. Systems and Software Verification: Model-Checking Techniques and Tools. By B. Berard, M. Bidoit, A. Finkel, F. Laroussinie, A. Petit, L. Petrucci, and P. Schnoebelen, Springer, 1st Edition , (2001). ISBN-10: 3642074782
2. The Way of Z: Practical Programming with Formal Methods by Jonathan Jacky, Cambridge University Press (November 28, 1996). ISBN-10: 0521559766
3. Z: An Introduction to Formal Methods by Antoni Diller, Wiley; 2nd Edition (July 27, 1994). ISBN-10: 0471939730
4. Model Checking by Edmund M. Clarke Jr., Orna Grumberg, Doron A. Peled , MIT Press, 1st Edition (1999). ISBN-13: 978-0262032704.
5. Reactive Systems: Modelling, Specification and Verification by Luca Aceto, Anna Ingólfsdóttir, Kim Guldstrand Larsen and Jiri Srba, Cambridge University Press (August 13, 2007). ISBN-10: 0521875463
6. Fundamentals of Algebraic Specifications: Equations and Initial Semantics, H. Ehrig & B. Mahr, Springer-Verlag (1985), ISBN 0-387-13718-1.
7. Algebraic Specifications in Software Engineering by I. Van Horebeek & J. Lewi, Springer; 1st Edition (December 19, 1989). ISBN-10: 3540516263

Course Title: Bioinformatics

Course Code: CSEC-724
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
Introduce students to the current bioinformatics concepts and their implementations.

Course Syllabus:

The genetic material. Gene structure and information content. Open reading frames, Introns and exons. Protein structure and function. The nature of chemical bonds. Electronegativity, Hydrophilicity and hydrophobicity. Molecular biology tool. Polymerase chain reaction (PCR), DNA sequencing. Genomic information content. Data Searches and Pairwise Alignments. Substitution Patterns. Estimating substitution numbers. Kimura's two-parameter model, Models with even more parameters, Substitutions between protein sequences. Variations in substitution rates between genes. Molecular clocks. Distance-Based Methods of Phylogenetics. Distance matrix methods. Character-Based Approaches to Phylogenetics: Parsimony, Strategies for faster searches, Consensus trees. Tree confidence. Molecular phylogenies. Genomics and Gene Recognition. Prokaryotic gene structure. GC-content. Prokaryotic gene density. Eukaryotic genomes. Eukaryotic gene structure. Open reading frames. GC-content. Gene expression. Transposition. Repetitive elements. Eukaryotic gene density. Protein Folding: Polypeptide composition. Secondary structure, Tertiary and quaternary structure, Protein folding, Structure prediction, Threading. Proteomics: From genomes to proteomes. Protein classification, Experimental techniques. Inhibitors and drug design. Ligand screening. Docking. Database screening. X-ray crystal structures. Empirical methods and prediction techniques. Postranslational modification prediction.

Course Outline:

1. Molecular Biology And Biological Chemistry: The Genetic Material: Nucleotides, Orientation, Base Pairing, The Central Dogma Of Molecular Biology. Gene Structure and Information Content: Promoter Sequences, The Genetic Code. Open Reading Frames, Introns and Exons. Protein Structure and Function: Primary Structure, Secondary, Tertiary and Quaternary Structure. The Nature of Chemical Bonds: Anatomy of An Atom, Valence. Electronegativity, Hydrophilicity and Hydrophobicity. Molecular Biology Tool: Restriction Enzymes, Gel Electrophoresis, Blotting, Hybridization and Microarrays, Cloning. Polymerase Chain Reaction (PCR), DNA Sequencing. Genomic Information Content: C Value Paradox, Reassociation Kinetics.
2. Data Searches and Pairwise Alignments: Dot Plots. Simple Alignments. Scoring. Gaps: Simple Gap Penalties, Origination and Length Penalties. Scoring Matrices. Dynamic Programming: The Needleman And Wunsch Algorithm. Local and Global Alignments: Global and Semi-Global Alignments, The Smith-Waterman Algorithm. Database Searches: BLAST and Its Relatives, Other Algorithms. Multiple Sequence Alignments.
3. Substitution Patterns: Patterns of Substitutions Within Genes: Mutation Rates. Functional Constraint.Synonymous Vs. Non-synonymous Changes, Indels and Psuedogenes, Substitutions Vs. Mutations, Fixation. Estimating Substitution Numbers: Jukes/Cantor Model, Transitions and Transversions. Kimura's Two-Parameter Model, Models With Even More Parameters, Substitutions Between Protein Sequences. Variations In Substitution Rates Between Genes. Molecular Clocks: Relative Rate Tests, Causes Of Rate Variation In Lineages. Evolution in Organelles.
4. Distance-Based Methods of Phylogenetics: History of Molecular Phylogenetics. Advantages to Molecular Phylogenies. Phylogenetic Trees: Terminology of Tree Reconstruction, Rooted and Unrooted Trees, Gene Vs. Species Trees, Character and Distance Data. Distance Matrix Methods: UPGMA. Estimation of Branch Lengths. Transformed Distance Method, Neighbor's Relation Method, Neighbor-Joining Methods. Maximum Likelihood Approaches. Multiple Sequence Alignments.
5. Character-Based Approaches to Phylogenetics: Parsimony: Informative and Uninformative Sites, Unweighted Parsimony, Weighted Parsimony. Inferred Ancestral Sequences. Strategies for Faster Searches: Branch and Bound, Heuristic. Consensus Trees. Tree Confidence:

Bootstrapping, Parametric Tests. Comparison of Phylogenetic Methods. Molecular Phylogenies: The Tree of Life, Human Origins.

6. Genomics and Gene Recognition: Prokaryotic Genomes. Prokaryotic Gene Structure: Promoter Elements, Open Reading Frames, Conceptual Translation, Termination Sequences. GC-Content. Prokaryotic Gene Density. Eukaryotic Genomes. Eukaryotic Gene Structure: Promoter Elements, Regulatory Protein Binding Sites. Open Reading Frames: Introns And Exons, Alternative Splicing, Cpg Islands. GC-Content: Isochores, Codon Usage Bias, Gene Expression: Cdnas And Ests, Serial Analysis of Gene Expression (SAGE), Microarrays. Transposition. Repetitive Elements. Eukaryotic Gene Density.
7. Protein Folding: Polypeptide Composition: Amino Acids. Backbone Flexibility, Phi and Psi. Secondary Structure: Accuracy of Predictions, Chou-Fasman/GOR Method. Tertiary and Quaternary Structure: Hydrophobicity, Disulfide Bonds, Active Structures Vs. Most Stable Structures. Protein Folding: Lattice Models, Off-Lattice Models, Energy Functions and Optimization. Structure Prediction: Comparative Modeling, Threading: Reverse Protein Folding. Predicting RNA Secondary Structures.
8. Proteomics: From Genomes to Proteomes. Protein Classification: Enzyme Nomenclature, Families and Super-Families, Folds. Experimental Techniques: 2D Electrophoresis, Mass Spectrometry, Protein Microarrays. Inhibitors and Drug Design. Ligand Screening: Docking, Database Screening. X-Ray Crystal Structures. Empirical Methods and Prediction Techniques. Postranslational Modification Prediction: Protein Sorting, Proteolytic Cleavage, Glycosylation, Phosporylation and Sulfation.

References Material:

1. Fundamental Concepts of Bioinformatics by Dan E. Krane and Michael L. Raymer, Benjamin Cummings; 1st Edition (September 22, 2002). ISBN-10: 0805346333
2. Bioinformatics For Dummies by Jean-Michel Claverie Ph. D. and Cedric Notredame Ph.D., For Dummies; 2nd Edition (December 18, 2006). ISBN-10: 0470089857
3. Essential Bioinformatics by Jin Xiong, Cambridge University Press; 1 Edition (March 13, 2006). ISBN-10: 0521600820
4. Introduction to Bioinformatics by Arthur Lesk, Oxford University Press, USA; 3rd Edition (June 2, 2008). ISBN-10: 0199208042

Course Title: Service-Oriented Architecture

Course Code: ITEC-709
Course Structure: Lectures: 3/Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

By the end of this course students will be able to understand SOA, Service Orientation and Web Services. The will also be able to analyze and design business based on SOA principles.

Course Syllabus:

Introducing SOA. Web Services & Primitive SOA. Web Services & Contemporary SOA (Activity Management & Composition). Web Services & Contemporary SOA *(Advance Messaging, Metadata & Security).* Principles of Service-Orientation. Service Orientation & Contemporary SOA. SOA Delivery Strategies. Service Oriented Analysis. Service Modelling (Process). Service Oriented Design. WSDL-Related XML Schema Language. SOAP Language

Basic, Service Interface Design Tools. Service Oriented Design Steps to Composing SOA. Considerations for Choosing Service Layers, Considerations for Positioning Core SOA Standards (Industry Standards, & SOA, XML & SOA, The WS-I Baisc Profile, WDSL & SOA, XML Schema & SOA, SOAP & SOA, Namespaces & SOA, UDDI & SOA) Considerations for Choosing SOA Extensions (Choosing SOA Characteristics, Choosing WS* Specifications, WS-BPEL & SOA). Entity Centric Business Service Design, Application Service Design, Service Design Guidelines.

Course Outline:

1. Introducing SOA; Fundamental SOA, Common Characteristics, Common Misperceptions about SOA: Common Tangible Benefits Of SOA, Common Pitfalls Of Adopting SOA.
2. Web Services & Primitive SOA: The Web Services Framework, Web Services, Service Descriptions (WSDL), Messaging (With SOAP).
3. Web Services & Contemporary SOA (Activity Management & Composition): Message Exchange Patterns, Coordination, Atomic Transactions, Business Activities, Orchestration Choreographies.
4. Web Services & Contemporary SOA *(Advance Messaging, Metadata & Security)* Addressing Reliable Messaging, Correlation, Metadata Exchange, Notification & Eventing.
5. Principles of Service-Orientation: Service Orientation & The Enterprise, Anatomy of a Service Oriented Architecture, Common Principles of Service Orientation, How Services-Orientation Principles, Service Orientation & Object Orientation, Native Web Service Support for Service Orientation Principles.
6. Service Orientation & Contemporary SOA: Service Layer Abstraction, Application Service Layer, Business Service Layer, Orchestration Service Layer, Agnostic Services, Service Layer Configuration Scenarios.
7. SOA Delivery Strategies SOA Delivery Lifecycle Phases, Top Down Strategy, Bottom Up Strategy, Agile Strategy.
8. Service Oriented Analysis: Introduction, Benefits of a Business Centric SOA, Deriving Business Services, Deriving Business Services.
9. Service Modelling (Process): Introduction, Modelling Guidelines, Classifying Service Model Logic, Different Modelling Approaches.
10. Service Oriented Design: Introduction, WSDL-Related XML Schema Language, WSDL Language(Like Definitions, Types, Message & Part, Porttype, Interface, & Operation Elements, Input & Output-When Used With Operation, Binding, Input & Output-When Used With Binding, Service, Port & Endpoint, Import, Documentation), SOAP Language Basic (Envelop, Header, Body, Fault) Service Interface Design Tools.
11. Service Oriented Design Steps To Composing SOA, Considerations For Choosing Service Layers, Considerations For Positioning Core SOA Standards (Industry Standards, & SOA, XML & SOA, The WS-I Baisc Profile, WDSL & SOA, XML Schema & SOA, SOAP & SOA, Namespaces & SOA, UDDI & SOA) Considerations For Choosing SOA Extensions (Choosing SOA Characteristics, Choosing WS* Specifications, WS-BPEL & SOA).
12. Service Oriented Design: Overview, Entity Centric Business Service Design, Application Service Design, Service Design Guidelines.

Reference Material:

1. Service-Oriented Architecture (SOA): Concepts, Technology, and Design by Thomas Erl, Prentice Hall (August 12, 2005). ISBN-10: 0131858580
2. Service-Oriented Architecture (SOA): Concepts, Technology, and Design by Thomas Erl, Prentice Hall (August 12, 2005). ISBN-10: 0131858580
3. SOA Design Patterns by Thomas Erl, Prentice Hall PTR; 1st Edition (January 9, 2009)

4. Service-Oriented Architecture (SOA): A Planning and Implementation Guide for Business and Technology by Eric A. Marks and Michael Bell, Wiley; 1st Edition (April 28, 2006). ISBN-10: 0471768944
5. Applied SOA: Service-Oriented Architecture and Design Strategies by Michael Rosen, Boris Lublinsky, Kevin T. Smith and Marc J. Balcer, Wiley; 1st Edition (June 16, 2008). ISBN-10: 0470223650

Course Title: Advanced Web development

Course Code: CSEC-707
Prerequisites: Web Systems and Technologies.

Course Objectives:
To introduce students with Web Systems and Technologies Implement HTML5 coding solutions using HTML5 elements, attributes and values. Apply CSS33 functionality to Web documents using various properties, selectors and techniques. Integrate basic JavaScript coding into a Web page to create HTML5 APIs. Consider HTML5 and CSS33 techniques to apply to both traditional and mobile delivery platforms, including mobile apps .Transform traditional Web pages into mobile Web pages. Understanding PHP frameworks and advanced technologies. Something new in JQuery. Mobile websites and mobile apps development.

Course Syllabus:
Introduction to HTML5 and CSS33, Advanced concepts in HTML5 Structure Elements, Validating HTML5 Code, HTML5 APIs, Cross-Browser Compatible HTML5 Forms, New Form Elements in HTML5, HTML5 Global Attributes for Form Elements, Embedding JavaScript into HTML5 Documents, Cascading Style Sheets (CSS3), Style Guides, , CSS3 Positioning Schemes, The CSS3 Box Model, Introduction to CSS33, Introduction to Advanced CSS33 Techniques, CSS33 2D and 3D Transformations, CSS33 Transitions, CSS33 Animations, CSS33 User Interfaces, Creating Menus and Buttons with CSS33, Advanced PHP concepts, debugging and logging, Runtime error handling using PHP exception handling mechanism, Web services including SOAP,NU SOAP and WSDL. Popular frameworks including CakePHP, Yii, Zend and Codelgniter. Advanced JQuery concepts, JQuery functions, Validating User Input with JavaScript, Migration to Mobile Devices. The Web Development Trifecta.

Course Outline:

1. Advanced HTML5 concepts: Structure Elements, Validating HTML5 Code, The <video> Element, The <audio> Element, Introduction to HTML5 Forms, Cross-Browser Compatible HTML5 Forms, New Form Elements in HTML5, HTML5 Global Attributes for Form Elements.
2. HTML5 APIs, Document Object Model (DOM), The Canvas API, The Offline AppCache API, The Geolocation API, The Drag-and–Drop API, The File API, The History API, Retrieving Data with *XMLHttpRequest.*
3. Advanced CSS33 concepts: Cascading Style Sheets (CSS3), Style Guides, CSS3 and HTML, CSS3 Terms and Syntax, Applying CSS3 Styles, Page Layout with CSS3, CSS3 Positioning Schemes, The CSS3 Box Model.
4. Introduction to CSS33, CSS33 Selectors and Properties, CSS33 Background Properties, CSS33 Border Properties, CSS33 Font Properties, CSS33 Text Effects, Introduction to Advanced CSS33 Techniques, CSS33 2D and 3D Transformations, CSS33 Transitions, CSS33 Animations, CSS33 User Interfaces, Creating Menus and Buttons with CSS33.

5. Advanced JavaScript concepts: Learning JavaScript Design Patterns, Introduction to Object-Oriented JavaScript.
6. Advanced PHP concepts: functions, date and time , debugging and logging, string manipulation, database connectivity methods
7. PHP extensions and application repository –PEAR, Smarty Templates, code reuse, feeding a function, return data from a function, Runtime error handling using PHP exception handling mechanism, Send e-mail using SMTP.
8. Web services including SOAP, NU SOAP and WSDL, popular frameworks including CakePHP, Yii, Zend and Codelgniter.
9. Advanced JQuery concepts: Bind/Unbind, Live/Die, Ajax Queue/Sync, Setting up widgets in JQuery Namespace
10. Migration to Mobile Devices, Mobile Web Sites vs. Mobile Apps, Designing Web Sites for Mobile Devices, Page Layout for Mobile Devices, Navigation and Hyperlinks for Mobile Devices, Images and Mobile Design, Validating and Testing Mobile Web Pages, Responsive Web Design.

Course Title: Big Data Analysis

Course Code: CSEC-714
Credit Hours: 3

Course Objectives:
At the end of this course, the student will become familiar with the fundamental concepts of Big Data management and analytics; will become competent in recognizing challenges faced by applications dealing with very large volumes of data as well as in proposing scalable solutions for them; and will be able to understand how Big Data impacts business intelligence, scientific discovery, and our day-to-day life.

Course Syllabus:
Introduction to Big Data, Defining Big Data, Delivering Business benefit from Big Data, Storing Big Data, Analyzing your data characteristics, Overview of Big Data stores, Selecting Big Data Stores, Processing Big Data, Integrating disparate data stores, Employing Hadoop MapReduce, The building blocks of Hadoop MapReduce, Handling streaming data, Tools and Techniques to Analyze Big Data, Abstracting Hadoop MapReduce jobs with Pig, Performing ad hoc Big Data querying with Hive, Creating business value from extracted data, Developing a Big Data Strategy, Employing Hadoop MapReduce, Defining a Big Data strategy for your organization, Enabling analytic innovation, Implementing a Big Data solution.

Reference Material:
1. Big Data: A Revolution that Will Transform how We Live, Work, and Think, Kenneth Cukier and Viktor Mayer-Schönberger, Latest Edition
2. Data-Intensive Text Processing with MapReduce, Morgan & Claypool Publishers, Latest Edition.
3. Learning Spark: Lightning-Fast Big Data Analysis, Andy Konwinski, Holden Karau, Matei Zaharia, and Patrick Wendell, Latest Edition
4. Anand Rajaraman and Jeff Ullman, Mining of Massive Datasets, Cambridge Press, Latest Edition
5. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques. Latest Edition

Course Title: Cloud Computing

Course Code: CSEC-715
Credit Hours: 3
Prerequisite: Computer Networks

Course Objectives:

This course gives an introduction to cloud computing and related techniques, issues, ecosystem and case studies. Students will learn and understand about such fundamental distributed computing "concepts" for cloud computing, how these techniques work inside today's most widely-used cloud computing systems and various research papers will be studied.

Course Syllabus:

Overview of Distributed Computing, Emergence of Cloud Computing, Global Nature of the Cloud, Cloud-Based Service Offerings, Grid Computing , Reliability of Cloud Model, Benefits of Cloud Model, Legal Issues, Key Characteristics of Cloud Computing, Challenges for the Cloud. The Evolution of Cloud Computing. Web Services Delivered from the Cloud: Communication-as-a-Service (CaaS), Infrastructure-as-a-Service, Monitoring-as-a-Service (MaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Storage: HDFS, NAAS, SAN, Distributed Graph Processing, MapReduce , MapReduce Paradigm, MapReduce Examples, Emerging Paradigms, Distributed Graph Processing, Hadoop Scheduling, Dominant-Resource Fair Scheduling, Building Cloud Networks. Virtualization. Federation, Presence, Identity, and Privacy in the Cloud. Security in the Cloud. Common Standards in Cloud Computing. End-User Access to Cloud Computing. Mobile Internet Devices and the Cloud.

Reference Material:

1. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, Latest Edition
2. Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton, Recursive Press, Latest Edition
3. Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide by David S. Linthicum, Addison-Wesley Professional, Latest Edition
4. Cloud Computing Bible by Barrie Sosinsky, Wiley, Latest Edition

Course Title: Machine Learning

Course Code: CSEC-701
Credit Hour: 3
Prerequisites: None

Course Objectives:

In this course, student will learn about the most effective machine learning techniques, and gain practice implementing them and getting them to work. More importantly, student will learn about not only the theoretical underpinnings of learning, but also gain the practical know-how needed to quickly and powerfully apply these techniques to new problems.

Course Syllabus:

This course provides a broad introduction to machine learning, data mining, and statistical pattern recognition. Topics include: (i) Supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks). (ii) Unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning). (iii) Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI). The course will also draw from numerous case studies and applications, so that you'll also learn how to apply learning algorithms to building smart robots (perception, control), text understanding (web search, anti-spam), computer vision, medical informatics, audio, database mining, and other areas.

Course Outline:

Following is a tentative syllabus for the class:

1. Introduction to machine learning [TB, Chapter 1].
2. Linear regression [RB1, Chapter 3, Section 3.1; RB2, Chapter 3, Section 3.1,3.2].
3. Gradient Descent as general parameter Learning/optimization approach [TB, Chapter 4]
4. Logistic regression, One-vs-all classification, Regularization. [Handout 2; RB1, Chapter 4 and RB2, Chapter 4]
5. Neural Networks. (TB, Chapter 4)
6. Practical advice for applying learning algorithms: How to develop, debugging, feature/model design, setting up experiment structure
7. Probability and Bayesian Analytics. [Handout 3]
8. Naive Bayes. (TB, Chapter 6)
9. Support Vector Machines (SVMs) and the intuition behind them. [RB 1, Chapter 7]
10. Unsupervised learning: clustering and dimensionality reduction.
11. Anomaly detection.
12. Probabilistic Graphical Models: Bayesian Belief Networks [RB, Chapter 8]
13. Probabilistic Graphical Models: Learning from Data [RB, Chapter 8]
14. Probabilistic Graphical Models: EM algorithm [RB 9]
15. Hidden Markov Models [RB Chapter 13]

Reference Material:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning. Springer, 2006.
2. Tom Mitchell, Machine Learning. McGraw-Hill, 1997. [Text Book (TB)]
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning. Springer, 2009 [Reference Book 2 (RB2)]

Course Title: Soft Computing

Course Code: CSEC-732
Credit Hours: 3

Course Objectives:
Soft computing is a collection of methodologies, which aim to exploit tolerance for imprecision, uncertainty and partial truth to achieve tractability, robustness and low cost solutions. It is the use of inexact solutions to computationally hard tasks such as the solution of NP-

complete problems, for which there is no known algorithm that can compute an exact solution in polynomial time. Soft computing differs from conventional (hard) computing in that, unlike hard computing, it is tolerant of imprecision, uncertainty, partial truth, and approximation. In effect, the role model for soft computing is the human mind.

Course Syllabus:
Overview of Soft Computing, Probabilistic Graphical Models, Bayesian Networks, Inferencing in Graphical Models, Swarm Intelligence, Ant Colony Optimization, Particle Swarm Optimization, Cat Swarm Optimization, Convergence Analysis, Neural Networks, Deep Learning, Convolutional Neural Networks, Relational Learning, Tensor Factorization, Ensemble Methods.

Reference Material

1. Fundamentals of Computational Swarm Intelligence, John Wiley & Sons 2011, Andries P.Engelbrecht
2. Deep learning", MIT Press Cambridge (EE.UU.) 2016, Ian Goodfellow, Yoshua Bengio, Aaron Courville
3. Probabilistic graphical models principles and techniques", MIT Press Cambridge, Mass. 2012, Daphne Koller, Nir Friedman
4. Research Articles/Handouts will be provided in the class.

Course Title: Advanced Artificial Intelligence

Course Code: CSEC-717
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites:

Course Objectives:
This course will introduce the key principles in artificial intelligence. It will cover simple representation schemes, problem solving paradigms, constraint propagation, and search strategies. Areas of application such as knowledge representation, natural language processing, expert systems, vision and robotics will be explored. The Prolog programming language will also be introduced.

Course Syllabus:
Introduction to AI, Turing Test, Strong AI vs Weak AI, Heuristics, Applications and Methods, History of AI. Uninformed Search: Search in IS, Genrate-and-Test Paradigm, Blind Search Algorithm. Informed Search: Heuristics, The Best-First Search, The Beam Search, The A* Search, The Bidirectional Search. Search Using Game: Game Trees and Minimum, Game Theory. Logic in AI: Logic and Representation, Propositional Logic, Predicate Logic, Other Logics. Knowledge Representation: Search Tree, Production System, Objects, Frames, Scripts & the Conceptual Dependency System, Semantic Networks, Recent Approaches, Agents. Prolog Programming. Production Systems: Strong Methods vs. Weak Methods, Production System and Inference Methods, Stochastic Processes and Markov Chain. [Uncertainty in AI: Fuzzy Sets, Fuzzy Logic, Fuzzy Inference, Probability Theory and Uncertainty. [Expert Systems: Characteristics of ES, Knowledge Engineering, Knowledge Acquisition, Classical ES, Case-Based Reasoning. Neural Networks: Introduction, The Perceptron Learning Rule, Back propagation, Discrete Hopfield Networks, Application Areas. Evolutionary Computation: Simulated Annealing, Genetic Algorithms, Genetic, Genetic Programming. Natural Language Processing: History of NLP, Syntax and Formal Grammars, Syntax and

Formal Grammar, Statistical Parsing, Hidden Markov Model, Wordnet, Question Answering System. Automated Planning: Planning Terminology, Planning as Search, Hierarchical Planning, Case-Based Planning, Planning Approaches to Learning System. Advanced Computer Games: Rote Learning and Generalization, Signature Table and Book Learning , Programing Methods, Search in Machines

Course Outline:

1. Introduction: Turing Test, Strong AI vs Weak AI, Heuristics, Applications and Methods, History of AI. [TB: Ch. 1]
2. Uninformed Search: Search in IS, Genrate-and-Test Paradigm, Blind Search Algorithm. [TB: Ch. 2],
3. 3: Informed Search: Heuristics, The Best-First Search, The Beam Search, The A* Search, The Bidirectional Search. [TB: Ch. 3]
4. Search Using Game: Game Trees and Minimum, Game Theory. [TB: Ch. 4]
5. Logic in AI: Logic and Representation, Propositional Logic, Predicate Logic, Other Logics. [TB: Ch. 5]
6. Knowledge Representation: Search Tree, Production System, Objects, Frames, Scripts & the Conceptual Dependency System, Semantic Networks, Recent Approaches, Agents.
7. Prolog Programming [Online Resources]
8. Production Systems: Strong Methods vs. Weak Methods, Production System and Inference Methods, Stochastic Processes and Markov Chain. [TB: Ch. 7].
9. Uncertainty in AI:. Fuzzy Sets, Fuzzy Logic, Fuzzy Inference, Probability Theory and Uncertainty. [TB: Ch. 8]
10. Expert Systems: Characteristics of ES, Knowledge Engineering, Knowledge Acquisition, Classical ES, Case-Based Reasoning. [TB: Ch. 9].
11. Neural Networks: Introduction, The Perceptron Learning Rule, Back propagation, Discrete Hopfield Networks, Application Areas. [TB: Ch. 10]
12. Evolutionary Computation: Simulated Annealing, Genetic Algorithms, Genetic, Genetic Programming. [TB: CH. 11]
13. Natural Language Processing: History of NLP, Syntax and Formal Grammars, Syntax and Formal Grammar, Statistical Parsing, Hidden Markov Model, Wordnet, Question Answering System. [TB: Ch. 12]
14. Automated Planning: Planning Terminology, Planning as Search, Hierarchical Planning, Case-Based Planning, Planning Approaches to Learning System.[TB: Ch. 13]

Reference Material

1. Artificial Intelligence in the 21st Century by Stephen Lucci by Danny Kopec, Mercury Learning and Information (May 18, 2012). ISBN-10: 1936420236
2. Artificial Intelligence: A Modern Approach, 2nd Edition, by Russell and Norvig, Prentice Hall
3. Artificial Intelligence: A Systems Approach by M. Tim Jones, Jones and Bartlett Publishers, Inc; 1st Edition (December 26, 2008). ISBN-10: 0763773379

Course Title: Advanced Human Computer Interaction

Course Code: CSEC-713
Credit Hours: 3
Prerequisite: Human Computer Interaction

Course Objective

This course provides an overview advanced topics of human-computer interaction, Moreover

course introduces students to design thinking and the basic practices of interaction design. It will cover the importance of human-computer interaction/interface design, iterative design, input/output techniques, how to design and evaluate interfaces, and research topics. The aim is to identify the important research issues, and to ascertain potentially fruitful future research directions in relation to the multimodal emotion analysis and to human-computer interaction.

Course Syllabus

Accessibility and Assistive Technologies, Affective Interaction, Future Interfaces, Human Factors for Digital Health, Persuasive Games ,Physical Computing and Prototyping, Socio-technical Systems, interaction Design, Mobile and ubiquitous, Evaluation techniques, Programming of Interactive systems(user interfaces), User-Centered Design Methods, Situated interaction, User modeling, Multimodal interaction, Intelligent systems, Affective computing, Cognitive interaction, Software Architectures for User Interfaces

Recommended Books

1. Interaction Design: Beyond Human-Computer Interaction by Jenny Preece (Author), Helen Sharp (Author), Yvonne Rogers, Latest Edition.
2. Modern Statistical Methods for HCI, Robertson**,** Judy**,** Kaptein**,** Maurits Latest Edition
3. Handbook of Research on Human-Computer Interfaces, Developments, and Applications
4. João Rodrigues ,Pedro Cardoso Jânio Monteiro and Mauro Latest Edition.
5. Affective Computing (MIT Press) by Rosalind W. Picard
6. Designing the User Interface: Strategies for Effective Human-Computer Interaction , Latest Edition
7. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale**,** Human-Computer Interaction Latest Edition.

Course Title: Advanced Topics in Wireless Networks

Course Code: ITEC-707
Credit Hour: 3
Prerequisite: Computer Networks

Course Objectives:

The advent of wireless and wired networks convergence and as the Internet is increasingly becoming the tool for a wide range of technical, economical and industrial applications, resources management becomes very crucial and vital issue for any future networks. The objectives of this course are to focus on resource management and performance analysis in transporting multimedia traffic in wireless communication networks. Topics include: traffic characteristics, connection admission control, packet scheduling, access control, and mobility and handoff management.

Course Outline:

Introduction to Radio Resource Management for Wireless Networks, Resource Management for Circuit-Switched Services , Traffic Modeling , Access Control and Admission Control , Mobility Management and Handoff Management , MAC and Packet Transmission Scheduling , Resource Management in Ad Hoc Networks, Applications: Resource Management in Packet Access, CDMA2000 & WCDMA (i.e., UMTS) Systems, Qos and QoE, Internet of Things (IOT) ,WRAN and CRAN, Vehicular Adhoc Network

Recommended Books:

1. J. Zander and S.-L. Kim, Radio Resource Management for Wireless Networks, Artech House Publishers, latest Edition

2. S. Kyriazakos and G. Karesos, Practical Radio Resource Management in wireless networks, Latest Edition.
3. T. Janevski, Traffic Analysis and Design of Wireless IP Networks, Latest Edition Jamalipour, The Wireless Mobile Internet, Wiley, Latest Edition
4. M. Hassan and R. Jain, High Performance TCP/IP Networking, Latest Edition
5. T. S. Rappaport, Wireless communications, Principles and Practice, Latest Edition
6. M. Schwartz, Broadband Integrated Networks, Latest Edition

Course Title: Advanced Web Engineering

Course Code: CSEC-731
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course is aimed to provide students with conceptual understanding required to develop web applications and web services according to international standards**.**

Course Syllabus:
The Need for Web Engineering. Web Effort Estimation. Web Productivity Measurement and Benchmarking. Web Quality. Web Usability. Web System Reliability and Performance. Web Application Testing. Process Improvement in Small Settings. Conceptual Modeling of Web Applications. Model-Based Web Application Development. W2000: A Modeling Notation for Complex Web Applications. Statistics Analysis. W3C Web Content Accessibility Guidelines. Internationalization. Classroom Group Assignements: Instructors are advised to ask students to review the Current Status of W3C Specifications: HTML, CSS, Best Practices for Authoring HTML, Web Fonts, SMIL, Media Access, Timed Text, SVG, Web Real Time Communication, Audio, Mobile Web Authoring, Device Independence Authoring, CSS Mobile, SVG Tiny, XHTML For Mobile, Mobile Web Applications, Mobile Web for Social Development, Geospatial, Accessible Rich Internet Applications (WAI-ARIA), DOM, DOM events, Declarative Web Applications, JavaScript APIs, Mobile Web Applications, WICD, Widgets, XBL, Web Components, Web Performance. [W3C website]

Course Outline:
1. The Need for Web Engineering: Introduction, Web Applications Versus Conventional Software, The Need for an Engineering Approach, Empirical Assessment [TB:Ch.1]
2. Web Effort Estimation: Introduction. Effort Estimation Techniques, Measuring Effort Prediction Power and Accuracy, Which Is the Most Accurate Prediction Technique? Case Study: Data Validation, Variables and Model Selection, Extraction of effort Equation Model Validation. [TB:Ch.2]
3. Web Productivity Measurement and Benchmarking: Introduction, Productivity Measurement Method, Case Study: Productivity Measure Construction, Productivity Analysis. [TB:Ch.3]
4. Web Quality: Different Perspectives of Quality, Evaluating Web Quality using WebQEM, Case Study: Evaluating the Quality of Two Web Applications: External Quality Requirements, Designing and Executing the Elementary Evaluation, Designing and Executing the Partial/Global Evaluation, Analysis and Recommendations. [TB:Ch.4]
5. Web Usability: Principles and Evaluation Methods: Introduction, Usability in the Software Lifecycle, Web Usability, Web Usability Criteria, Evaluation Methods, Automatic

Tools To Support Evaluations, Evaluation of the DEI Application: Design Inspection, Web Usage Analysis.[TB:Ch. 5]

6. Web System Reliability and Performance: Introduction, Web Application Services, Applications Predominantly Dynamic, Testing Loop Phase, Performance Improvements, Case Study: Service Characterization and Design, Testing Loop Phase, System Consolidation and Performance Improvement. [TB:Ch.6]
7. Web Application Testing: Introduction, Web Application Testing: Challenges and Perspectives, Web Application Representation Models, Unit Integration and System Testing of a Web Application, Strategies for Web Application Testing, Tools for Web Application Testing. [TB:Ch.7]
8. An Overview of Process Improvement in Small Settings: Initiating SPI Efforts, Process Improvement Cycle, Process Assessments, Implementation in Small Settings. [TB:Ch.8]
9. Conceptual Modeling of Web Applications: The OOWS Approach: Introduction, A Method to Model Web Applications, A Strategy To Develop the Web Solution, Case Study: *Valencia CF Web Application.* [TB:Ch.9]
10. Model-Based Web Application Development: The OOHDM approach, Building an Online CD Store with OOHDM, From Design to Implementation, Discussion and Lessons Learned. [TB:Ch.10]
11. W2000: A Modeling Notation for Complex Web Applications: Introduction, Modeling Elements, Models, Example Application: Information Model, Navigation Model, Presentation Model, 4 Service Model. [TB:Ch.11]
12. Statistics Analysis: Describing Individual Variables, Types of Variables, Descriptive Statistics, The Normal Distribution, Overview of Sampling Theory, Other Probability Distributions, Identifying Relationships in the Data: Chi-Square Test for Independence, Correlation Analysis, Regression Analysis Analysis of Variance (ANOVA), Comparing Two Estimation Models. [TB:Ch.12]
13. W3C Web Content Accessibility Guidelines: Introduction to Web Accessibility, Essential Components of Web Accessibility, How People with Disabilities Use the Web, Improving the Accessibility of Your Web Site, Managing Accessibility, Evaluating Web Accessibility. Standards, guidelines, and techniques for making accessible websites: WCAG, ATAG, UAAG, WAI-ARIA. [W3C website]
14. Internationalization: Internationalization of Web Design and Applications, Internationalization of Web Architecture, Internationalization of XML, Internationalization of Web Services. [W3C website]

Classroom Group Assignments: Instructors are advised to ask students to review the Current Status of W3C Specifications: HTML, CSS, Best Practices for Authoring HTML, Web Fonts, SMIL, Media Access, Timed Text, SVG, Web Real Time Communication, Audio, Mobile Web Authoring, Device Independence Authoring, CSS Mobile, SVG Tiny, XHTML For Mobile, Mobile Web Applications, Mobile Web for Social Development, Geospatial, Accessible Rich Internet Applications (WAI-ARIA), DOM, DOM events, Declarative Web Applications, JavaScript APIs, Mobile Web Applications, WICD, Widgets, XBL, Web Components, Web Performance. [W3C website]

Reference Material:

1. Web Engineering: A Practioner's Approach by Roger Pressman and David Lowe, McGraw-Hill Science/Engineering/Math; 1st Edition (January 22, 2008). ISBN-10: 0073523291
2. Web Engineering by Emilia Mendes and Nile Mosley, Springer; Softcover reprint of

hardcover 1st Edition. 2006 edition (November 9, 2010). ISBN-10: 3642066453

3. W3C Online Resources

Course Title: Agent Based Modeling

Course Code: CSEC-708
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Introduction to agent based modeling. Introduction to Net Logo. Complexity in Social Worlds. Net Logo Commands. Net Logo Procedures. Model properties (Why agent-based objects?, Agents, environments, and timescales).Biological systems: fireflies, flocking, slime mold, bees, ants (flocking behavior slime mold).Biological systems: predator/prey, debugging (Verification and validation).Social systems: segregation, Schelling, Micro motives and Macro behavior. A self-forming neighborhood model. Cellular automata. Critical phenomena. Sand piles. Current research topics in Agent Based Modeling.

Reference Material:

1. Agent-Based Models, Nigel Gilbert, SAGE Publications, 2008

Course Title: Business Process Management Trends & Technologies

Course Code: ITEC-710
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course will cover topics fundamentals and principles of Business Process Management. The course is designed to achieve following objectives:

1. Understand the key terms and concepts in BPM
2. Learn the major methodologies and techniques for implementing BPM
3. Discover the various technologies that support BPM
4. Learn what a BPM management and process-centric organization is and how it
5. works
6. Understand the metrics and measurements critical to managing processes
7. Learn how to identify critical processes

Course Syllabus:
Introduction d BPM, Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. Evolution of Enterprise Systems Architectures. Business Process Modeling. Process Orchestrations. Process Choreographies. .Modeling in BPMN. Properties of Business Processes. Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes. Business Process Management Methodology. Business Process Management Technologies.

Course Outline:

1. Introduction: Motivation and Definitions, Business Process Lifecycle, Classification of

Business Processes, Goals, Structure, and Organization.

2. Evolution of Enterprise Systems Architectures: Traditional Application Development, Enterprise Applications and their Integration, Enterprise Modeling and Process Orientation, Workflow Management, Enterprise Services Computing.
3. Business Process Modeling: Foundation, Conceptual Model and Terminology, Abstraction Concepts, From Business Functions to Business Processes, Activity Models and Activity Instances, Process Models and Process Instances, Process Interactions, Modeling Process Data, Modeling Organization, Modeling Operation, Business Process Flexibility**,** Architecture of Process Execution Environments.
4. Process Orchestrations: Control Flow Patterns, Petri Nets, Event-driven Process Chains, Workflow Nets, Graph-Based Workflow Language, Business Process Model and Notation.
5. Process Choreographies: Motivation and Terminology, Development Phases, Process Choreography Design, Process Choreography Implementation, Service Interaction Patterns, Choreography Modeling in BPMN.
6. Properties of Business Processes: Data Dependencies, Object Lifecycle Conformance, Structural Soundness, Soundness, Relaxed Soundness, Weak Soundness, Lazy Soundness, Soundness Criteria Overview.
7. Business Process Management Architectures: Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes: Case Handling.
8. Business Process Management Methodology: Dependencies between Processes, Methodology Overview, Phases in Detail.
9. Business Modeling Specifications
10. Six Sigma and Lean
11. BPM Implementation and Governance
12. BPM Technology (BPM Suites)

Reference Material:

1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2ndEdition(May 3, 2012). ISBN-10: 3642286151.
2. Business Process Management Common Body Of Knowledge by Yvonne Lederer Antonucci, et. al., CreateSpace Independent Publishing Platform (March 8, 2009). ISBN-10: 1442105666
3. Business Process Change: A Guide for Business Managers and BPM and Six Sigma by Paul Harmon (2007) Professionals (2nd edition). Morgan Kaufmann Publishers.
4. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Edition (January 21, 2011). ISBN-10: 3642151892
5. Business Process Management, 2nd Edition: Practical Guidelines to Successful Implementations by John Jeston and Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
6. Process Management: Practical Guidelines to Successful Implementation by T.S. Malik, Global India Publications Pvt Ltd; 1st Edition (December 31, 2009). ISBN-10: 9380228368
7. Business Process Management: Practical Guidelines to Successful Implementations by John Jeston & Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
8. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody-

Cassidy Press (October 17, 2011). ISBN-10: 0982368119
9. Workflow Modeling: Tools for Process Improvement and Application Development, 2nd Edition by Alec Sharp and Patrick McDermott, Artech House; 2nd Edition (October 31, 2008). ISBN-10: 1596931922
10. Process Analysis and Improvement: Tools and Techniques by Seppanen, Marvic S., Kumar, Sameer & Chandra, Charu (2005). McGraw-Hill
11. Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals (The MK/OMG Press) by Paul Harmon and Business Process Trends, Morgan Kaufmann; 2nd Edition (July 27, 2007). ISBN-10: 0123741521

Course Title: Computer Vision

Course Code: CSEC-722
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: Linear Algebra

Course Objectives:
The course concentrates on the knowledge of Computer Vision and its importance in Computing area having multiple applications.

Course Syllabus:
Introduction to Computer Vision, Image formation, Processing, Feature Detection and Matching, Alignment, Image Stitching, Dense Motion Estimation, Structure from Motion, Recognition, Computational Photography, Stereo Correspondence, 3D Reconstruction, Image-based Rendering, Statistical Texture Description, Methods Based on Spatial Frequencies, Laws' Texture Energy Measures, Texture Recognition Method Applications.

Course Syllabus:
1. Computer Vision an Introduction.
2. Image formation.
3. Image Processing.
4. Feature Detection and Matching.
5. Feature-based Alignment.
6. Image Stitching.
7. Dense Motion Estimation.
8. Structure from Motion.
9. Recognition.
10. Computational Photography.
11. Stereo Correspondence.
12. 3D Reconstruction.
13. Image-based Rendering.
14. Statistical Texture Description, Methods Based on Spatial Frequencies, Co-occurrence Matrices, Edge Frequency, Primitive Length (Run Length).
15. Laws' Texture Energy Measures, Fractal Texture Description, Multiscale Texture Description – Wavelet Domain Approaches, other Statistical Methods of Texture Description, Syntactic Texture Description Methods, Shape Chain Grammars, Graph Grammars, Primitive Grouping in Hierarchical Textures, Hybrid Texture Description methods, Texture Recognition Method Applications.

Reference Material:

1. Computer Vision Algorithms and Applications by Richard Szeliski, Springer, (2011), ISBN-13: 978-1848829343
2. Image Processing, Analysis, and Machine Vision by Milan Sonka, CL Engineering, 3rd Edition, (2008), ISBN-13: 9780495082521
3. Computer Vision: Models, Learning, and Inference by Dr Simon J. D. Prince, Cambridge University Press, (2012), ISBN-13: 978-1107011793

Course Title: Enterprise Data Center Design and Methodology

Course Code: ITEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course is aimed to introduce students with the essential knowledge about Data Center and methodologies that optimizes availability, scalability, and performance for that environment and provides centralized management services.

Course Syllabus:

Introduction to Data Centers, Application Architecture Models, Data Center Architecture, Data Center Services. Data Center Requirements. **S**erver Architecture. Application Architectures. Data Center Design. Network Infrastructure. Power Distribution. **D**ata Center Security. Server Load-Balancing. Designing the Data Center Infrastructure. Integrating Security into the Infrastructure. Server Performance Metrics. Server Capacity Planning. Performance Metrics of Data Center Devices.

Course Outline:

1. Overview of Data Centers: Introduction to Data Centers, Application Architecture Models, Data Center Architecture, Data Center Services.
2. Data Center Requirements: Data Center Pre-requisites, Budget Constraints, Selecting Geographical Location, Retrofitting.
3. Server Architecture: Network Attachment, Client and Server Packet Processing, TCP and Server Applications, UDP and Server Applications, Server Availability, Configuring a Web Server, Network Architecture Design Options.
4. Application Architectures: Taxonomy of Applications and Hosted Servers, Integration of Applications, Multitier Applications, Network Architecture Considerations, Multitier Design.
5. Data Center Design: Characteristics of an Outstanding Design, Guidelines for Planning a Data Center, Types of Server Farms and Data Centers, Data Center Topologies, Fully Redundant Layer 2 and Layer 3 Designs, Fully Redundant Layer 2 and Layer 3 Designs with Services, Design and Plan against Vandlism, Data Center Case Studies.
6. Network Infrastructure: Modular Cabling Design, Points of Distribution, Internet Access, Best Practices.
7. Power Distribution: Estimating Power Needs, UPS, Generators, UPDs, ESD.
8. Data Center Security: The Need for a Secure Data Center, Vulnerabilities and Common Attacks, Network Security Infrastructure, Security Fundamentals, Data Center Security Framework.
9. Server Load-Balancing: Introduction to Load Balancing, Key Concepts of Load Balancing, Redundancy Protocol, Connection and Session State Failover, Generic Load Balanc-

er Architecture.

10. Designing the Data Center Infrastructure: Topology Overview, Switching Paths, Using VLANs to Virtualize the Physical Data Center Infrastructure, Link Redundancy and Load Distribution, Spanning-Tree Considerations, Internal Redundancy Considerations, Over view of Layer 2 & Layer 3 Data Center Design refrence to Infrastucture, Using OSPF in Data Center Design, Using EIGRP in Data Center Design, Layer 3 Configuration.
11. Integrating Security into the Infrastructure: Defining Security Zones, Internet Edge, Campus Core, Intranet Server Farms, Server-Farm Design Alternatives, Management Network.
12. Server Performance Metrics: Benchmarking, Aspects of System Performance, Factors Impacting CPU Performance, SPEC Benchmarking.
13. Server Capacity Planning: Server Sizing and Capacity Planning, Identifying the Slowest Link, Capacity Planning for Servers.
14. Performance Metrics of Data Center Devices: Traffic Patterns Overview, Performance Metrics Overview, Load Balancer and SSL Offloader Metrics.
15. Best Practices in IT: Defining Best Practices, Deploying Best Practices, Benefits of BP, Systems Management BP, Servers Cluster BP, Data Storage BP, Network Management BP, Documentation Best Practices.

Reference Material:

1. Data Center Fundamentals by Mauricio Arregoces and Maurizio Portolani, Cisco Press (December 14, 2003). ISBN-10: 1587050234
2. Administering Data Centers: Servers, Storage, and Voice over IP by Kailash Jayaswal, Wiley; 1st Edition (November 28, 2005). ISBN-10: 047177183X
3. The Datacenter as a Computer: An Introduction to the Design of Warehouse-Scale Machines by Urs Hoelzle and Luiz Andre Barroso, Morgan and Claypool Publishers; 1st Edition (May 29, 2009).ISBN-10: 159829556X

Course Title: Information Security

Course Code: ITEC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Introduction to Information Security, The Need for Security, Legal, Ethical, and Professional Issues in Information Security, Risk Management, Planning for Security, Security Technology, Security Technology, Cryptography, Physical Security, Implementing Information Security, Security and Personnel, Information Security Maintenance and eDiscovery.

Course Outline:

1. Introduction to Information Security: History of IS, What is Security, CNSS Security model, Component of Information Systems, Balancing Information Security and Access, Approaches to Information Security Implementation, The Security System Development Life Cycle, Security Professionals and the Organizations, Communities of Interest.
2. The Need for Security: Business Need, Threats, Attacks, Secure Software Development.
3. Legal, Ethical, and Professional Issues in Information Security: Laws and Ethics in Information Security, International Laws and Legal Bodies, Ethics and Information Secu-

rity, Codes of Ethics and Professional Organizations, International Agencies.

4. Risk Management: Introduction to RM, Risk Identification, Risk assessment, Risk Control Strategies, Selecting a risk Control Strategy, Quantitative VS qualitative Risk Control Practices, Risk Control Practices.
5. Planning for Security: Information Security Planning and Governance, Information Security Policies, Standards, and Governance, Information Security Blue Prints, Continuity Strategies.
6. Security Technology: Firewalls, VPNs, and Wireless: Access Control, Firewalls, Protecting Remote Connections.
7. Security Technology: Intrusion Detection and Prevention Systems and Other Security Tools: Intrusion Detection and Presentation Systems, Honeyspots, Honeynets, and Padded Cell Systems, Scanning and Analysis Tools, Biometric Access Control.
8. Cryptography: Foundations of Cryptography, Cipher Methods, Cryptographic Algorithms, Cryptography Tools, Protocols for secure Communications, Attack on Cryptosystems.
9. Physical Security: Physical Access Controls, Fire Security and Safety, Failure of Supporting Utilities and Structural Collapse, Interception of Data, Considerations for Physical Security.
10. Implementing Information Security: Information Security Project Management, Technical Aspects of Implementation, Nontechnical Aspects of Implementation, Information Security Certifications.
11. Security and Personnel: Positioning and Staffing Function, Credentials of Information Security Professionals, Employment Policies and Practices, Security Considerations for Non-employees.
12. Information Security Maintenance and eDiscovery: Security Management Maintenance Models, Digital Forensics.

[Instructors need to devise a contents delivery plan]

Reference Material:

1. Principles of Information Security Michael E. Whitman and Herbert J. Mattord, Course Technology; 4th Edition (January 1, 2011). ISBN-10: 1111138214
2. Information Systems Security Professional Study Guide by James M. Stewart, Mike Chapple, and Darril Gibson, Sybex; 6th Edition (July 10, 2012). ISBN-10: 1118314174
3. Information Security: An Integrated Collection of Essays by Marshall D. Abrams, Harold J. Podell, Sushil Jajodia, Ieee Computer Society (September 1994). ISBN-10: 0818636610
4. Secrets and Lies: Digital Security in a Networked World by Bruce Schneier, Wiley; 1st Edition (January 30, 2004).
5. Information Security Management Handbook By Harold F. Tipton, Micki Krause, Auerbach Publications; 6th Edition (March 17, 2008). ISBN-10: 1420067087

Course Title: Information Theory

Course Code: CSEC-725
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:

The course will introduce students with key concepts of Information Theory.

Course Syllabus:
Information Sources. Pair Processes. Block Independent Channels. Entropy. The Entropy Ergodic Theorem. Distortion and Approximation. Approximating Random Vectors and Processes. Distortion and Entropy. Relative Entropy. Information Rates. Distortion and Information. Ergodic Theorems for Densities. Source Coding Theorems. Asynchronous Block Codes, Sliding-Block Source Codes, Geometric Interpretation, Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Course Outline:
1. Information Sources: Probability Spaces and Random Variables, Random Processes and Dynamical Systems, Distributions, Standard Alphabets, Expectation, Asymptotic Mean Stationarity, Ergodic Properties.
2. Pair Processes: Channels, Codes, and Couplings, Pair Processes, Channels, Stationarity Properties of Channels, Extremes: Noiseless and Completely Random Channels, Deterministic Channels and Sequence Coders, Stationary and Sliding-Block Codes, Block Codes, Random Punctuation Sequences, Memoryless Channels, Finite-Memory Channels, Output Mixing Channels.
3. Block Independent Channels, Conditionally Block Independent Channels, Stationarizing Block Independent Channels, Primitive Channels, Additive Noise Channels, Markov Channels, Finite-State Channels and Codes, Cascade Channels, Communication Systems, Couplings, Block to Sliding-Block: The Rohlin-Kakutani Theorem.
4. Entropy: Entropy and Entropy Rate, Divergence Inequality and Relative Entropy, Basic Properties of Entropy, Entropy Rate, Relative Entropy Rate, Conditional Entropy and Mutual Information, Markov Approximations, Relative Entropy Densities.
5. The Entropy Ergodic Theorem: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, The Asymptotic Equipartition Property.
6. Distortion and Approximation: Distortion Measures, Fidelity Criteria, Average Limiting Distortion, Communications Systems Performance, Optimal Performance, Code Approximation.
7. Approximating Random Vectors and Processes, The Monge/Kantorovich/Vasershtein Distance. Variation and Distribution Distance, Coupling Discrete Spaces with the Hamming Distance, Process Distance and Approximation, Source Approximation and Codes, d-bar Continuous Channels.
8. Distortion and Entropy: The Fano Inequality, Code Approximation and Entropy Rate, Pinsker's and Marton's Inequalities, Entropy and Isomorphism, Almost Lossless Source Coding, Asymptotically Optimal Almost Lossless Codes, Contents xv, Modeling and Simulation.
9. Relative Entropy: Divergence, Conditional Relative Entropy, Limiting Entropy Densities, Information for General Alphabets, Convergence Results.
10. Information Rates: Information Rates for Finite Alphabets, Information Rates for General Alphabets, A Mean Ergodic Theorem for Densities, Information Rates of Stationary Processes, The Data Processing Theorem, Memoryless Channels and Sources,
11. Distortion and Information: The Shannon Distortion-Rate Function, Basic Properties, Process Definitions of the Distortion-Rate Function, The Distortion-Rate Function as a Lower Bound, Evaluating the Rate-Distortion Function.
12. Ergodic Theorems for Densities: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, Ergodic Theorems for Information Densities.
13. Source Coding Theorems:Source Coding and Channel Coding, Block Source Codes for AMS Sources, Block Source Code Mismatch, Block Coding Stationary Sources, Block

Coding AMS Ergodic Sources Subadditive Fidelity Criteria.

14. Asynchronous Block Codes, Sliding-Block Source Codes, Geometric Interpretation, Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Reference Material:

1. Entropy and Information Theory by Robert M. Gray, Springer; 2nd Edition. Edition (February 3, 2011). ISBN-10: 1441979697
2. Information and Coding Theory by Gareth A. Jones, J.Mary Jones, Springer; 2000 Edition (July 31, 2000). ISBN-10: 1852336226
3. Information Theory And Evolution by John Scales Avery, World Scientific Publishing Company; 2nd Edition (July 16, 2012). ISBN-10: 9814401234
4. Elements of Information Theory by Thomas M. Cover, Joy A. Thomas, Wiley-Interscience; 2nd Edition (July 18, 2006). ISBN: 0-471-24195-4

Course Title: Intelligent Multi Agent Systems

Course Code: CSEC-736
Course Structure: Lectures: 3/Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Intelligent Multi Agent Systems is an important area having multiple applications in Computing. The course will introduce students with key concepts and knowledge of Intelligent Multi Agent Systems.

Course Syllabus:

Basics of Intelligent Agents, Multi agent Systems, Agent Interaction Protocols, Distributed Problem Solving & Planning, Distributed Planning, Search Algorithm for Agents, Distributed Rational Decision Making, Learning in Multi agent Systems, Computational Organization Theory, Formal Methods in Distributed Artificial Intelligence (DAI), Industrial and Practical Applications of DAI, Design: The Conceptual Context, The Process, System Implementation, System Operation, Development Tools. Groupware and Computer Supported Cooperative Work. Distributed Models for Decision Support.Concurrent Programming for DAI.

Course Outline:

1. Intelligent Agents: What are Agents, Intelligent Agents, Agents& Expert Systems, Abstract Architecture for Intelligent Agents, Concrete Architecture for Intelligent Agents, Agent Programming, METATEM Multi Agent systems.
2. Multi agent Systems: Characteristics of Multi agent Environment, Agent Communications, Knowledge Query & Implementation Language (KQML), Knowledge Interchange Format (KIF), Ontologies.
3. Agent Interaction Protocols: Coordination & Cooperation Protocol, Contract-net, blackboard systems, Multi agent belief Maintenance, Market Mechanism.
4. Distributed Problem Solving & Planning: Task Structure, Task Sharing, Result Sharing.
5. Distributed Planning: Centralized Planning for Distributed Plan, Distributed Planning for Centralized Plans, Distributed Planning for Distributed Plans, Distribution Plan Representation & Execution.
6. Search Algorithm for Agents: Filtering Algorithm, Hyper Resolution Based Consistency Algorithm, Asynchronous Backtracking & Weak Commitment Search, Path Finding

Problem: Asynchronous Dynamic Programming, A*, Moving Target Search, Real Time Bidirectional Search, Real Time Multi Agent System.

7. Distributed Rational Decision Making: Evaluation Criteria, Voting, Auctions, Bargaining, General Equilibrium Market Mechanism, Contract Nets, Coalition Formation.
8. Learning in Multi agent Systems: General Characterization, Learning & Activity Coordination, Learning About & From Other Agents, Learning & Communication.
9. Computational Organization Theory: Organization, Computational Organization Theory, Modeling Organizations Concepts, Agent and Agency, Organizational Design, Task, Technology, Dynamics, Methodological Issues: Virtual Experiments and Data Collection, Validation and Verification, Computational Frameworks.
10. Formal Methods in DAI (Distributed Artificial Intelligence): Logic-Based Representation and Reasoning, Cognitive Primitives, BDI Implementations: Coordination, Communications; Social Primitive; Tools and Systems: Direct Implementations & Partial Implementations, Traditional Approaches.
11. Industrial and Practical Applications of DAI: Overview of the Industrial Life-Cycle, Use of Agents in the Life Cycle, Agents in Product Design, Agents in Planning and Scheduling, Agents in Real-Time Control, Industry Constrains in the Life Cycle of an Agent-Based System: Requirements, Positioning, and Specification, Design: The Conceptual Context, Design: The Process, System Implementation, System Operation, Development Tools.
12. Groupware and Computer Supported Cooperative Work: Groupware, Computer Supported Cooperative Work, Aspects of Groupware, Keepers, Coordinators, Communicators, Team-Agents, Agent Models, Multi-Aspect Groupware, Social and Group Issues in Designing Groupware Systems, Supporting Technologies and Theories, Keepers, Coordinators, Communicators, Team-Agents, Other Taxonomies of Groupware, Space/Time Matrix, Application Area, Groupware and Internet, Internet as Infrastructure Internet as Presumed Software.
13. Distributed Models for Decision Support: Decision Support Systems, The Decision Support Problem, Knowledge-Based Decision Support, Distributed Decision Support Models, An Agent Architecture for Distributed Decision Support Systems, Information Model, Knowledge Model, Control Model, Application Case Studies, Environmental Emergency Management, Energy Management, Road Traffic Management.
14. Concurrent Programming for DAI: Defining Multi-agent Systems, Actors, Semantics of Actors, Equivalence of Actor Systems, Actors and Concurrent Programming, Representing Agents as Actors, Mobility of Actors, Resource Model, Agent Ensembles, Customizing Execution Contexts, Interaction Protocols, Coordination, Naming and Groups.

Reference Material:

1. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence by Gerhard Weiss, The MIT Press (July 31, 2000). ISBN-10: 0262731312
2. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
3. Intelligent Software Agents: Foundations and Applications by Walter Brenner, Rüdiger-Zarnekow, Hartmut Wittig and A.S. Rudd, Springer; Softcover reprint of the original 1st Edition (July 31, 2012). ISBN-10: 3642804861
4. Agent Technology for E-Commerce by Maria Fasli, Wiley; 1st Edition (March 6, 2007). ISBN-10: 0470030305

Course Title: Knowledge Management Systems & Technologies

Course Code: ITEC-708
Course Structure: Lectures:3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

By the end of the course, students should be able to:

- Appraise current thought on knowledge management in the light of contemporary debates on knowledge productivity, strategic capability and organizational learning;
- Apply theories of knowledge management relevant to current workplace practice;
- Apply the tools and techniques of knowledge management.

Course Syllabus:

History and paradigms of knowledge management. Types of knowledge. Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents. Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies. KM Processes: Discovery/ Detection, Capture and Codification, Organization, Sharing, transfer, Acquisition, Verification, Utilization, Creation, Reuse. KM Frameworks and Models. KM Frameworks and Models. Knowledge Capture and Codification. Knowledge Codification. Knowledge Taxonomies. Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence. Strategic and Practical Implications of Knowledge Capture and Codification. Knowledge Sharing and Communities of Practice. Knowledge Application. The Role of Organizational Culture. Knowledge Management Tools. Knowledge Management Strategy. The Value of Knowledge Management. Organizational Learning and Organizational Memory. The KM Team. The KM Profession, The Ethics of KM.

Course Outline:

1. History and paradigms of knowledge management; Types of knowledge: Explicit Knowledge, Tacit Knowledge, Embedded Knowledge, Embrained knowledge, Embodied knowledge, Encoded knowledge, Encultured knowledge; Organizational Internal & External Knowledge; Managers' Knowledge; Personal knowledge. Knowledge Economy: Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents; Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies.
2. KM Processes: Knowledge Discovery/ Detection, Knowledge Capture and Codification, Knowledge Organization, Knowledge Sharing, Explicit Knowledge Sharing, Knowledge transfer, Knowledge Acquisition, Knowledge Verification, Knowledge Utilization, Knowledge Creation, Knowledge Reuse;
3. KM Frameworks and Models: The SECI Model, Alen Frost's Model, Boisot's KM Model, Hedlund's KM Model, Earl's KM Model, Carayannis's KM Model, Wiig's KM Model, Edvinsson's Model of Intellectual Capital, Snowden's KM Model, Inkpen & Dinur's KM Model.
4. KM Frameworks and Models: Van Buren's Model of IC Management, Bukowitz & Williams's KM Model, Gamble & Blackwell's KM Model, Demerest's KM Model, Frid's KM Model, Stankosky & Baldanza's KM Framework, Kogut & Zander's KM Model, Botha et. al. KM Model, Integrated Knowledge Management Model.
5. Knowledge Capture and Codification: Tacit Knowledge Capture at the Individual, Group,

and Organizational Levels, xplicit Knowledge Codification, Cognitive Maps, Decision Trees, Knowledge Taxonomies, The Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence; Strategic and Practical Implications of Knowledge Capture and Codification

6. Knowledge Sharing and Communities of Practice: Sociograms and Social Network Analysis, Knowledge-Sharing Communities, Types of Communities, Roles and Responsibilities in CoPs, Knowledge Sharing in Virtual CoPs, Obstacles to Knowledge Sharing, Strategic and Practical Implications of Knowledge Sharing.
7. Knowledge Application: Knowledge Application at the Individual Level, Characteristics of Individual Knowledge Workers, Bloom ' s Taxonomy of Learning Objectives, Task Analysis and Modeling, Knowledge Application at the Group and Organizational Levels, Knowledge Reuse, Knowledge Repositories, E-Learning and Knowledge Management Application, Strategic & Practical Implications of Knowledge Application.
8. The Role of Organizational Culture: Different Types of Cultures, Organizational Culture Analysis, The Effects of Culture on Individuals, Organizational Maturity Models, KM Maturity Models, CoP Maturity Models, Transformation to a Knowledge-Sharing Culture, Impact of a Merger on Culture, Impact of Virtualization on Culture, Strategic and Practical Implications of Organizational Culture.
9. Knowledge Management Tools: Knowledge Capture and Creation Tools, Content Creation Tools, Data Mining and Knowledge Discovery, Blogs, Mashups, Content Management Tools, Folksonomies and Social Tagging/Bookmarking, Personal Knowledge Management (PKM), Knowledge Sharing and Dissemination Tools, Groupware and Collaboration Tools, Wikis, Social Networking, Web 2.0, and KM 2.0, Knowledge Acquisition and Application Tools, Intelligent Filtering Tools, Adaptive Technologies, Strategic and Practical Implications of KM Tools and Techniques.
10. Knowledge Management Strategy: Developing a Knowledge Management Strategy, Knowledge Audit, Gap Analysis, The KM Strategy Road Map, Balancing Innovation and Organizational Structure, Types of Knowledge Assets Produced.
11. The Value of Knowledge Management: KM Return on Investment (ROI) and Metrics, The Benchmarking Method, The Balanced Scorecard Method, The House of Quality Method, The Results-Based Assessment Framework, Measuring the Success of Communities of Practice.
12. Organizational Learning and Organizational Memory: How Do Organizations Learn and Remember? Frameworks to Assess Organizational Learning and Organizational Memory, The Management of Organizational Memory, Organizational Learning, The Lessons Learned Process, Organizational Learning and Organizational Memory Models, A Three-Tiered Approach to Knowledge Continuity.
13. The KM Team: Major Categories of KM Roles, Senior Management Roles, KM Roles and Responsibilities within Organizations, The KM Profession, The Ethics of KM.

Reference Material:

1. Essentials of Knowledge Management: Concepts, Theories and Practices by M. A. Pasha & S. Pasha, Innovators Knowledge Services (2012). ISBN:978-969-9791-04-8
2. Knowledge Management In Theory And Practice by Kimiz Dalkir, The MIT Press; 3rd Edition (March 4, 2011). ISBN-10: 0262015080
3. The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms by Amrit Tiwana, Prentice Hall; 2nd Edition (August 29, 2002). ISBN-10: 013009224X
4. Principles of Knowledge Management: Theory, Practice and Cases by Elie Geisler and Nilmini Wickramasinghe, M.E.Sharpe (January 15, 2009). ISBN-10: 0765613220

5. Knowledge Management: Concepts, Methodologies, Tools and Applications (6-volume set) by Murray E. Jennex, IGI Global; Reprint edition (August 10, 2007). ISBN-10: 1599049333

Course Title: Multimedia Systems Theory & Principles

Course Code: CSEC-716
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course introduces students with theory and principles of multimedia contents constituting multimedia system.

Course Syllabus:
Introduction to Multimedia and Tools, Graphics and Image Data Representations, Color in Image and Video, Basics of Digital Audio, Lossless Compression Algorithms, Lossy Compression Algorithms, Image Compression Standards, Basic Video Compression Techniques, MPEG Video Coding MPEG-1, 2, 4-7; Basic Audio Compression Techniques, MPEG Audio Compression.

Course Outline:
1. Introduction to Multimedia: What is Multimedia? Multimedia and Hypermedia, Overview of Multimedia Software Tools. [TB1: Ch. 1]
2. Graphics and Image Data Representations: Graphics/Image Data Types, Popular File Formats. [TB1: Ch. 3]
3. Color in Image and Video: Color Science, Color Models in Images, Color Models in Video Fundamental Concepts in Video: Types of Video Signals, Analog Video, Digital Video. [TB1: Ch. 4, 5]
4. Basics of Digital Audio: Digitization of Sound, MIDI: Musical Instrument Digital Interface, Quantization and Transmission of Audio. [TB1: Ch. 6]
5. Lossless Compression Algorithms: Introduction, Basics of Information Theory, Run-Length Coding, Variable-Length Coding (VLC), Dictionary-Based Coding, Arithmetic Coding, Lossless Image Compression. [TB1: Ch. 7]
6. Lossy Compression Algorithms: Distortion Measures, The Rate-Distortion Theory, Quantization, Transform Coding, Wavelet-Based Coding, Wavelet Packets. [TB1: Ch. 8]
7. Image Compression Standards: The JPEG Standard, The JPEG2000 Standard, The JPEG-LS Standard. [TB1: Ch. 9]
8. Basic Video Compression Techniques: Introduction to Video Compression, Video Compression Based on Motion Compensation, Search for Motion Vectors, H.261, H.263. [TB1: Ch. 10]
9. MPEG Video Coding MPEG-1 and 2. [TB1: Ch. 11]
10. MPEG Video Coding MPEG-4, 7. [TB1: Ch. 12]
11. Basic Audio Compression Techniques: ADPCM in Speech Coding, G.726 ADPCM, Vocoders. [TB1: Ch. 13]
12. MPEG Audio Compression: Psychoacoustics, MPEG Audio. [TB1: Ch. 13]

Reference Material:
1. Fundamentals of Multimedia by Z. M. Li and M. S. Drew, Prentice Hall (2004), ISBN:

0-13-127256-X
2. Digital Multimedia by N. Chapman and J. Chapman. 2nd Edition, Wiley 2004, ISBN: 0-470-85890-7
3. The Technology of Video and Audio Streaming by David Austerberry, Focal Press; 2nd Edition (2004). ISBN-10: 0240805801
4. Multimedia Security: WaTermarking, Steganography, and Forensics by Frank Y. Shih, CRC Press; 1st Edition (2012), ISBN-10: 1439873313
5. Multimedia Computing by Daniel Cunliffe and Geoff Elliott, Lexden Publishing Ltd (2005). ISBN-10: 1904995055
6. Multimedia Foundations: Core Concepts for Digital Design by Vic Costello, Ed Youngblood and Susan Youngblood, Focal Press; 1st Edition (2012). ISBN-10: 0240813944

Course Title: Natural Language Processing

Course Code: CSEC-720
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Objective:
Natural language processing (NLP) is one of the most important technologies of the information age. Understanding complex language utterances is also a crucial part of artificial intelligence. Applications of NLP are everywhere because people communicate most everything in language: web search, advertisement, emails, customer service, language translation, radiology reports, etc. There are a large variety of underlying tasks and machine learning models behind NLP applications. Upon completing, you will be able to recognize NLP tasks in your day-to-day work, propose approaches, and judge what techniques are likely to work well. This course will cover the fundamental concepts in NLP.

Course Syllabus:
This course covers a range of topics in computational linguistics/natural language processing, including its introduction to Regular Expressions, Text Normalization, Edit Distance, N-gram Language Models, Naive Bayes and Sentiment Classification, Logistic Regression, Vector Semantics, Neural Networks and Neural Language Models, Part-of-Speech Tagging, Sequence Processing with Recurrent Networks, Formal Grammars of English/Urdu, Syntactic Parsing, etc.

Course Outline:
1. Introduction [TB1, Ch. 1]
2. Regular Expressions, Text Normalization, and Edit Distance: Regular Expressions,
3. Words, Corpora, Text Normalization, Minimum Edit Distance, etc. [TB1, Ch. 2]
4. N-gram Language Models: N Grams, Evaluating Language Models, Generalization and Zeros, Smoothing, etc. [TB1, Ch.3]
5. Naive Bayes and Sentiment Classification: Naïve Bayes Classifiers and their training with
6. examples, Its optimization for sentiment analysis and for other text classification, etc. [TB1, Ch.4]
7. Logistic Regression: Classification: The sigmoid; Learning in Logistics Regression; The Cross
8. Entropy loss function; Gradient Descent, Regularization, etc. [TB1, Ch. 5]

9. Vector Semantics: Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for
10. measuring similarity, TF-IDF Weighting terms in the vector, etc. [TB1, Ch. 6]
11. Neural Networks and Neural Language Models: Units, The XOR problem, Feed
12. Forward Neural Network, Training Neural Nets, etc. [TB1, Ch. 7]
13. Part-of-Speech Tagging: Word Classes, Penn POS Tagset, POS Tagging, HMM POS
14. Tagging, etc. [TB1, Ch. 8]
15. Sequence Processing with Recurrent Networks: Simple Recurrent Networks, Applications of
16. RNNs, Deep Networks, Managing Context in RNNs, etc. [TB1, Ch. 9]
17. Formal Grammars of English/Urdu: Constituency, Context Free Grammars, Rules of
18. English/Urdu, Treebanks, etc. [TB1, Ch. 10]
19. Syntactic Parsing: Ambiguity, CKY Parsing, Partial Parsing, etc. [TB1, Ch. 11]

Reference Material:

1. Daniel Jurafsky and James H. Martin. 2018. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Third Edition. Prentice Hall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural
3. Language Processing. MIT Press.
4. Steven Bird. 2009. Natural Language Processing with Python. O'Reilly. (Free on SearchWorks)
5. Philipp Koehn. 2010. Statistical Machine Translation. Cambridge.
6. Yoshua Bengio. 2009. Learning Deep Architectures for AI. Technical Report. (Free from
7. Stanford network)
8. Frederick Jelinek. 1998. Statistical Methods for Speech Recognition. MIT Press.
9. James Allen. 1995. Natural Language Understanding. Benjamin/Cummings, 2ed. Psycholinguistics: Tanenhaus & Trueswell (2006), Human Sentence Processing website

Course Title: Grammar Engineering

Course Code: CSEC-733
Course Structure: Lectures: 3/ Lab: 1
Credit Hours: 4
Prerequisites:

Course Objective:

Natural language processing (NLP) enables computers to make use of data represented in human language (including the vast quantities of data available on the web) and to interact with computers on human terms. Applications from machine translation to speech recognition and web-based information retrieval demand both precision and robustness from NLP technology. Meetings these demands will require better hand-built grammars of human languages combined with sophisticated statistical processing methods. This course focuses on the implementation of linguistic grammars, drawing on a combination of sound grammatical theory and engineering skills.

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Course Syllabus:
Introduction, LFG, Templates, C & F description, Agreement, Determiners, Rules & alternations, Adjuncts, Obliques, Prepositions, Pronouns, Punctuation, Generation & Optimality, Complements, Uncertainty, Imperatives, Finite-State Morpholog, Free Word Order and the Shuffle Operator, Coordination

Course Outline:

1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:

1. Crouch, Dick, Mary Dalrymple, Ronald M. Kaplan, Tracy Holloway King, John T. Maxwell III, und Paula Newman (2008). XLE Documentation. Palo Alto: Palo Alto Research Center.
2. Butt, Miriam, Tracy Holloway King, Maria-Eugenia Nino and Fred-erique Segond. 1999. A Grammar Writer's Cookbook. CSLI Publications.
3. Dalrymple, Mary. 2001. Lexical-Functional Grammar. Academic Press.
4. Kaplan, Ronald M. und John T. Maxwell III (1995). Constituent Coordination in Lexical Functional Grammar. In Dalrymple, Mary, Ronald M. Kaplan, John T. Maxwell III, und Annie
5. Zaenen (eds.)(1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications. First published in Proceedings of COLING-88, vol. 1 (1988). Budapest.
6. Kaplan, Ronald M. und Annie Zaenen (1989). Long-distance Dependencies, Constituent Structure, and Functional Uncertainty. In Baltin, Mark und Anthony Kroch (eds.), Alternative Conceptions of Phrase Structure, pp. 17-42. Chicago University Press. Republished in Dalrymple et al. (eds.) (1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications.
7. Kaplan, Ronald M., John T. Maxwell III, Tracy Holloway King, und Dick Crouch (2004). Integrating Finite-state Technology with Deep LFG Grammars. Proceedings of the Workshop on Combining Shallow and Deep Processing for NLP. Proceedings of ESSLLI 2004.

Course Title: Reliability Engineering

Course Code: SEEC-701
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:
Introduction to Reliability Engineering. The Need for Reliable Software. Software Reliability Engineering Concepts. Basic Definitions. Software Reliability and System Reliability. The Dependability Concept. Reliability Modeling. Availability Modeling. Statistical Reliability Models for Software Reliability. Best Current Practices of software Reliability Engineering. Software Metrics for Reliability Assessment. Software Testing and Reliability. Software Reliability Tools. Review of Reliability Theory. Analytical Techniques and Basic Statistics for Reliability Engineering. Current research topics in Reliability Engineering.

Course Outline:
1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:
1. An Introduction to Reliability and Maintainability Engineering, Ebeling, C. E., Waveland Press, Inc., second edition. 2009 (ISBN 1-57766-625-9)
2. IEEE Recommended Practice in Software ReliabilityHandbook of Software Reliability Engineering by Michael R. Lyu. Published by IEEE Computer Society Press and McGraw-Hill Book Company, 2008

Course Title: Software Configuration Management

Course Code: SEEC-702
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:
Management of the SCM Process. Organizational Context for SCM. Constraints and Guidance for the SCM Process. Planning for SCM. SCM Plan. Surveillance of Software Configuration Management. Software Configuration Identification. Identifying Items to Be Con-

trolled. Software Library. Software Configuration Control. Requesting, Evaluating, and Approving Software Changes. Implementing Software Changes. Deviations and Waivers. Software Configuration Status Accounting. Software Configuration Status Information. Software Configuration Status Reporting. Software Configuration Auditing. Software Functional Configuration Audit. Software Physical Configuration Audit. In-process Audits of a Software Baseline. Software Release Management and Delivery. Software Building. Software Release Management. Software Configuration Management Tools.Current research topics in Software Configuration Management.

Course Outline:

1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:

1. Software Configuration Management Patterns: Effective Teamwork, Practical Integration by Stephen P. Berczuk, Brad Appleton, 2003

Course Title: Software Measurement and Metrics

Course Code: SEEC-703
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:

Introduction to quality control and planning needs (Measurement Concepts, Measurement as a support process, Review Metrics Models and Standards). Measurement goals (Formulating problem and goal statement, Prioritize information needs and objectives, Formalize measurement goals). Specify Measures (Identify questions and indicators, Identify data elements, Operational definitions for measures). Specify Data Collection and Storage Procedures. Sources of data. How to collect and store the measurement data? Specify Analysis Procedures. Potential data analyses. Methods and tools for measuring software. Develop software measurement reporting. Current research topics in Software Measurement and Metrics.

Reference Material:

1. Metrics and Models in Software Quality Engineering, Stephen H. Kan, Addison Wesley, 2003

2. Measuring the Software Process, Anita Carleton, William A. Florac, Addison-Wesley 1999
3. The Big Book of Six Sigma training Games, Chris Chen and Hadley Roth, McGraw-Hill, 2005

Course Title: Software Risk Management

Course Code: SEEC-704
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:
What is risk and risk management?. Motivation for risk management. Reasons we don't do risk management. SEI's Risk Management paradigm. Identifying and recording software risk. Risk Taxonomy. Tools and methods for identifying and recording risks. Analyzing and classifying risks. Complex project management theory. Software Risk Identification. Software Risk Analysis. Software Risk Planning. Software Risk Monitoring. Software Qualitative Risk Analysis. Quantitative Risk Analysis. Risk management and the SDLC. Risk management in CMM. Other useful tools for successful risk management. Current research topics in Software Risk Management.

Reference Material:
1. Software Engineering Risk Management by Dale Walter Karolak, 1995, ISBN9780818671944
2. Applied Software Risk Management: A Guide for Software Project Managers by C. Ravindranath Pandian, 2006, ISBN 9780849305245
3. Software Risk Management by Boehm, Barry, W. IEEE Computer Society Press, ISBN 10: 0818689064

Course Title: Speech Recognition and Synthesis

Course Code: CSEC-735
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Objective:
This course offers an in-depth introduction to automatic speech recognition (ASR), the problem of automatically extracting text from human speech. This class will cover many theoretical and practical aspects of machine learning techniques that are employed in large-scale ASR systems. Apart from teaching classical algorithms that form the basis of statistical speech recognition, this class will also cover the latest deep learning techniques that have made important advances in achieving state-of-the-art results for speech recognition.

Course Syllabus:
This course is an introduction to automatic speech recognition, speech synthesis, and dialogue systems, from the computer science and linguistics (rather than EE) perspective. Focus on understanding of key algorithms including the noisy channel model, Hidden Markov Models (HMMs), GMM (Gaussian Mixture Model) acoustic models, A* and Viterbi decod-

ing, N- gram language modeling, unit selection synthesis, dialogue architectures, and the role of linguistic knowledge (esp. phonetics, intonation, pronunciation variation, disfluencies, emotion).

Course Outline:

1. Overview of Course, Intro to Probability Theory, and ASR Background: N-gram Language Modeling J+M New Chapter 4: N-grams
2. TTS: Background (part of speech tagging, machine learning, classification, NLP) and Text Normalization J+M New Chapter 7: Phonetics , J+M New Chapter 8 Speech Synthesis, pages 1-10 , J+M New Chapter 5 Word Classes and Part-of-Speech Tagging, pages 1-36, but skip section 5.6 , Optional Advanced Reading: Chapter 4 "Text Segmentation and Organisation" from Taylor, Paul. 2007. Chapter 5 "Text Decoding" from Taylor, Paul. 2007.
3. TTS: Grapheme-to-phoneme, Prosody (Intonation, Boundaries, and Duration) and the Festival software J+M New Chapter 8, pages 10-25 , Read sections 1, 2, 3, 4, 5, and 6.1 and 6.1.1 from Alan Black's lecture notes on TTS and Festival. , Festival manual (used as Festival's scripting language): Introduction to Scheme for C Programmers, from Cal Tech. Optional Advanced Reading: Chapter 6 "Prosody Prediction from Text" from Taylor, Paul. 2007.
4. TTS: Waveform Synthesis (Diphone and Unit Selection Synthesis) J+M New Chapter 8, pages 25-end Optional Advanced Reading: Chapter 16 "Unit Selection Synthesis" from Taylor, Paul. 2007. Optional Advanced Reading: Optional: Section 7 from Alan Black's lecture notes on TTS and Festival. Optional Advanced Reading: The rest of Section 6 of Alan Black's lecture notes
5. ASR: Noisy Channel Model, Bayes, HMMs, Forward, Viterbi J+M New Chapter 6: Hidden Markov Models, pages 1-20 J+M New Chapter 9: Automatic Speech Recognition, pages 1-12
6. ASR: Feature Extraction and Acoustic Modeling, Evaluation J+M New Chapter 9: Automatic Speech Recognition pages 12-31, 31-45 J+M New Chapter 10: Speech Recognition: Advanced Topics pages 11-16
7. ASR: Learning (Baum-Welch) and Disfluencies J+M New Chapter 9: Automatic Speech Recognition 46-52 , J+M New Chapter 10: Speech Recognition: Advanced Topics pages 1-11

Reference Material:

1. The new edition of Jurafsky and Martin. 2007. Speech and Language Processing.
2. Selected chapters from Taylor, Paul. 2007. Text-to-Speech Synthesis
3. Some papers from the literature

Course Title: Telecom Management

Course Code: ITEC-706
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Networks

Course Objectives:

The course provides the understanding of the operation and management of a telecommunication business.

Course Syllabus:
Introduction to Telecommunication Management and Planning. Telecommunication Strategic Planning. Developing Requirements and Specifications. Managing Long-Distance Services. Managing Internet Services. Managing PBX and Key Telephone Equipment. Managing Automatic Call Distributors. Managing Voice Processing Equipment. Managing Local Area Network and Internets. Managing Wide Area Networks. Managing Video and Audio Conferencing Equipment. Managing Convergence. Developing a Telecommunication Operations Plan. Disaster Prevention and Recovery. Telecommunications Project Management. Managing Telecommunications Security.

Course Outline:
1. Introduction to Telecommunication Management and Planning
2. Telecommunication Strategic Planning
3. Developing Requirements and Specifications
4. Managing Long-Distance Services
5. Managing Internet Services
6. Managing PBX and Key Telephone Equipment
7. Managing Automatic Call Distributors
8. Managing Voice Processing Equipment
9. Managing Local Area Network and Internets
10. Managing Wide Area Networks
11. Managing Video and Audio Conferencing Equipment
12. Managing Convergence
13. Developing a Telecommunication Operations Plan
14. Disaster Prevention and Recovery
15. Telecommunications Project Management
16. Managing Telecommunications Security

Reference Material:
1. The Irwin Handbook of Telecommunications Management by James Harry Green, McGraw-Hill; 3rd Edition (March 22, 2001). ISBN-10: 0071370587
2. Telecom Management Crash Course : A Telecom Company Survival Guide by P. J. Louis, McGraw-Hill Professional; 1st Edition (June 1, 2002). ISBN-10: 0071386203
3. The Essentials of Telecommunications Management: A Simple Guide to Understanding a Complex Industry by Jayraj Ugarkar, AuthorHouse (March 29, 2010). ISBN-10: 1434397254

Course Title: Telecommunication Systems

Course Code: ITEC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Networks

Course Objectives:
The course provides an in-depth investigation of telecommunications system concepts and Terminology. The course covers the most popular telecommunication networks and forthcoming technologies.

Course Syllabus:
Communication Channel and the Communication Network Technologies. Digital Telephony.

Switching and Signaling Systems. Switching Fabric Interfaces and ICs, Optics and the Future. Cellular Systems. Fixed Wireless Access Technologies. Digital Subscriber Loop. Transmission Techniques. Telecommunication Systems Testing. Embedded Systems Design for Telecommunications.

Course Outline:

1. Communication Channel and the Communication Network: Introduction and Development of Telecommunications, Signals in Communication, Characteristics of the Communication Channel, The Communication Networks, Enabling Technologies.
2. Digital Telephony: From Analog to Digital, Advantages and Disadvantages of Digital Techniques, PCM Techniques and Standards, Low Bit-Rate Voice Coding, Voice over the Internet, Devices for Digital Telephony.
3. Switching and Signaling Systems Switching, Circuit Switching and Packet Switching, Signaling Systems, Digital Exchanges, Private Branch Exchanges and Key Phone Systems, Merging Data and Voice, Packet Switching Systems, Switching Fabric Interfaces and ICs, Optics and the Future.
4. Cellular Systems: Advantages and Constraints of Wireless Access, Basic Components of Wireless Access, Cellular System Operation, The Cellular Radio Environment, Frequency Assignment and Multiple Access Schemes for Cellular Systems, Capacity of Cellular Systems, First Generation Cellular Systems and Standards, Second Generation Cellular Systems and Standards, Third Generation Cellular Systems and Standards, Mobile Device Hardware, Architecture, and Implementation, Technological Trends.
5. Fixed Wireless Access: Access Technologies, WLL Technologies Primarily for Voice Provision, Broadband Fixed Wireless Access Systems, Enabling Technologies.
6. Digital Subscriber Loop: Signal Impairment and the Channel Length, DSL Techniques, Different Versions of DSL, Spectral Consideration in DSL, Operation of DSL, DSL Chip Sets, ISO Seven-Layer Model, ATM, and DSL Systems, End-to-End ADSL Systems and Standards.
7. Transmission Techniques.
8. Telecommunication Systems Testing: Transmission Line Behavior, Decibel Measurements, Basic TDM Techniques and Digital Transmission Systems, Plesiochronous Higher-Order Digital Multiplexing, Synchronous Digital Multiplexing, Optical Networks, Emerging Technologies.
9. Embedded Systems Design for Telecommunications: AMR Speech Codecs and the GSM Environment, Digital Signal Processor Architecture, AD6526 Multiprocessor Architecture, AMR Speech Codec, Algorithmic Complexity of the AMR Speech Codec, Implementation considerations of AMR Speech Codec and porting the Code.

Reference Material:

1. Essentials of Modern Telecommunications Systems by Nihal Kularatna and Dileeka Dias, Artech House (May 2004). ISBN-10: 1580534910
2. The Irwin Handbook of Telecommunications by James Harry Green, McGraw-Hill; 5th Edition (October 26, 2005). ISBN-10: 0071452222
3. Telecommunications Essentials: The Complete Global Source for Communications Fundamentals, Data Networking and the Internet, and Next-Generation Networks by Lillian Goleniewski, Addison-Wesley Professional; 1st Edition (January 5, 2002). ISBN-10: 0201760320
4. Fundamentals of Communications Systems by Michael Fitz, McGraw-Hill Professional; 1st Edition (June 27, 2007). ISBN-10: 0071482806

Course Title: Text Processing and Data Analysis

Course Code: CSEC-734
Course Structure: Lectures: 3/Labs: 1
Credit Hours: 4
Prerequisites: None

Course Objectives:
The processing and analysis of large datasets has become a regular task in sciences. This introductory course into the scripting language PERL provides the basis for designing rapid, reproducible and scalable solutions to this problem. The scripting language PERL is an intuitive and powerful tool for developing custom-tailored solutions for problems ranging from basic data handling and management up to the design of complex workflows and novel algorithms for data analysis. In this course we will introduce the basic concepts of PERL, making you familiar with the various data types and the general structure of PERL scripts, but also with the basic concepts of a structured and standardized data analysis. Based on specific examples from NLP we will guide you through the implementation of first algorithms in PERL aiding in the solution of your particular data analysis problems.

Course Syllabus:
Background, Introduction to Perl, Scalar Data, Built in Functions, Arrays, Functions, Writing Safe Code, Control Structures, File Input / Output, Introduction to Text Processing, Text Processing Functions, Loop Control, Hashes, DBM Databases, Advanced Sorting, Regular Expressions, Environment Variables, CGI-Programming, Process Management, References and Data Structures, Graphics, Javascript

Course Outline:
1. Course goals, syllabus, and introduction to Perl. [TB1, Ch 1]
2. Scalar data [TB1, Ch 2]
3. Lists and arrays [TB1, Ch 3]
4. Subroutines [TB1, Ch 4]
5. Hashtables, Input/Output [TB1, Ch 5-6]
6. HTML (Internet)
7. Files and directories [TB1, Ch 11-12]
8. Modules, basic CGI [TB1, Ch 13]
9. Regular expressions [TB1, Ch 7]
10. Regular expressions (cont.) [TB1, Ch 8-9]
11. More control structures, strings, sorting [TB1, Ch 10-15]
12. Simple databases; DBI, DBM [TB1, Ch 16]
13. Internet tools, processes, advanced topics [TB1, Ch 14, 17]

Reference Material:
1. Learning Perl by Randal L. Schwartz and Tom Phoenix, 3rd edition, known as the Llama book.
2. Programming Perl by Larry Wall, Tom Christiansen, and Jon Orwant, 3rd edition, known as the Camel book.
3. CPAN: Comprehensive Perl Archive Network. Online, at http://www.cpan.org/
4. Perl Cookbook by Tom Christiansen and Nathan Torkington, known as the Cookbook.
5. Mastering Perl/Tk by Stephen Lidie and Nancy Walsh

Course Title: Virtualization in Cloud Computing

Course Code: ITEC-711
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
This course gives an inside look as traditional physical data centers evolve and morph into virtual entities and cloud environments. Students will learn in-depth details and considerations for planning, designing, and migrating to Virtualized Data Centers (VDCs) and cloud environments. They will learn to design VDC and cloud infrastructures, maintaining the most robust and elastic computing, network, and storage environments.

Course Syllabus:
Virtualization, Virtualization Types, Virtualization Management, Cloud Computing, Service Models, Cloud Adoption and Barriers, Return on Investment and Cloud Benefits; Typical Design Patterns and Use Cases, Design Patterns, Cloud Use Cases, Deployment Models, IaaS as a Foundation, Cloud Consumer Operating Model. Data Center Architecture and Technologies. IT Services. The Cisco Cloud Strategy. Cloud Management Reference Architecture. Cloud Service Fulfillment. Cloud Service Assurance. Billing and Chargeback. Technical Building Blocks of IaaS. Automating and Orchestration Resources. Cloud Capacity Management. Case Study - Hybrid Cloud: Cisco Cloud Enablement Services, Company Profile, Business Goals, Cloud Strategy, Cloud Maturity, IT Platform, Cloud Reference Model, Private Cloud Services, Orchestration and Automation Transition Architecture, Telco Solution, Solution, Out-of-the-Box Services, Diggit Service Requirements.

Course Outline:
1. Virtualization: Virtualization Types, Virtualization Management, Cloud Computing, Service Models, Cloud Adoption and Barriers, Return on Investment and Cloud Benefits; Typical Design Patterns and Use Cases, Design Patterns, Cloud Use Cases, Deployment Models, IaaS as a Foundation, Cloud Consumer Operating Model.
2. Data Center Architecture and Technologies: Architecture, Architectural Building Blocks of a Data Center, Design Evolution, Virtual PortChannel (vPC), Layer 2 Multi-Pathing (L2MP), Network Services and Fabric Evolution in the DC, Service Assurance, Evolution of the Services Platform.
3. IT Services: Classification of IT Services and Information, Four Cornerstones of Cloud Economics.
4. The Cisco Cloud Strategy: A Brief History of IT Service Delivery, The Cisco Cloud Strategy: An Overview, Infrastructure Evolution to Support Cloud Services.
5. Cloud Management Reference Architecture: Standards, TMF eTOM, IT Infrastructure Library (ITLI), ITU-T TMN, Building Cloud Models Using Standards, Integration of Management Systems/Functions.
6. Service Fulfillment: Cloud Fulfillment Using ITILV3, Cloud End-to-End Service Provisioning Flow, Service Orchestration, Cloud End-to-End Architecture Model.
7. Service Assurance: Cloud Assurance Flow Using the ITIL Process, Cloud End-to-End Monitoring Flow, Service Assurance Architecture.
8. Billing and Chargeback: Billing and Chargeback Terminology, Cloud Consumers and Providers, Cloud Services Billing Considerations, Cloud Order-to-Cash Process Flow, Billing and Charging Architecture.

9. Technical Building Blocks of IaaS: IaaS Service Composition, Developing and Offering Cloud Products, Persisting Service Data.
10. Automating and Orchestration Resources: Building the Cloud, Adding Services to the Cloud, Creation and Placement Strategies, Service Life Cycle Management.
11. Cloud Capacity Management: Tetris and the Cloud, Cloud Capacity Model, Demand Forecasting, Procurement in the Cloud.
12. Case Study - Hybrid Cloud: Cisco Cloud Enablement Services, Company Profile, Business Goals, Cloud Strategy, Cloud Maturity, IT Platform, Cloud Reference Model, Private Cloud Services, Orchestration and Automation Transition Architecture, Telco Solution, Solution, Out-of-the-Box Services, Diggit Service Requirements.

Reference Material:

1. Cloud Computing: Automating the Virtualized Data Center by Venkata Josyula, Malcolm Orr and Greg Page, Cisco Press; 1st Edition (December 9, 2011). ISBN-10: 1587204347.
2. IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach by Mickey Iqbal, Mithkal Smadi, Chris Molloy, and Jim Rymarczyk, Mc Press; 1stEdition (January 1, 2011). ISBN-10: 1583473548
3. Microsoft Private Cloud Computing by Aidan Finn, Hans Vredevoort, Patrick Lownds, and Damian Flynn, Sybex; 1stEdition (July 10, 2012). ISBN-10: 1118251474
4. Advanced Server Virtualization: VMware and Microsoft Platforms in the Virtual Data Center by David Marshall , Wade A. Reynolds, and Dave McCrory, Auerbach Publications; 1st Edition (May 17, 2006). ISBN-10: 0849339316
5. Data Center Virtualization: A practical guide to successful deployments of a Virtualized Data Center Infrastructure by Sukento Sukirya, Pete Gore, Brian Clay, and Pierre Vachon, Cisco Press (December 14, 2003). ISBN-10: 1587050234

Course Title: Advanced Requirements Engineering

Course Code: SECC-701
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Syllabus: Software Requirements Fundamentals: Product and process requirements, Functional and non-functional requirements, Emergent properties, Quantifiable requirements, System and software requirements. Requirements Process: Process models, Process actors, Process support and management, Process quality and improvement. Requirements Analysis: Requirements sources, Elicitation techniques. Requirements Analysis: Requirements classification, Conceptual modeling, Architectural design and requirements allocation, Requirements negotiation, Formal analysis. Requirements Specification: System definition document, System requirements document, Software requirements specification. Requirements Validation: Requirements reviews, Prototyping, Model validation, Acceptance tests. Practical Considerations: Iterative nature of the requirements process, Change management, Requirements attributes, Requirements tracing, Measuring requirements. Software Requirements Tools. Current research topics in requirement engineering.

Reference Material:

1. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Bruce R. Maxim, 8th Ed, McGraw-Hill Education, 2015.
2. Object-Oriented Analysis, Design and Implementation, Brahma Dathan, Sarnath Ramnath, 2nd Ed, Universities Press, India, 2014.
3. Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures, Hassan Gomaa, Cambridge University Press, 2011.
4. Applying UML & Patterns: An Introduction to Object-Oriented Analysis & Design and Iterative Development, Craig Larmen, 3rd Edition.
5. Head First Design Patterns, Eric Freeman, Elisabeth Freeman, Kathy Sierra and Bert Bates, O'Reilly Media, Inc., 2004.

Course Title: Advanced Software System Architecture

Course Code: SECC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Quality attributes in the context of architecting. Qualitative and quantitative assessment of architectures. Architectural modeling through Architecture Description Languages. System modeling its relation to software architecting. Architecting for evolution and variability. Partitioned and layered architectures. System-of-Systems and Ultra-Large Scale Systems. Software Product Lines and Configurable Software. Self-Adaptive Software. Architectural Description Languages. Feature Modeling. Architecture and Model-Based Testing. Current research topics in software system architecture..

Reference Material:

1. Designing Software Architectures: A Practical Approach (SEI Series in Software Engineering), Humberto Cervantes, Rick Kazman, 1st Edition, Addison-Wesley Professional, 2016.
2. Software Product Lines: Practices and Patterns, P. Clements and L. Northrup, Addison-Wesley, 2002.
3. Software Architecture : Foundations, Theory, and Practice, R. Taylor, N. Medvidović and E.M. Dashofy, John Wiley, 2010

Course Title: Software Testing and Quality Assurance

Course Code: SECC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Testing techniques. Black Box testing, White Box and Grey Box testing techniques. Quality Assurance planning and execution. Automated testing topics include constructing a framework, scripting techniques, generating a test data, generating test architecture, pre/post-

processing, test maintenance, and job specific metrics. Current research topics in Software Testing and Quality Assurance.

Reference Material:

1. Software Quality Assurance: Integrating Testing, Security, and Audit (Internal Audit and IT Audit), Abu Sayed Mahfuz, Auerbach Publications, 2016.
2. Practical Model-Based Testing: A Tools Approach, Mark Utting and Bruno Legeard, Morgan Kaufmann Publishers Inc., San Francisco, CA, 2006.
3. Software Quality Engineering, Testing, Quality Assurance, and Quantifiable improvements, Jeff Tian, IEEE Computer Society, 2005.
4. Introduction to Software Engineering, P Ammann and J Offutt, Cambridge University Press, 2008.

Course Title: Parallel Processing: Algorithms and Architectures-I

Course Code: CSEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: Advanced Algorithm of Analysis

Course Objectives:

The course covers the needed perspective, taxonomy, and analysis tools for the understanding key concepts of parallel processing. It also delimits the models of parallel processing which has become quite important in recent years.

Course Syllabus:

Introduction to Parallelism. Types of parallelism. Parallel Algorithms. Parallel Algorithm Complexity. P RAM and Basic Algorithms. Shared-Memory Algorithms. Sorting and Selection Networks. Circuit-Level Examples. Sorting on a 2-D Mesh or Torus. Routing on a 2-D Mesh or Torus. Numerical 2-D Mesh Algorithms. Other Mesh-Related Architectures.

Course Outline:

1. Introduction to Parallelism: Why parallel processing? Parallel processing ups and downs, Types of parallelism: A taxonomy, Constraints of parallel processing, Effectiveness of parallel processing. Introduction to Parallel Algorithms: Some simple computations, some simple architectures, Algorithms for a linear array, Algorithms for a binary tree, Algorithms for a 2D mesh, Algorithms with shared variables.
2. Parallel Algorithm Complexity: Asymptotic complexity, Algorithm optimality and efficiency, Complexity classes, Parallelizable tasks and the NC class, Parallel programming paradigms, Solving recurrences. Models of Parallel Processing: Development of early models, SIMD versus MIMD architectures, Global versus distributed memory, The PRAM shared-memory model, Distributed-memory or graph models, Circuit model and physical realizations.
3. PRAM and Basic Algorithms: PRAM submodels and assumptions, Data broadcasting, Semigroup or fan-in computation, Parallel prefix computation, Ranking the elements of a linked list, Matrix multiplication. More Shared-Memory Algorithms: Sequential rank-based selection, A parallel selection algorithm, A selection-based sorting algorithm, Alternative sorting algorithms, Convex hull of a 2-D point set, Some implementation aspects.
4. Sorting and Selection Networks: What is a sorting network? Figures of merit for sorting networks, Design of sorting networks, Batcher sorting networks, Other classes of sorting

networks, Selection networks. Other Circuit-Level Examples: Searching and dictionary operations, A tree-structured dictionary machine, Parallel prefix computation, Parallel prefix networks, The discrete Fourier transform, Parallel architectures for FFT.

5. Sorting on a 2-D Mesh or Torus: Mesh-connected computers, Theshearsort algorithm, Variants of simple shearsort, Recursive sorting algorithms, A non-trivial lower bound, Achieving the lower bound,
6. Routing on a 2-D Mesh or Torus: Types of data routing, Useful elementary operations, Data routing on a 2-D array, Greedy routing algorithms, Other classes of routing algorithms, Wormhole routing
7. Numerical 2-D Mesh Algorithms: Matrix multiplication, Triangular system of equations, Tridiagonal system, Arbitrary system of linear equations, Graph algorithms, Image-processing algorithms
8. Other Mesh-Related Architectures: Three or more dimensions, Stronger and weaker connectivities, Meshes augmented with non-local links, Meshes with dynamic links, Pyramid and multi-grid systems, Meshes of trees

Reference Material:

1. Introduction to Parallel Processing: Algorithms and Architectures by Behrooz Parhami, Springer; (2006) ISBN-10: 0306459701
2. Parallel Algorithms and Architectures by Michel Cosnard and Denis Trystram, Intl Thomson Computer Pr (Sd) (September 1996). ISBN-10: 0534946070
3. Parallel Processing and Parallel Algorithms: Theory and Computation by Seyed H Roosta, Springer; 1st Edition (December 10, 1999). ISBN-10: 0387987169
4. Introduction to Parallel Algorithms by Joseph JaJa, Addison-Wesley Professional; 1stEdition (April 3, 1992). ISBN-10: 0201548569

Course Title: Parallel Processing: Algorithms and Architectures-II

Course Code: CSEC-729
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: Parallel Processing: Algorithms and Architectures - I

Course Objectives:

The course is the 2nd part of the Parallel Processing. It continue covering the needed perspective, taxonomy, and analysis tools for the understanding key concepts of parallel processing. It also delimits the models of parallel processing which has become quite important in recent years.

Course Syllabus:

Hypercubes and Their Algorithms. Sorting and Routing on Hypercubes. Sampler of other Networks: Performance parameters for networks, Star and pancake networks, Ring-based networks, Composite or hybrid networks, Hierarchical (multi-level) networks, Multi-stage interconnection networks. Emulation and Scheduling. Data Storage, Input, and Output. Reliable Parallel Processing. Shared-Memory MIMD Machines. Data-Parallel SIMD Machines.

Course Outline:

1. Hypercubes and Their Algorithms: Definition and main properties, Embeddings and their usefulness, Embedding of arrays and trees, A few simple algorithms, Matrix multiplication, Inverting a lower triangular matrix.

2. Sorting and Routing on Hypercubes: Defining the sorting problem, Bitonic sorting, Routing problems on a hypercube, Dimension-order routing, Broadcasting on a hypercube, Adaptive and fault-tolerant routing. Other Hypercubic Architectures: Modified and generalized hypercubes, Butterfly and permutation networks, Plus-or-minus-2i network, The cube-connected cycles, Shuffle and shuffle-exchange networks.
3. Sampler of Other Networks: Performance parameters for networks, Star and pancake networks, Ring-based networks, Composite or hybrid networks, Hierarchical (multi-level) networks, Multi-stage interconnection networks. Emulation and Scheduling: Emulations among architectures, Distributed shared memory, The task scheduling problem, A class of scheduling algorithms, Some useful bounds for scheduling, Load balancing and dataflow systems
4. Data Storage, Input, and Output: Data access problems and caching, Cache coherence protocols, Multi-threading and latency hiding, Parallel I/O technology, Redundant disk arrays, Interfaces and standards.
5. Reliable Parallel Processing: Defects, faults, failures, Defect-level methods, Fault-level methods, Error-level methods, Malfunction-level methods, Degradation-level methods. System and Software Issues: Coordination and synchronization, Parallel programming, Software portability and standards, Parallel operating systems, Parallel file systems, Hardware/software interaction
6. Shared-Memory MIMD Machines: Variations in shared memory, MIN-based BBN Butterfly, Vector-parallel Cray Y-MP, Latency-tolerant Tera MTA, CC-NUMA Stanford DASH, SCI-based Sequent NUMA-Q. Message-Passing MIMD Machines: Mechanisms for message passing, Reliable bus-based Tandem NonStop, Hypercube-based nCUBE3, Fat-tree-based Connection Machine, Omega-network-based IBM SP2, Commodity-driven Berkeley NOW.
7. Data-Parallel SIMD Machines: Where have all the SIMDs gone? The first supercomputer: ILLIAC IV, Massively parallel Goodyear MPP, Distributed Array Processor (DAP), Hypercubic Connection Machine, Multi-connected MasPar MP-2. Past, Present, and Future: Milestones in parallel processing, Current status, issues, and debates, TFLOPS, PFLOPS, and beyond, Processor and memory technologies, Interconnection technologies, The future of parallel processing.

Reference Material:

1. Introduction to Parallel Processing: Algorithms and Architectures by BehroozParhami, Springer; (2006). ISBN-10: 0306459701
2. Parallel Algorithms and Architectures by Michel Cosnard and Denis Trystram, Intl Thomson Computer Pr (Sd) (September 1996). ISBN-10: 0534946070
3. Parallel Processing and Parallel Algorithms: Theory and Computation by Seyed H Roosta, Springer; 1st Edition (December 10, 1999). ISBN-10: 0387987169
4. Introduction to Parallel Algorithms by Joseph JaJa, Addison-Wesley Professional; 1st Edition (April 3, 1992). ISBN-10: 0201548569

Course Title: Research Methodology

Course Code: SEEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Introduction to Research. Objectives of Research. Importance of Research Methodology in Research Study. Types of Research. Steps in Conducting Research. What is Literature Review? Why need for Literature Review. Types of Literature Review. Systematic Literature Review Protocol. Problem Statement and Problem formulation. Criteria for selecting a problem. Identifying Types of variables in Research. Types of hypothesis. Identifying Target Population. Types of Sampling. Sampling Techniques. Quantitative Research Methods. Scientific Methods. Design of Quantitative Surveys. Techniques to Conduct Quantitative Methods. Introduction to Qualitative Research. Qualitative Research Methods. Data Analysis and Theory in Qualitative Research Articles. Introduction to Mixed Methods Research. Design of Mixed Methods Research. Evaluation of Mixed Methods Research. Case Study. How to Conduct a Case Study. Case Study Protocol. Importance and Benefits of Case Study. Types of Statistical Tests to Conduct Data Analysis. Data Analysis Tools. Introduction to SPSS. Hands on Practice of SPSS. How to Define variables in SPSS. How to Record Collected Data in SPSS. Types of Tests via SPSS including Regression. Correlation. Cross tabulation and others. How to write Good Research Proposal. Contents of Thesis. Important Elements of Research Thesis.

Reference Material:
1. Research design: Qualitative, quantitative and mixed methods approaches, Creswell, J. W. Thousand Oaks, CA: Sage,4th Ed. 2014

Course Title: Swarm Intelligence

Course Code: CSEC-709
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course is aimed to provide students' knowledge of up-to-date efficient variants of different meta heuristics together with their potential applications. Also to develop the interest of students in both research and development.

Course Syllabus:
Introduction to swarm intelligence and key principles, From real to virtual ants, Introduction to mobile robotics, unsupervised multi-agent machine-learning, Collective movements in natural societies, Multi-level modeling of self-organized systems, Combined modeling, Division of labor and task-allocation mechanisms, Market-based and threshold-based algorithms, Aggregation and segregation, Distributed structure building.

Course Outline:
1. Introduction to swarm intelligence and key principles (e.g., self-organization, stigmergy), natural and artificial examples, computational and embedded SI. Foraging, trail laying/following mechanisms. Open-space, multi-source foraging experiments: biologi-

cal data and microscopic models.
2. From real to virtual ants: Ant System (AS), the first combinatorial optimization algorithm based on ant trail/following principles. Application to a classical operational research problem: the Travel Salesman Problem (TSP). From AS to Ant Colony Optimization (ACO). Ant-based algorithms (ABC, Ant-Net) applied to routing in telecommunication networks. Definitive assignment of course projects.
3. Introduction to mobile robotics: basic hardware and software concepts centered around the differential drive vehicle used in the course (e-Puck). Introduction to control architecture for mobile robots with special focus on reactive control architectures.
4. Introduction to unsupervised multi-agent machine-learning techniques for automatic design and optimization: terminology and classification, Genetic Algorithms (GA) and Particle Swarm optimization (PSO). Comparison between both techniques in theory and practice.
5. Application of machine-learning techniques to automatic control design and optimization in single-robot and multi-robot experiments. Specific issues for automatic control design and optimization in collective systems (e.g., credit assignment problems, noise resistance).
6. Collective movements in natural societies; focus on flocking phenomena. Collective movements in artificial systems: Reynolds' virtual agents (Boids) and experiments with multi-robot systems (flocking, formation).
7. Multi-level modeling of self-organized robotic systems: microscopic and macroscopic models; Markov formalism; linear and nonlinear micro-to-macro mapping, model analysis.
8. Combined modeling and machine-learning methods for control optimization. Diversity and specialization metrics.
9. Division of labor and task-allocation mechanisms, part I: threshold-based algorithms.
10. Division of labor and task-allocation mechanisms, part II: market-based algorithms and comparisons between threshold-based and market-based algorithms. A short tutorial on sensor networks, networked robotic systems and their relation with Swarm Intelligence.
11. Aggregation and segregation. Social insects, data clustering algorithms, and collective robotics experiments.
12. Distributed structure building in natural and artificial systems.

Reference Material:
1. Computational Intelligence: An Introduction, Andries Engelbrecht, Wiley, 2007
2. “Swarm Intelligence: From Natural to Artificial Systems", E. Bonabeau, M. Dorigo, and G. Theraulaz, Santa Fe Studies in the Sciences of Complexity, Oxford University Press, 1999. ISBN: 0195131592

Course Title: Evolutionary Computation

Course Code: CSEC-710
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
It is intended as a fundamental introduction, as well as a survey of the many aspects of evolutionary algorithms (EAs), in particular GA, GP, ES, and will concentrate on the basic

concepts of representation, operators and overall control, followed by examples of the use of these concepts in important applications. As such, this course will not do much in-depth study of any one area. Rather the course is intended as a good introduction for those who have had no exposure to EC and as a stepping stone for those interested in more specific areas.

Course Syllabus:
Evolutionary Computation, Genetic Algorithms, Genetic Programming, Swarm Intelligence, Ant Colony Optimization, Particle Swarm Optimization, Multi Objective Optimization, Neighboring Algorithms, Co-Evolution, Differential Evolution

Course Outline:

1. Introduction to Evolutionary Computation, Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, A simple evolutionary algorithm.
2. Search Operators, Recombination/Crossover for strings (e.g., binary strings), e.g., one-point, multi-point, and uniform crossover operators, Mutation for strings, e.g., bit-flipping, Recombination/Crossover and mutation rates, Recombination for real-valued representations, e.g., discrete and intermediate recombination, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc, Why and how a recombination or mutation operator works?
3. Selection Schemes, Fitness proportional selection and fitness scaling, Ranking, including linear, power, exponential and other ranking methods, Tournament selection, Selection pressure and its impact on evolutionary search
4. Search Operators and Representations, Mixing different search operators, An anomaly of self-adaptive mutations, The importance of representation, e.g., binary vs. Gray coding, Adaptive representations
5. Evolutionary Combinatorial Optimization, Evolutionary algorithms for TSPs, Evolutionary algorithms for lecture room assignment, Hybrid evolutionary and local search algorithms
6. Co-evolution, Cooperative co-evolution, Competitive co-evolution
7. Niching and Speciation, Fitness sharing (explicit and implicit), Crowding and mating restriction
8. Constraint Handling, Common techniques, e.g., penalty methods, repair methods, etc. Analysis, Some examples
9. Genetic Programming, Trees as individuals, Major steps of genetic programming, e.g., functional and terminal sets, initialization, crossover, mutation, fitness evaluation, etc. Search operators on trees, Automatically defined functions, Issues in genetic programming, e.g., bloat, scalability, etc., Examples
10. Multi objective Evolutionary Optimization, Pareto optimality, Multi objective evolutionary algorithms
11. Learning Classifier Systems, Basic ideas and motivations, Main components and the main cycle, Credit assignment and two approaches
12. Theoretical Analysis of Evolutionary Algorithms, Schema theorems, Convergence of EAs, Computational time complexity of EAs, No free lunch theorem

Reference Material:

1. Evolutionary Computation: A Unified Approach, Ken De Jong, 2006.
2. How to Solve It: Modern Heuristics, Z. Michalewicz and D. B. Fogel, Springer, 2000.
3. Computational Intelligence: An Introduction, Andries Engelbrecht, Wiley, 2007

Course Title: Computational Intelligence

Course Code: CSEC-711
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course is aimed to provide students' knowledge of up-to-date efficient variants of different meta heuristics together with their potential applications. Also to develop the interest of students in both research and development.

Course Syllabus:
Optimization, Constrained, unconstrained optimization, Parameter space, function space, and fitness space, Local and global optima, Multi-objective optimization, Classification / Learning, Classification (Supervised Learning), Clustering (Unsupervised Learning), Reinforcement Learning, Control Systems, Expert Systems

Course Outline:

1. Introduction to Computational Intelligence topics, Fundamental concepts
2. Introduction to Evolutionary Computing, Evolutionary computation terms, Canonical genetic algorithm
3. Evolutionary computation variations, Evolutionary programming and Evolution strategies
4. Implementation of Evolutionary Computing
5. Swarm Intelligence, Particle Swarm Optimization
6. Classification, Learning, and Adaptation, Supervised, Unsupervised, Reinforcement Learning
7. Data partitioning and Cross Validation, Error metrics: Mean squared error, receiver operating characteristic curves, Neural Networks and Evolutionary Computation: Explanation and Sensitivity Analysis
8. Neural Networks Implementation, Evolutionary and swarm-based neural networks
9. Fuzzy sets,Membership functions, linguistic variables
10. Fuzzy Logic, Fuzzy set operators, Fuzzy rule-based systems
11. Fuzzification, defuzzification
12. Fuzzy control
13. Evolving fuzzy rule systems
14. Basic ANN Code
15. Neuro-fuzzy systems
16. Fuzzy-GA systems
17. Support Vector Machines
18. Probabilistic reasoning: Bayesian reasoning and Dempster-Shafer theory
19. Bayesian belief networks
20. Fuzzy belief networks
21. Evolving belief networks
22. Artificial Immune Systems

Reference Material:

1. Russell Eberhart and Yuhui Shi - Computational Intelligence: Concepts to Implementations (2007)

2. Fakhreddine Karray and Clarence de Silva - Soft Computing and Intelligent Systems Design (2004)
3. Andries Engelbrecht - Computational Intelligence: an Introduction (2007
4. Amit Konar - Computational Intelligence: Principles, Techniques, and Applications (2005)
5. Vojislav Kecman - Learning and Soft Computing: Support Vector Machines, Neural Networks, and Fuzzy Logic Models (2001)

Course Title: Advanced Software Project Management

Course Code: SECC-704
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: Software Engineering
Course Objectives:
To develop students' ability to plan and manage software development projects successfully, maximizing the return from each stage of the software development life cycle.

Course Syllabus:
Comparison of PM Tools, PMI's Knowledge Areas, PMI Framework, PMI Process Groups, Project Planning, Project Evaluation, comparison of Software Effort Estimation techniques, Comparison of different software development and designing models. Analyzing different risk management methodologies. Studying latest conference and journal papers related to state of the art techniques.

Reference Material:

1. Software Project Management by Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009). ISBN-10: 0077122798
2. A Guide to the Project Management Body of Knowledge, 3rdEdition (PMBOK Guides), ISBN-13: 978-1930699458
3. Mastering Software Project Management: Best Practices, Tools and Techniques by Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing (2010). ISBN-10: 1604270349
4. Effective Project Management: Traditional, Agile, Extreme by Robert K. Wysocki, Wiley; 6th Edition (2011). ISBN-10: 111801619X
5. The Software Project Manager's Handbook - Principles that work at work by Dwayne Phillips, 2ndEdition, IEEE Computer Society Press and Wiley Inter-science, 2004. ISBN 0-471-67420-6

Course Title: Fog Computing

Course Code: CSEC-712
Course Structure: Lectures: 3
Credit Hours: 3
Prerequisite:

Course Objectives:

This course is designed to give a multitude of technologies that comprise the modern concept of Fog and Edge computing, their applications, architectures, and technologies. Fog Computing is an emergent architecture for computing, storage, control, and networking that distributes these services closer to end users along the cloud-to-things continuum. It covers

both mobile and wire line scenarios, traverses across hardware and software, resides on network edge but also over access networks and among end users, and includes both data plane and control plane.

Course Syllabus:

This course gives an introduction to Fog Computing, IoT and related techniques, issues, Fog Computing Architectures, Feasible Service Models of Fog Computing Architecture, Fog Computing Applications: Smart city, Smart health, Smart Building, Internet of Energy and Smart Transportation. Other topics of content include Fog/IoT Data storage and Management, Real-time streaming data processing, Data analytics, Resource-constrained devices management and optimization, Scheduling for Fog infrastructures, Reliability, Security and Privacy, privacy challenges and solutions. Students will also learn and understand about Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit, Common Standards in Fog Computing: The Open Fog Consortium, Standards of Application Development, Building and simulating of use-Case Studies in Smart Health / Smart Cities / Smart Government /Smart Industrial Environments/Industry 4.0.

Course Outline:

1. Overview: From Cloud to Fog, Potentials, trends, and prospects in edge technologies: Fog, cloudlet, mobile edge, and micro data centers
2. Overview: From IT to loT to IoE, Basic attributes and challenges for IoE
3. Fog/Edge Computing Computing Architectures, Feasible Service Models of Fog/Edge Computing Architecture
4. Fog/Edge Computing Applications: Smart city, Smart health, Smart Building, Internet of Energy, smart transportation
5. Fog/Edge/IoT Data storage and Management, Real-time streaming data processing, Data analytics
6. Resource-constrained devices management and optimization
7. Scheduling for Fog/Edge infrastructures
8. Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit:
9. Components of iFogsim: physical components and logical components, Module placement policies,
10. Installation of iFogSim, Building Simulation with iFogSim, Creation of physical and logical components
11. Application Case Studies: a latency-sensitive online game, Intelligent Surveillance through Distributed Camera Networks, Performance Evaluation
12. Example Scenarios: Sensors with different tuple emission rate, Send specific number of tuples from a sensor, Connect lower level Fog devices with nearby gateways, Mobility of a Fog device, Make Cluster of Fog devices, Simulation of a Placement Policy
13. Common Standards in Fog Computing: The Open Fog Consortium, Standards of Application Development
14. Building and simulating a Use-Case Study in Smart Health / Smart Cities / Smart Government / Smart Industrial Environments / Industry 4.0
15. Fog/Edge/IoT Reliability, Security and Privacy, Fog/Edge privacy challenges and solutions

Reference Material:

1. Internet of Things principals and paradigms, edited by Rajkumaar Buyya, AmirVahid, ISBN 978-0-12-805395-9
2. Fog Computing Concepts, Frameworks and Technologies by mahmood Zaigham (Ed. 2018), ISBN 978-3-319-94890-4
3. Fog and Edge Computing: Principles and Paradigms, edited by Rajkumar Buyya, Satish Srirama, Wiley Press
4. The Rise of Fog Computing in the Digital Era, edited by K. G. Srinivasa, Pankaj Lathar, G. M. Siddesh, ISBN 152256070X, 9781522560708
5. https://www.openfogconsortium.org/resources/#use-cases
6. Fog of everything: energy-efficient networked computing architectures, research challenges, and a case study (https://ieeexplore.ieee.org/document/7921687/)
7. FOCAN: A Fog-supported Smart City Network Architecture for Management of Applications in the Internet of Everything Environments (https://arxiv.org/abs/1710.01801)
8. iFogSim: A Toolkit for Modeling and Simulation of Resource Management Techniques in Internet of Things, Edge and Fog Computing Environments (https://arxiv.org/abs/1606.02007)
9. Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit
10. Building a Sustainable Internet of Things: Energy-Efficient Routing Using Low-Power Sensors Will Meet the Need (https://www.researchgate.net/publication/323491668_Building_a_Sustainable_Internet_of_Things_Energy-Efficient_Routing_Using_Low-Power_Sensors_Will_Meet_the_Need)
11. Fog computing job scheduling optimization based on bees swarm (https://www.tandfonline.com/doi/abs/10.1080/17517575.2017.1304579?journalCode=teis20)
12. Priority based scheduling in Fog Computing
13. Mobility aware Application Scheduling in Fog Computing
14. Data Storage and management in fog/edge Computing - webcourse https://webcourse.cs.technion.ac.il/236826/Winter2017-2018/ho/WCFiles/Data%20storage%20and 20management%20in%20Fog%20-%20final%20.pptx
15. https://www.cds.net/blog/2018/03/fog-computing-and-iot/
16. FogStore: Toward a Distributed Data Store for Fog Computing (https://arxiv.org/pdf/1709.07558)
17. An architecture for Load Balancing Techniques for Fog Computing https://pdfs.semanticscholar.org/24e5/022d0b6775f460159dd1a96d63ec4fbb4f68.pdf
18. Multiobjective optimization for computation offloading in Fog Computing https://ieeexplore.ieee.org/document/8168252/\
19. An overview of Fog Computing and its security issues, Security and privacy issues of fog

Curriculum
of
MS Software Engineering
for
Main Campus, Sub Campuses,
and
Affiliated Colleges

Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall 2018)

Curriculum of MS Software Engineering Program

MSSE Program's Rationale

The mission of the Masters of Science (Software Engineering) program is to equip students with theoretical and applied knowledge of software for the solution of complex problems. It is aimed to prepare the students to learn independently in a constantly changing discipline.

The objective of the dedicated and committed faculty of this department is to prepare our highly enthusiastic students for a variety of rewarding careers. Our engineering curriculum has been carefully designed to match your skills and aspirations in order to keep pace with rapid advancements in computer engineering and growing needs of computing and information technology. Innovation and creativity is the major focus of MS Software Engineering programme. A range of subjects such as software engineering, pattern recognition & analysis, analysis of stochastic systems, numerical analysis, computer vision, parallel processing computer systems, advanced operating systems, advanced topics in computer networks and distributed systems, digital image processing and digital system design help you in acquiring the skills and qualities needed to greatly contribute in this very attractive discipline of engineering- in fact the most dominant technology in today's world.

Recent developments in computer hardware, software and communication technologies have offered new exciting opportunities and challenges for creation of innovative learning environments for Software Engineering and its curricula design. The challenge of getting all newly emerging technologies incorporated into the curriculum is becoming pivotal for the effectiveness of curricula. There is a need for curricula structures that are really able to meet the challenges of 21st century knowledge driven complex work places. The curriculum is required to provide integration of all components and the foundations that allow accessing all of the new knowledge and technology to fulfill the vision of future.

Program Structure

The graduate program embodies sufficient flexibility to fulfill the requirements of either an "academic" degree (Breadth-Based) obtained in preparation for further graduate study or a terminal "professional" degree (Depth-Based). The program is intended to establish an integrated breadth and depth based curriculum model to assure that the common aspects of various potential graduate programs in Computer Science are captured.

Generally graduate programs are structured with a common core of fundamental material and a wide range of options for rest of the course work. MSSE curriculum structure is implemented in four-semester time. A project/thesis work is unified with student's chosen depth oriented specialties. Followings are the program's details:

Program Objectives

The objectives of MS (Software Engineering) program are:

1. Prepare students who can critically apply concepts, theories and practices to provide creative solutions of complex computing problems.
2. Prepare students who can define, plan, implement and test a medium-sized software project using appropriate software engineering processes, methods and techniques.

3. Prepare students to effectively communicate their ideas in written and electronic form, and prepare them to work collaboratively in a team environment.
4. Prepare students with a theoretical software engineering background and applied research needed to enter a doctorate program in software engineering.
5. Prepare students to join an appropriate and respectable level position in a computing-related field, and to maintain their professional skills in rapidly evolving field.

Duration

The **minimum duration** for completion of MS degree is two years. The HEC allows a **maximum period of four years** to complete MS degree requirements.

Eligibility Criteria

The minimum requirements for admission in a Master degree program are:

a. BS (SE/CS/IT) 4 years' degree program with a minimum CGPA of 2.0.

OR

b. MCS or M.Sc. (Computer Science) 2 years' degree program.

OR

c. BCS 3 years' program degree applicants may be provisionally admitted in the MS(SE) program. Candidates will be required to take additional courses to complete at least 130 credit hours before being formally enrolled in the MS (SE) program.

OR

d. 16-years education with science/engineering degree.

Note:

I. Under eligibility criterion 1-3, the university/department may recommend additional deficiency courses, from the BS (SE) curriculum, considering the deficiency of the candidates.

II. Under eligibility criterion number 4, candidates will be required to complete the deficiency coursework prior to the MS (SE) coursework to ensure the pre-requisite competency in SE. The deficiency coursework will be determined based on the core SE courses of the BS (SE) degree.

Degree Requirements

For the award of MS degree, a student must have:

a. Passed courses totalling at least 30 credit hours, including four core courses.
b. Obtained a CGPA of 2.5 or more.

c.

Distribution of Courses:

Followings are the distribution of total credit hours:

Category or Area	Credit Hours
Core	12
Elective	12
Thesis	6
Total Credit Hours	30

List of Core Courses

S No	Course Code	Pre. Req.	Course Title	Credit Hours
1	SECC-701	None	Advanced Requirements Engineering	3(3+0)
2	SECC-702	None	Advanced Software System Architecture	3(3+0)
3	SECC-703	None	Software Testing and Quality Assurance	3(3+0)
4	SECC-704	None	Advance Software Project Management	3(3+0)

List of Elective Courses

S No	Course Code	Pre. Req.	Course Title	Cr. Hrs.
5	ITEC-707	Computer Networks	Advanced Topics in Wireless Networks	3(3+0)
6	CSEC-717	Artificial Intelligence	Advanced Artificial Intelligence	3 (3+0)
7	CSEC-713	Human Computer Interaction	Advanced Human Computer Interaction	3(3+0)
8	CSEC-707	Web system and technology	Advanced Web development	3(3+0)
9	CSEC-731	None	Advanced Web Engineering	3 (3+0)
10	CSEC-708	None	Agent Based Modeling	3(3+0)
11	CSEC-714	None	Big Data Analysis	3(3+0)
12	CSEC-724	None	Bioinformatics	3(3+0)
13	ITEC-710	None	Business Process Management Trends & Technologies	3 (3+0)
14	CSEC-715	Computer	Cloud Computing	3(3+0)

		Networks		
15	CSEC-711	None	Computational Intelligence	3(3+0)
16	CSEC-722	Linear Algebra	Computer Vision	
17	CSEC-718	None	Digital Image Processing	3(3+0)
18	CSEC-706	DBMS	Distributed Computing	3(3+0)
19	ITEC-703	DBMS	Distributed Database Systems	3(3+0)
20	CSEC-730	OS	Distributed System	3(3+0)
21	ITEC-705	None	Enterprise Data Center Design and Methodology	3 (3+0)
22	CSEC-721	None	Expert Systems	3(3+0)
23	CSEC-704	None	Formal Methods	3(3+0)
24	CSEC-702	None	Functional Programming	3(3+0)
25	CSEC-718	None	Fuzzy Logic	3(3+0)
26	CSEC-703	Linear Algebra	Game Theory	3(3+0)
27	CSEC-733	None	Grammar Engineering	4(3+1)
28	CSEC-727	Design and Analysis of Algorithms	Graph Theory & Algorithms	3(3+0)
29	CSEC-728	None	Information Retrieval	3(3+0)
30	ITEC-702	None	Information Security	3 (3+0)
31	CSEC-725	Probability & Statistics	Information Theory	3(3+0)
32	CSEC-736	None	Intelligent Multi Agent systems	3(3+0)
33	CSEC-723	None	Intelligent Agents Technology	3(3+0)
34	ITEC-708	None	Knowledge Management Systems & Technologies	3 (3+0)
35	CSEC-701	None	Machine Learning	3(3+0)
36	ITEC-701	None	Multimedia Databases	3(3+0)
37	CSEC-716	None	Multimedia Systems Theory & Principles	3(3+0)
38	CSEC-720	None	Natural Language Processing	3(3+0)
39	CSEC-705	None	Parallel Processing: Algorithms and Architectures-I	3(3+0)
40	CSEC-729	Parallel Processing: Algorithms and Architectures-I	Parallel Processing: Algorithms and Architectures-II	3(3+0)
41	SEEC-701	Software Engineering	Reliability Engineering	3(3+0)
42	SEEC-705	None	Research Methodology	3(3+0)

43	ITEC-709	None	Service-Oriented Architecture	3(3+0)
44	CSEC-732	None	Soft Computing	3(3+0)
45	SEEC-702	Software Engineering	Software Configuration Management	3(3+0)
46	SEEC-703	Software Engineering	Software Measurement and Metrics	3(3+0)
47	SEEC-704	Software Engineering	Software Risk Management	3(3+0)
48	CSEC-735	None	Speech Recognition and Synthesis	3(3+0)
49	CSEC-737	Probability & Statistics	Stochastic Processes	3(3+0)
50	CSEC-726	Probability & Statistics	Stochastic Systems	3(3+0)
51	ITEC-706	Computer Networks	Telecom Management	3 (3+0)
52	ITEC-704	Computer Networks	Telecommunication Systems	3 (3+0)
53	CSEC-734	None	Text Processing and Data Analysis	4(3+1)
54	ITEC-711	None	Virtualization in Cloud Computing	3 (3+0)
55	ITCC-702	None	Information Privacy and Security	3 (3+0)
56	ITCC-703	None	Cryptography	3 (3+0)
57	ITCC-704	None	Advanced Database Management Systems	3 (3+0)
58	CSCC-701	None	Advanced Theory of Computation	3(3+0)
59	CSCC-703	Analysis of Algorithms	Advanced Algorithm Analysis	3(3+0)
60	CSCC-703	Operating Systems	Advanced Operating Systems	3(3+0)
61	CSCC-704	Computer Architecture	Advanced Computer Architecture	3(3+0)
62	CSEC-709	None	Swarm Intelligence	3(3+0)
63	CSEC-710	None	Evolutionary Computation	3(3+0)
64	CSEC-712	None	Fog Computing	3(3+0)

Sample Scheme of Study for MSSE Program

2–year Program (4 Semesters/Terms)

(30 Credit Hours)

Semester/Term 1 (12 Credit Hours)			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	SECC-701	Advanced Requirements Engineering	3(3+0)
2	SECC-703	Advanced Software System Architecture	3(3+0)
3		Elective I	3(3+0)

Total Credit Hrs.	9

Semester/Term 2 (9 Credit Hours)			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	SECC-702	Software Testing and Quality Assurance	3(3+0)
2	SECC-704	Advanced Software Project Management	3(3+0)
3		Elective II	3(3+0)
Total Credit Hrs.			9

Semester/Term 3 (6 Credit Hours)			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	SECC-700	Thesis-I	3(0+3)
2		Elective III	3(3+0)
		Elective IV	3(3+0)
Total Credit Hrs.			9

Semester/Term 4 (6 Credit Hours)			
#	**Code**	**Course Title**	**Cr. Hrs.**
1	SECC-700	Thesis-II	3(0+3)
Total Credit Hrs.			3

Total Program Credit Hours: 30

Course Contents for MS Software Engineering

Contents of Core Courses

Course Title: Advanced Requirements Engineering
Course Code: SECC-701
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Syllabus:
Software Requirements Fundamentals: Product and process requirements, Functional and non-functional requirements, Emergent properties, Quantifiable requirements, System and software requirements. Requirements Process: Process models, Process actors, Process support and management, Process quality and improvement. Requirements Analysis: Requirements sources, Elicitation techniques. Requirements Analysis: Requirements classification, Conceptual modeling, Architectural design and requirements allocation, Requirements negotiation, Formal analysis. Requirements Specification: System definition document, System requirements document, Software requirements specification. Requirements Validation*:* Requirements reviews, Prototyping, Model validation, Acceptance tests. Practical Considerations: Iterative nature of the requirements process, Change management, Requirements attributes, Requirements

tracing, Measuring requirements. Software Requirements Tools. Current research topics in requirement engineering.

Reference Material:

1. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Bruce R. Maxim, 8th Ed, McGraw-Hill Education, 2015.
2. Object-Oriented Analysis, Design and Implementation, Brahma Dathan, Sarnath Ramnath, 2nd Ed, Universities Press, India, 2014.
3. Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures, Hassan Gomaa, Cambridge University Press, 2011.
4. Applying UML & Patterns: An Introduction to Object-Oriented Analysis & Design and Iterative Development, Craig Larmen, 3rd Edition.
5. Head First Design Patterns, Eric Freeman, Elisabeth Freeman, Kathy Sierra and Bert Bates, O'Reilly Media, Inc., 2004.

Course Title: Advanced Software System Architecture

Course Code: SECC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Quality attributes in the context of architecting. Qualitative and quantitative assessment of architectures. Architectural modeling through Architecture Description Languages. System modeling its relation to software architecting. Architecting for evolution and variability. Partitioned and layered architectures. System-of-Systems and Ultra-Large Scale Systems. Software Product Lines and Configurable Software. Self-Adaptive Software. Architectural Description Languages. Feature Modeling. Architecture and Model-Based Testing. Current research topics in software system architecture..

Reference Material:

1. Designing Software Architectures: A Practical Approach (SEI Series in Software Engineering), Humberto Cervantes, Rick Kazman, 1st Edition, Addison-Wesley Professional, 2016.
2. Software Product Lines: Practices and Patterns, P. Clements and L. Northrup, Addison-Wesley, 2002.
3. Software Architecture : Foundations, Theory, and Practice, R. Taylor, N. Medvidović and E.M. Dashofy, John Wiley, 2010

Course Title: Software Testing and Quality Assurance

Course Code: SECC-703
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
Testing techniques. Black Box testing, White Box and Grey Box testing techniques. Quality Assurance planning and execution. Automated testing topics include constructing a framework, scripting techniques, generating a test data, generating test architecture, pre/post-processing, test maintenance, and job specific metrics. Current research topics in Software Testing and Quality Assurance.

Reference Material:
1. *Software Quality Assurance: Integrating Testing, Security, and Audit* (Internal Audit and IT Audit), Abu Sayed Mahfuz, Auerbach Publications, 2016.
2. *Practical Model-Based Testing: A Tools Approach,* Mark Utting and Bruno Legeard, Morgan Kaufmann Publishers Inc., San Francisco, CA, 2006.
3. *Software Quality Engineering, Testing, Quality Assurance, and Quantifiable improvements*, Jeff Tian, IEEE Computer Society, 2005.
4. *Introduction to Software Engineering*, P Ammann and J Offutt, Cambridge University Press, 2008.

Course Title: Advanced Software Project Management

Course Code: SECC-704
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Prerequisites: Software Engineering
Course Objectives:
To develop students' ability to plan and manage software development projects successfully, maximizing the return from each stage of the software development life cycle.

Course Syllabus:
Comparison of PM Tools, PMI's Knowledge Areas, PMI Framework, PMI Process Groups, Project Planning, Project Evaluation, comparison of Software Effort Estimation techniques, Comparison of different software development and designing models. Analyzing different risk management methodologies. Studying latest conference and journal papers related to state of the art techniques.

Reference Material:
1. Software Project Management by Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009). ISBN-10: 0077122798
2. A Guide to the Project Management Body of Knowledge, 3rdEdition (PMBOK Guides), ISBN-13: 978-1930699458
3. Mastering Software Project Management: Best Practices, Tools and Techniques by Murali

K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing (2010). ISBN-10: 1604270349
4. Effective Project Management: Traditional, Agile, Extreme by Robert K. Wysocki, Wiley; 6th Edition (2011). ISBN-10: 111801619X
5. The Software Project Manager's Handbook - Principles that work at work by Dwayne Phillips, 2nd Edition, IEEE Computer Society Press and Wiley Inter-science, 2004. ISBN 0-471-67420-6

Contents of Elective Courses

Course Title: Advanced Theory of Computation

Course Code: CSCC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course aims to teach the basic methods and conclusions of the Theory of Computation. Students learn to apply these methods to problems from different fields and be guided by the results in searching for computational solutions to the problems.

Course Syllabus:
Mathematical Tools and Techniques; Proofs, Principle of Mathematical Induction, Recursive Definitions, Structural Induction. Regular Languages and Regular Expression, Finite Automata. Nondeterministic Finite Automata; Regular & Non-regular Languages; Context-Free Grammars, Regular Grammars, Derivation Tree and Ambiguity, An Unambiguous CFG for Algebraic Expression, Simplified Forms and Normal Forms. Pushdown Automata; Context-Free and Non-Context-Free Languages. Detailed Investigation: Turing Machines, Recursively Enumerable and Languages. Unsolvable Problems, Computable Functions, Measuring and Classifying Complexity, Traceable and Possibly Intractable Problems. P and NP, Polynomial-Time Reduction and NP-Completeness, Cook's Theorem, NP-Complete Problems.

Course Outline:
1. Mathematical Tools and Techniques: Logic and Proofs, Sets, Functions and Equivalence Relations, Languages. [TB: Ch. 1]
2. Proofs, Principle of Mathematical Induction, Recursive Definitions, Structural Induction. [TB: Ch. 2]
3. Regular Languages and Regular Expression, Finite Automata: Finite Automata: Examples and Definitions. Distinguishing One String from Another, Union, Intersection, and Complements. [TB: Ch. 3]
4. Nondeterministic Finite Automata, Nondeterministic Finite Automata with A-Transitions, Kleene's Theorem. [TB: Ch. 4]

5. Regular & Non-regular Languages, The Criteria for Regularity, Minimal Finite Automata, The Pumping Lemma for Regular Languages, Decision Problems, Regular Languages and Computers. [TB: Ch. 5]
6. Context-Free Grammars, Regular Grammars, Derivation Tree and Ambiguity, An Unambiguous CFG for Algebraic Expression, Simplified Forms and Normal Forms. [TB: Ch. 6]
7. Pushdown Automata: Definitions and Examples, Deterministic Pushdown Automata, A PDA corresponding to a Given CFG, A CFG corresponding to a Given PDA, Parsing. [TB: Ch. 7]
8. Context-Free and Non-Context-Free Languages: The Pumping Lemma for Context-Free Languages, Intersections and Complements of CFLs, Decision Problems Involving Context-Free Languages. [TB: Ch. 8]

Detailed Investigation

9. Turing Machines: Definitions and Examples, Computing Partial Functions with a TM, Combining TMs, Variations of TM, Non-deterministic TM, Universal TM, Models of Computation and the Church-Turing Thesis. [TB: Ch. 9]
10. Recursively Enumerable and Languages: Recursively Enumerable and Recursive, Enumerating a Language, More General Grammars, Context-Sensitive Languages and the Chomsky Hierarchy, Not All Languages are Recursively Enumerable. [TB: Ch. 10]
11. Unsolvable Problems: A No-recursive Language and an Unsolvable Problem, The Halting Problem, Unsolvable Problems Involving TMs, Rice's Theorem, Post's Correspondence Problem, Unsolvable Problems Involving CFG. [TB: Ch. 11]
12. Computable Functions: Primitive Recursive Functions, PRF and Bounded Operations, Unbounded Minimalization and ų-Recursive Functions, Godel Numbering, All Computable Function Are ų-Recursive. [TB: Ch. 12]
13. Measuring and Classifying Complexity: Growth Rates of Function, Time and Space Complexity of a TM, Complexity Classes. [TB: Ch. 13]
14. Traceable and Possibly Intractable Problems: P and NP, Polynomial-Time Reduction and NP-Completeness, Cook's Theorem, NP-Complete Problems. [TB: Ch. 14]

Reference Material:

1. Introduction to Languages and the Theory of Computation by John Martin, McGraw-Hill Science/Engineering/Math; 4th Edition (February 2, 2010). ISBN-10: 0073191469
2. Theory of Computation by George Tourlakis, Wiley; 1st Edition (April 17, 2012). ISBN-10: 1118014782
3. Introducing the Theory of Computation by Wayne Goddard, Jones & Bartlett Publishers; 1st Edition (January 18, 2008). ISBN-10: 0763741256
4. Theory of Computation by Dexter C. Kozen, Springer; 1st Edition (December 15, 2010). ISBN-10: 1849965714
5. Introduction to the Theory of Computation by Michael Sipser, Course Technology; 3rd Edition (June 27, 2012). ISBN-10: 113318779X

Course Title: Advanced Algorithm Analysis

Course Code: CSCC-703
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Analysis of Algorithms

Course Objectives:
This is an advanced course in design and analysis of algorithms covering topics typically not covered in undergraduate algorithms. In this course the students will learn how to : (i) design and implement 'new' algorithms in the real world. (ii) map problems to algorithmic problems. (iii) read and understand algorithms published in journals. (iv) develop writing skills to present your own algorithms (v) collaborate and work together with other people to design new algorithms.

Course Syllabus:
Dynamic Programming, Greedy Algorithms, Amortized Analysis, Fibonacci Heaps, van Emde Boas Trees, Single-Source Shortest Paths, All-Pairs Shortest Paths, Maximum Flow, Multithreaded Algorithms, String Matching Algorithms, Approximation Algorithms, and Parallelism Parallel Graph Algorithms.

Course Outline:
1. Dynamic Programming: Rod Cutting, Matrix-Chain Multiplication, Elements of Dynamic Programming, Longest Common Subsequence, Optimal Binary Search Trees. [TB1: Ch. 15]
2. Greedy Algorithms: An Activity-Selection Problem, Elements of the Greedy Strategy, Huffman Codes, Matroids and Greedy Methods, A Task-Scheduling Problem as A Matroid. [TB1: Ch. 16]
3. Amortized Analysis: Aggregate Analysis, The Accounting Method, The Potential Method, Dynamic Tables. [TB1: Ch. 17]
4. Fibonacci Heaps: Structure Of Fibonacci Heaps, Mergeable-Heap Operations, Decreasing a Key and Deleting a Node, Bounding the Maximum Degree. [TB1: Ch. 19]
5. vanEmde Boas Trees: Preliminary Approaches, A Recursive Structure, The Van Emde Boas Tree. [TB1: Ch. 20]
6. Single-Source Shortest Paths: The Bellman-Ford Algorithm, Single-Source Shortest Paths In Directed Acyclic Graphs, Dijkstra's Algorithm, Difference Constraints and Shortest Paths, Proofs of Shortest-Paths Properties. [TB1: Ch. 24]
7. All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication, The Floyd-Warshall Algorithm, Johnson's Algorithm for Sparse Graphs. [TB1: Ch. 25]
8. Maximum Flow: Flow Networks, The Ford-Fulkerson Method, Maximum Bipartite Matching, Push-Relabel Algorithms, The Relabel-To-Front Algorithm. [TB1: Ch. 26]
9. Multithreaded Algorithms: The Basics Of Dynamic Multithreading, Multithreaded Matrix Multiplication, Multithreaded Merge Sort. [TB1: Ch. 27]
10. String Matching: The Naive String-Matching Algorithm, The Rabin-Karp Algorithm, String Matching With Finite Automata, The Knuth-Morris-Pratt Algorithm. [TB1: Ch. 32]
11. Approximation Algorithms: The Vertex-Cover Problem, The Traveling-Salesman Problem, The Set-Covering Problem, Randomization And Linear Programming, The Subset-Sum Problem. [TB1: Ch. 35]
12. Parallel Algorithms: Parallelism, The PRAM Model, Simple Parallel Operations, Parallel

Searching, Parallel Sorting, Parallel Numerical Algorithms, Parallel Graph Algorithms. [TB2: Ch. 9]

Reference Material:

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, The MIT Press; 3rd Edition (2009). ISBN-10: 0262033844
2. Analysis of Algorithms: an active learning approach by Jeffrey J. McConnell, Jones & Bartlett Pub; 2nd Edition (November 2, 2007). ISBN-10: 0763707821
3. Approximation Algorithms by Vijay V. Vazirani, Springer (December 1, 2010). ISBN-10: 3642084699
4. Algorithms and Theory of Computation Handbook, Second Edition, Volume 2: Special Topics and Techniques, Chapman and Hall/CRC; 2nd Edition (November 20, 2009). ISBN-10: 1584888202

Course Title: Advanced Operating Systems

Course Code: CSCC-703
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisite: Operating Systems

Course Objectives:
The students will learn about advanced OS concepts, design and internal processes

Course Syllabus:
Operating System Architecture, Multitasking, Multiuser, Multiprocessing, Multi- Threading OS, Operating System Services For Process Management, Process Scheduling Concepts, System Calls For Process Management, Process Communication And Synchronization Concepts, Memory And I/O Management Overview, UNIX Commands For System Administration. Multitasking OS. Multiprocessor Systems. Memory Management. Unit V I/O Systems. File System.

Course Outline:

1. Introduction: Operating System Architecture, Multitasking, Multiuser, Multiprocessing, Multi- Threading OS, Operating System Services for Process Management, Process Scheduling Concepts, System Calls for Process Management, Process Communication And Synchronization Concepts, Memory and I/O Management Overview, UNIX Commands for System Administration.
2. Multitasking OS :Design and Implementation Kernel Of Multitasking OS :Services, Process State Transitions, Functional Specification, Implementation Considerations, System List, Ready List And Its Manipulation, IPC and Synchronization, Process Management , Interrupt Management
3. Multiprocessor Systems: Introduction, Parallel Hardware And Interconnections, Types of Multiprocessor OS, Sharaing OS, Mutiprocesor OS Design Considerations, Threads, Thread Scheduling, Kernel Mode Processes, Multiprocessor Synchronization, Implementation of Mutual Exclusion.
4. Memory Management: Overview, Pages, Zones, Kmalloc, Vmalloc, Slab Layer, Slab Layer Allocator, Deallocator, Statically Allocating on The Stack, High Memory Mapping. Non

Contiguous Memory Management.

5. Unit V I/O Systems: I/O Device Types, I/O Structure, Driver Interfaces, Disk Device Driver Access Strategies, Unification Of Files And I/O Devices, Generalized Disk Device Drivers, Disk Caching, I/O Scheduler.
6. File System: File System Organization, Operations, Implementation, File Descriptors, File Blocks Allocaton, Mapping of File Blocks, System Calls For The File System: Open, Read, Write, Lseek, Close. Mounting and Un Mounting File Systems, Link, Unlink, File System Abstractions, VFS, File System Maintenance, File Security.

Reference Material:

1. Stallings, William, and Goutam Kumar Paul. Operating systems: internals and design principles. Pearson, 2012. ISBN-10: 0024154938;ISBN-13: 978-0024154934
2. Operating systems a design oriented approach by charlescrowly, Irwin Professional Publishing (November 1, 1996). ISBN-10: 0256151512
3. The design of the UNIX Operating System by Maurice J. Bach, Prentice Hall; 1st Edition (June 6, 1986). ISBN-10: 0132017997
4. Understanding the Linux kernel Daniel Bovet and Marco Cesati, 3 O'Reilly Media; 3rd Edition (November 2005). ISBN-10: 0596005652
5. Modern Operating Systems by Andrew S. Tanenbaum, Prentice Hall; 3rd Edition (December 21, 2007). ISBN-10: 0136006639
6. Operating Systems Design and Implementation by Andrew S Tanenbaum and Albert S Woodhull, Prentice Hall; 3rd Edition (January 14, 2006)
7. Unix Network Programming, Volume 1: The Sockets Networking API W. Richard Stevens, BillFenner, and Andrew M. Rudoff, ISBN-978-81-203-0749-0, PHI.
8. Linux Kernel Development by Robert Love, Addison-Wesley Professional; 3rd Edition (July 2, 2010). ISBN-10: 0672329468
9. UNIX Systems Programming: Communication, Concurrency and Threads by Kay A. Robbins and Steve Robbins, Prentice Hall; 2nd Edition (June 27, 2003). ISBN-10: 0130424110

Course Title: Advanced Computer Architecture

Course Code: CSCC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Architecture

Course Objectives:

To develop an understanding of high-performance computer architecture, as a foundation for advanced work in computer architecture.

Course Syllabus:

Introduction to Advanced Computer Architecture and Parallel Processing, Multiprocessors Interconnection Networks, Performance Analysis of Multiprocessor Architecture, Shared Memory Architecture, Message Passing Architecture, Abstract Models, Network Computing, Parallel Programming in the Parallel Virtual Machine, Message Passing Interface (MPI), Scheduling and Task Allocation.

Course Outline:

1. Introduction to Advanced Computer Architecture and Parallel Processing: History, Flynn's Taxonomy of Computer Architecture, SIMD Architecture, MIMD Architecture, Interconnection Networks. [TB: Ch. 1]
2. Multiprocessors Interconnection Networks: Interconnection Networks Taxonomy, Bus-Based Dynamic Interconnection Networks, Switch-Based Interconnection Networks, Static Interconnection Networks, Analysis and Performance Metrics. [TB: Ch. 2]
3. Performance Analysis of Multiprocessor Architecture: Computational Models, An Argument for Parallel Architectures, Interconnection Networks Performance Issues, Scalability of Parallel Architectures, Benchmark Performance. [TB: Ch. 3]
4. Shared Memory Architecture: Classification of Shared Memory Systems, Bus-Based Symmetric Multiprocessors, Basic Cache Coherency Methods, Snooping Protocols, Directory Based Protocols, Shared Memory Programming. [TB: Ch. 4]
5. Message Passing Architecture: Introduction to Message Passing, Routing in Message Passing Networks, Switching Mechanisms in Message Passing, Message Passing Programming Models, Processor Support for Message Passing, Example Message Passing Architectures, Message Passing Versus Shared Memory Architectures. [TB: Ch. 5]
6. Abstract Models: The PRAM Model and Its Variations, Simulating Multiple Accesses on an EREW PRAM, Analysis of Parallel Algorithms, Computing Sum and All Sums, Matrix Multiplication, Sorting, Message Passing Model, Leader Election Problem, Leader Election in Synchronous Rings. [TB: Ch. 6]
7. Network Computing: Computer Networks Basics, Client/Server Systems, Clusters, Interconnection Networks, Cluster Examples, Grid Computing. [TB: Ch. 7]
8. Parallel Programming in the Parallel Virtual Machine: PVM Environment and Application Structure, Task Creation, Task Groups, Communication Among Tasks, Task Synchronization, Reduction Operations, Work Assignment. [TB: Ch. 8]
9. Message Passing Interface (MPI): Communicators, Virtual Topologies, Task Communication, Synchronization, Collective Operations, Task Creation, One-Sided Communication. [TB: Ch. 9]
10. Scheduling and Task Allocation: The Scheduling Problem, Scheduling DAGs without Considering, Communication, Communication Models, Scheduling DAGs with Communication, The NP-Completeness of the Scheduling Problem, Heuristic Algorithms, Task Allocation, Scheduling in Heterogeneous Environments. [TB: Ch. 10]
    [Instructors need to devise a contents delivery plan]

Reference Material:

1. Advanced Computer Architecture and Parallel Processing by Hesham El-Rewini, MostafaAbd-El-Barr, Wiley-Interscience; 1st Edition (January 18, 2005). ISBN-10: 012383872X
2. Advanced Computer Architectures by Sajjan G. Shiva, CRC Press (2005). ISBN-10: 0849337585
3. Advanced Computer Architecture by ByAmit Kumar Mishra, S K Kataria& Sons (2010). ISBN-10: 9380027494
4. Advanced Computer Architecture: A Design Space Approach by DezsoSima, Terence Fountain, Peter Kacsuk, Addison-Wesley; 1st Edition (July 7, 1997). ISBN-10: 0201422913

5. Scalable Parallel Computing Technology, Architecture, Programming by Kai Hwang, ZhiweiXu, McGraw-Hill Science/Engineering/Math; 1st Edition (February 1, 1998). ISBN-10: 0070317984

Contents of Elective Courses

Course Title: Functional Programming

Course Code: CSEC-702
Course Structure: Lectures: 3 / Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The students will gainan applied understanding of the concepts and practice of functional programming. The will be:

- to use the language to implement algorithms and data types to solve problems.
- to explain common errors in sample programs and offer corrections.
- to discuss functional programming and functional programs more generally:

Course Syllabus:
Computers and modeling, Pictures and functions, Types, The Haskell programming language, Haskell Interpreter, Implementing a Prime Number Test, Haskell Type Declarations, Identifiers in Haskell, Haskell Types, The Prime Factorization Algorithm, The map and filter Functions, Haskell Equations and Equational Reasoning. Mathematical Objects: Logical Connectives and their Meanings, Logical Validity and Related Notions, Making Symbolic Form Explicit. Lambda Algebra. The Use of Logical Proof. Sets, Types and Lists Operations. Relations. Functions. Induction and Recursion. Induction and Recursion over Trees. Induction and Recursion over Lists. Polynomials. Corecursion.

Course Outline:

1. Introducing functional programming: Computers and modeling, Pictures and functions, Types, The Haskell programming language, Haskell Interpreter, Implementing a Prime Number Test, Haskell Type Declarations, Identifiers in Haskell, Haskell Types, The Prime Factorization Algorithm, The map and filter Functions, Haskell Equations and Equational Reasoning.
2. Mathematical Objects: Logical Connectives and their Meanings, Logical Validity and Related Notions, Making Symbolic Form Explicit.
3. Lambda Abstraction, Definitions and Implementations, Abstract Formulas and Concrete Structures, Logical Handling of the Quantifiers, Quantifiers as Procedures.
4. The Use of Logical Proof: Proof Style, Proof Recipes, Rules for the Connectives, Rules for the Quantifiers, Strategic Guidelines, Reasoning and Computation with Primes.
5. Sets, Types and Lists: Sets, Paradoxes, Types and Type Classes, Special Sets, Algebra of Sets, Pairs and Products, Lists and List Operations.

6. Comprehension and Database Query, Using Lists to Represent Sets, A Data Type for Sets.
7. Relations: The Notion of a Relation, Properties of Relations, Implementing Relations as Sets of Pairs.
8. Implementing Relations as Characteristic Functions, Equivalence Relations, Equivalence Classes and Partitions, Integer Partitions.
9. Functions: Basic Notions, Surjections, Injections, Bijections, Function Composition, Inverse Function, Partial Functions, Functions as Partitions, Products, Congruences.
10. Induction and Recursion: Mathematical Induction, Recursion over the Natural Numbers, The Nature of Recursive Definitions.
11. Induction and Recursion over Trees, Induction and Recursion over Lists, Some Variations on the Tower of Hanoi, Induction and Recursion over Other Data Structures.
12. Polynomials: Difference Analysis of Polynomial Sequences, Gaussian Elimination, Polynomials and the Binomial Theorem, Polynomials for Combinatorial Reasoning.
13. Corecursion: Corecursive Definitions, Processes and Labeled Transition Systems, Proof by Approximation, Proof by Coinduction, Power Series and Generating Functions, Exponential Generating Functions.

Reference Material:

1. The Haskell Road to Logic, Maths and Programming by Kees Doets and Jan van Eijck, College Publications (May 7, 2004). ISBN-10: 0954300696
2. Functional Programming: Practice and Theory by Bruce J. MacLennan Addison-Wesley Professional; 1st Edition (January 11, 1990). ISBN-10: 0201137445
3. Haskell: The Craft of Functional Programming by Simon Thompson, Haskell, Addison-Wesley Professional; 3rd Edition (October 2, 2011). ISBN-10: 0201882957

Course Title: Game Theory

Course Code: CSEC-703
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: Linear Algebra

Course Syllabus:

Introduction To Game Theory, The Two-Person, Zero-Sum Game With Equilibrium Points, The General, Two-Person, Zero-Sum Game. Utility Theory, The Two Person, Non-Zero-Sum Game, The N-Person Game. Strategic Games. Infinite Games and Automata Theory. Back and Forth between Logic and Games. Graph Searching Games. Beyond Nash Equilibrium.

Course Outline:

1. Introduction To Game Theory, The Two-Person, Zero-Sum Game With Equilibrium Points, The General, Two-Person, Zero-Sum Game.
2. Utility Theory, The Two Person, Non-Zero-Sum Game.
3. The N-Person Game
4. Strategic Games: Basic Concepts, Iterated Elimination Of Strategies, Mixed Extension, Variations on the Definition of Strategic Games, Mechanism Design, Pre-Bayesian Games
5. Infinite Games and Automata Theory: Basic Notations And Definitions, Transformation of Winning Conditions, Tree Automata, Beyond Finite Automata.
6. Algorithms for Solving Parity Games: Games on Graphs, Solving Repeated Reachability

and Eventual Safety Games, Solving Parity Games.

7. Back and Forth Between Logic and Games: Introduction, Reachability Games and Parity Games, Reachability Games And Logic, Logics With Least And Greatest Fixed-Points, Definability Of Winning Regions in Parity Games, Inflationary Fixed-Point Logic and Backtracking Games.
8. Graph Searching Games: Introduction, Classifying Graph Searching Games, Variants Of Graph Searching Games, Monotonicity of Graph Searching, Obstructions, An Application to Graph-Decompositions, Complexity of Graph Searching.
9. Beyond Nash Equilibrium: Solution Concepts for The 21st Century: Robust and Resilient Equilibrium, Taking Computation into Account, Taking (Lack Of) Awareness into Account, Iterated Regret Minimization.

Reference Material:

1. Davis, Morton D. Game theory: A nontechnical introduction. Courier Corporation, 2012.. ISBN-10: 0486135152
2. Lectures in Game Theory for Computer Scientists by Krzysztof R. Apt (Ed) and Erich Grädel (Ed), Cambridge University Press; 1st Edition (February 14, 2011).
3. Games, Puzzles, and Computation by Robert A. Hearn and Erik D. Demaine, ISBN-10: 1568813228
4. Game Theory by Drew Fudenberg and Jean Tirole, The MIT Press (August 29, 1991). ISBN-10: 0262061414

Course Title: Graph Theory & Algorithms

Course Code: CSEC-727
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: **Design and Analysis of Algorithms**

Course Objectives:
The course is aimed to develop students' understanding of various techniques of graph theory and its applications.

Course Syllabus:
Fundamental Concepts of Graphs, Sub-Graphs, Connected Graphs, Trees, Non-separable Graphs, Connectivity, Planar Graphs, Vertex Colorings, Edge Colourings, Hamilton Cycles, Eigenvalues of Graph, Coverings and Packings in Directed Graphs. Integer Flows and Coverings.

Course Outline:

1. Fundamental Concepts of Graphs: What is A Graph, Simple Graphs, Graph and Their Representations, Isomorphism and Automorrphisms, Labelled Graphs, Graphs Arising From Other Structures, Incidents Graphs, Union and Intersection Graphs ,Cartesian Product, Directed Graphs.
2. Sub-Graphs: Sub-Graphs and Super graphs, Spanning and Induced Sub-Graphs, Decomposition and Coverings, Edge Cuts and Bonds, Even Sub-Graphs, Graph Reconstruction.
3. Connected Graphs: Walks and Connection, Cut Edges, Connection to Diagraphs, Cycle Double Covers.

4. Trees: Forests and Trees, Spanning Tree, Calay's Formula, Fundamental Cycles AndBonds, Co-Tree, Trees And Distance. Applications of Tree.
5. Non-separable Graphs: Cut Vertices, Separations and Blocks, Ear Decompositions, Strong Orientations, Directed Ear Decompositions, Even Cycles Decompositions.
6. Connectivity: Vertex Connectivity, Fan Lemma, Edge Connectivity, Three-Connected Graphs, Submodularity, Determining, ChordalGraphs, Simplicial vertices.
7. Planar Graphs: Plane and Planar Graphs, Duality, Euler's Formula, Bridges, Kuratowski'sTheorem.
8. Vertex Colorings: Chromatic Numbers, Critical Graphs, Girthand Chromatic Number, Perfect Graphs, List Colourings, The Adjacency Polynomial, Chromatic Polynomial. Applications of Vertex Colourings.
9. Edge Colourings: Edge Colouring Number, Vizing's Theorem, Snarks, Covering By Perfect Matchings, List Edge Colouring, Applications of Edge Colourings.
10. Hamilton Cycles: Hamiltonian and non-Hamiltonian graphs, Non-Hamiltonian Planar Graphs, Path Exchanges parity, Hamilton Cycles in Graphs.
11. Eigenvalues of Graph,
12. Coverings and Packings in Directed Graphs.
13. Integer Flows and Coverings.

Reference Material:

1. Graph Theory by J.A Bondy and U.S.R Murty, Springer; 1st Edition (2008). Corr. 3rd printing 2008 Edition (August 14, 2008). ISBN-10: 1846289696
2. A First Course in Graph Theory by Gary Chartrand and Ping Zhang, Dover Publications (February 15, 2012). ISBN-10: 0486483681
3. Graph Theory and Complex Networks: An Introduction by Maarten van Steen, Maarten van Steen (April 5, 2010). ISBN-10: 9081540610
4. Graphs & Digraphs by Gary Chartrand , Linda Lesniak, and Ping Zhang, Chapman and Hall/CRC; 5th Edition (October 19, 2010). ISBN-10: 1439826277

Course Title: Information Retrieval

Course Code: CSEC-728
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Objectives:
The deals with IR representation, storage, organization & access to information items

Course Syllabus:
Basic Concepts of IR, IR System Block, Diagram. Automatic Text Analysis, Indexing and Classification. Measures of Association. Clustering Algorithms. File Structures. IR Models. Search Strategies. Performance Evaluation. Online IR Systems &Interfaces Standards. Taxonomy and Ontology. Distributed and Parallel IR. Query Processing. Multimedia IR Models & Languages- Data Modeling Techniques to Represent Audio and Visual Document, Query Languages Indexing & Searching- Generic Multimedia Indexing Approach, Query Databases of Multimedia Documents, Display the Results of Multimedia Searches, One Dimensional Time Series, Two Dimensional Color Images, Automatic Feature Extraction. Searching the Web,

Challenges, Characterizing the Web, Search Engines, Browsing, Mata Searchers, Web Crawlers, Robot Exclusion, Web Data Mining, Metacrawler, Collaborative Filtering, Web Agents (Web Shopping, Bargain Finder,..), Economic, Ethical, Legal and Political Issues.

Course Outline:

1. Introduction: Basic Concepts of IR, Data Retrieval & Information Retrieval, IR System Block, Diagram. Automatic Text Analysis, Luhn's Ideas, Conflation Algorithm, Indexing and Index Term Weighing, Probabilistic Indexing, Automatic, Classification. Measures of Association, Different Matching Coefficient, Classification Methods, Cluster Hypothesis. Clustering Algorithms, Single Pass Algorithm, Single Link Algorithm, Rochhio's Algorithm and Dendograms.
2. File Structures, Inverted File, Suffix Trees & Suffix Arrays, Signature Files, Ring Structure, IR Models, Basic Concepts, Boolean Model, Vector Model, and Fuzzy Set Model. Search Strategies, Boolean Search, Serial Search, and Cluster based Retrieval, Matching Function
3. Performance Evaluation- Precision and Recall, Alternative Measures Reference Collection (TREC Collection), Libraries & Ibliographical System- Online IR System, Opacs, Digital Libraries - Architecture Issues, Document Models, Representation & Access, Prototypes, Projects & Interfaces, Standards.
4. Taxonomy and Ontology: Creating Domain Specific Ontology, Ontology Life Cycle, Distributed and Parallel IR: Relationships Between Documents, Identify Appropriate Networked Collections, Multiple Distributed Collections Simultaneously, Parallel IR – MIMD, Architectures, Distributed IR – Collection, Partitioning, Source Selection, Query Processing.
5. Multimedia IR Models & Languages- Data Modeling, Techniques to Represent Audio and Visual Document, Query Languages Indexing & Searching- Generic Multimedia Indexing Approach, Query Databases of Multimedia Documents, Display the Results of Multimedia Searches, One Dimensional Time Series, Two Dimensional Color Images, Automatic Feature Extraction.
6. Searching the Web, Challenges, Characterizing the Web, Search Engines, Browsing, Mata Searchers, Web Crawlers, Robot Exclusion, Web Data Mining, Metacrawler, Collaborative Filtering, Web Agents (Web Shopping, Bargain Finder,..), Economic, Ethical, Legal and Political Issues.

Reference Material:

1. Modern Information Retrieval: The Concepts and Technology behind Search by Ricardo Baeza-Yates and BerthierRibeiro-Neto, Addison-Wesley Professional; 2nd Edition (February 10, 2011). ISBN-10: 0321416910
2. The Geometry of Information Retrieval by C. J. van Rijsbergen, Cambridge University Press (September 13, 2004). ISBN-10: 0521838053
3. Managing Gigabytes: Compressing and Indexing Documents and Images by Ian H. Witten, Alistair Moffat, & Timothy C. Bell, Morgan Kaufmann; 1st Edition (May 17, 1999)
4. Information Retrieval: Algorithms and Heuristics by D. Grossman and O. Frieder, Springer; 2nd Edition (December 20, 2004). ISBN-10: 1402030045
5. An Introduction to Search Engines and Web Navigation by Mark Levene, Wiley; 2nd Edition (October 18, 2010). ISBN-10: 047052684X
6. Multimedia information System by V. S. Subrahamanian, Satish K. Tripathi, Springer,

(December 3, 2010). ISBN-10: 1441950427
7. Multimedia mining A highway to intelligent multimedia documents by Chabane Djeraba, Springer; 1st Edition (November 30, 2002). ISBN-10: 1402072473
8. Introduction to Information Retrieval by Christopher D. Manning, Prabhakar Raghavan, &Hinrich Schütze, Cambridge University Press; 1st Edition (July 7, 2008). ISBN-10: 0521865719
9. Search Engines: Information Retrieval in Practice by Bruce Croft, Donald Metzler, & Trevor Strohman, Addison-Wesley; 1st Edition (February 16, 2009). ISBN-10: 0136072240
10. Information Retrieval: Data Structures and Algorithms by William B. Frakesand Ricardo Baeza-Yates, Prentice Hall; 1st Edition (June 22, 1992). ISBN-10: 0134638379

Course Title: Distributed Computing

Course Code: CSEC-706
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: DBMS

Course Objectives:
This course covers the architecture and enabling technologies of Peer-2-Peer and distributed computing systems and their innovative applications.

Course Syllabus:
Centralized and Decentralized Systems, Taxonomy Dependency Considerations. Discovery Protocols. Structured Document Types. Distributed Security Techniques. Hash Functions. Digital Signature, Secure Channels, Secure Mobile Code. The Web as Distributed Environment: URI Templates, HTTP and Security, Representational State Transfer, The Semantic Web. Peer-2-Peer Environments. Volunteer Computing. Web Services: Architecture and Development, Service-Oriented Architecture. Distributed Objects and Agent Technologies. Grid Computing. P2P Applications Protocols and Architectures. Freenet. Middleware Protocols and Architectures. Web Services Protocols. Distributed Object Deployment Using Jini. P2P Deployment Using Jxta. Web Services Deployment.

Course Outline:
1. Introduction to Distributed Systems: Centralized and Decentralized Systems, Taxonomy Dependency Considerations, Examples of Distributed Applications, Examples of Middleware. Discovery Protocols: Service and Directory Discovery, Unicast Addressing, UDP, IP Multicast Addressing, Service Location Protocol.
2. Structured Document Types: HTML, XML, XHTML, Document Modelling and Validation. Distributed Security Techniques: Introduction, Design Issues, Hash Functions, Signing Messages with a Digital Signature, Secure Channels, Secure Mobile Code: Creating a Sandbox.
3. The Web - Distributed Environment -, Naming Things in a Uniform Way, URI Templates, Shared Representation of Things, Hypertext Transfer Protocol, HTTP and Security, Representational State Transfer, The Semantic Web. Peer-2-Peer Environments: Introduction, Historical Peer to Peer, The Shift to New Internet Users, Modern Definition

of Peer to Peer, Social Impacts of P2P, The P2P Environment, P2P Example Applications, True P2P and Good Distributed Design, Related Projects: Volunteer Computing.

4. Web Services: Introduction, Web Services Architecture and Development, Service-Oriented Architecture. Distributed Objects and Agent Technologies: What Are Distributed Objects? CORBA, Mobile Agents, Objects, Services and Resources, Distributing Objects Using Java, Remote Method Invocation.
5. Grid Computing: Introduction, Social Perspective, History of the Grid, The Grid Computing Architecture, The Criteria for a Grid, Types of Grid, Grid Computing Toolkit.
6. P2P Applications Protocols and Architectures: Gnutella: History of Gnutella, What Is Gnutella? A Gnutella Scenario: Discovering Peers, Gnutella in Operation, Searching Within Gnutella, Gnutella 0.6 Protocol Description, File Downloads, Gnutella Implementations. Scalability**:** Performance in P2P Networks, Unstructured P2P, Social Networks, Combining Network Topologies, The Convergence of the Napster and Gnutella Approaches, The Structured P2P Approach, New Trends.
7. Freenet: Introduction, Freenet Routing, Freenet Keys, Joining the Network, Current Developments. BitTorrent: What Is BitTorrent? The BitTorrent Protocol, BitTorrent, Inc., New Developments.
8. Middleware Protocols and Architectures: Jini: Introdcution, Jini Architecture, Registering and Using Jini Services, Jini: Tying Things Together, Organization of Jini Services & Events. Jxta : Background, Jxta Overview and Architecture, Jxta Network Overlay, The Jxta Protocols, Jxta Environment Considerations, Security, NAT and Firewalls.
9. Web Services Protocols: SOAP, WSDL, UDDI, WS-Extensions. OGSA: Overview, OGSI, WS-RF, Higher Level Interfaces. Web 2.0: The Web as Platform, Technologies and APIs, Computing in the Cloud, Ubiquitous Computing.
10. Distributed Object Deployment Using Jini: RMI Security, An RMI Application, A Jini Application, Running Jini Applications.
11. P2P Deployment Using Jxta: Starting the Jxta Platform, Peer Con_guration Using Jxta, Using the Jxta Con_gurator; Example Two: Using Jxta Pipes, P2P Environment: The Jxta Approac.
12. Web Services Deployment: Data Binding, Setup, Container Classes, Server Implementation, Service WSDL, Client Implementation.

Reference Material:

1. From P2P and Grids to Services on the Web: Evolving Distributed Communities by Ian J. Taylor Ian J. Taylor and Andrew Harrison, Springer; 2nd Edition (November 14, 2008). ISBN-10: 1848001223.
2. Peer-to-Peer : Harnessing the Power of Disruptive Technologies by Andy Oram, O'Reilly Media; 1st Edition (March 15, 2001)
3. Structured Peer-to-Peer Systems: Fundamentals of Hierarchical Organization, Routing, Scaling, and Security by Dmitry Korzun and Andrei Gurtov, Springer, (November 12, 2012).
4. K. Hwang and Z. Xu, Scalable Parallel Computing, McGraw-Hill, (1998). ISBN 0-07-031798-4.
5. Ian Taylor: From P2P to Web Services and Grids, Springer-Verlag, (2005). ISBN: 1-85233-869-5.
6. F. Berman, G. Fox, and T. Hey (Editors), Grid Computing, Wiley, (2003). ISBN: 0-470-

85319-0.

Course Title: Distributed System

Course Code: CSEC-730
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: OS

Course Objectives:
To help students gain a general understanding of the principles and concepts governing distributed environment in complex applications.

Course Syllabus:
Goals, Architecture, Examples of Distributed Systems, Characteristics, Hardware and Software Concepts, Design Issues, Challenges. SystemModels.Inter-process Communication and Coordination. Remote Procedural Call. Synchronization and Election. Distributed File Systems. Distributed Shared Memory. Fault Tolerant and Recovery.

Course Outline:

1. Introduction: Introduction to Distributed Systems: Goals, Architecture, Examples of Distributed Systems, Characteristics, Hardware and Software Concepts, Design Issues, Challenges. System Models: Architectural models, fundamental models and Failure Model.
2. Inter-Process Communication and Coordination: Message Passing Communication: Communication Primitives, Message Synchronization and Buffering, Pipe, Pipe and Socket APIs, Group Communication, Multicasting, Remote Procedural Call: Basic Operation, Implementation and Call Semantics, Failure Handling, LRPC Object Oriented Distributed Computing Technologies – Basics, Design Issues of Various Technologies Like RMI and CORBA With Semantics and Executions.
3. Synchronization and Election: Clock Synchronization: Logical and Physical Clocks, Algorithms and Uses, Mutual Exclusion: Centralize, Distributed and Token Ring Algorithms, Comparison. Logical Clocks: Lamport's Logical Clock, Vector Clocks, Global State: Needs, Properties and Various Global States Election Algorithm: Bully and Ring Algorithm.
4. Distributed File Systems: Introduction, Characteristics, File Service Architecture, Sun Network and Coda File System: Overview of NFS, Communication, Processes, Naming, Synchronization, Consistency and Replication, Fault Tolerance and Security, Naming Services: Case Study of Global Name Service and X.500 Directory Service.
5. Distributed Shared Memory: Replication: Introduction, Reasons for Replication, Object Replication and Scaling Technique, Distributed Shared Memory: Design and Implementation Issue; Data Centric Consistency Models - Strict, Sequential, Casual, Pram, Weak, Release, Entry Client-Centric Consistency Models: Eventual, Monotonic Reads, Monotonic Writes, Read Your Writes, Writes Follow Reads
6. Fault Tolerant and Recovery: Fault Tolerance: Concepts, Failure Models, Failure Masking by Redundancy, Process Resilience: Design Issues, Failure Masking and Replication, Agreement in Faulty Systems, Recovery: Introduction, Check-Pointing, Message Logging – Synchronous and Asynchronous, Adaptive Logging

Reference Material:

1. Distributed Systems – Concept and Design by George Coulouris, Jean Dollimore& Tim Kindberg, 4th Edition, Pearson (LPE). ISBN – 978-81-317-1840-7
2. Distributed Systems – Principles and Paradigms by Andrew S. Tanenbaum & Maarten van Steen, Prentice Hall; 2nd Edition (October 12, 2006) . ISBN-10: 0132392275
3. Distributed Computing: Principles, Algorithms, and Systems by Ajay D. Kshemkalyani and MukeshS inghal, Cambridge University Press; (March 3, 2011). ISBN-10: 0521189845
4. Distributed Operating System and Algorithm Analysis by Randay Chow and Theodore Johnson, Pearson (LPE). ISBN – 978-81-317-2859-8
5. Distributed Algorithms by Nancy A. Lynch, Morgan Kaufmann; 1st Edition (March 15, 1996). ISBN-10: 1558603484
6. Distributed Systems: An Algorithmic Approach by Sukumar Ghosh, Chapman and Hall/CRC; 1st Edition (November 22, 2006). ISBN-10: 1584885645

Course Title: Digital Image Processing

Course Code: CSEC-718
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

This course provides an introduction to basic concepts, methodologies and algorithms of digital image processing.

Course Syllabus:

Introduction to Digital Image Processing. Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition. Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing. Intensity Transformations and Spatial Filtering. Spatial Frequency, Fourier Theory, The Discrete Fourier Transform, Investigating Spectra. Filtering of Images, Deconvolution. Color Fundamentals, Color Models. Storage Media, File Formats. Segmentation Fundamentals, Point Line and Edge Detection. Non-contextual techniques. Morphological Image Processing Introduction. Compound Operations, Morphological Filtering, Greyscale Morphology. Image Compression. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Course Outline:

1. What Is Digital Image Processing? The Origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing.
2. Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition.
3. Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing.
4. Intensity Transformations and Spatial Filtering Background, Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering.

5. Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods, Using Fuzzy Techniques for Intensity Transformations and Spatial Filtering.
6. Spatial Frequency, Fourier Theory, the Discrete Fourier Transform, Investigating Spectra.
7. Filtering of Images, Deconvolution.
8. Color Fundamentals, Color Models.
9. Storage Media, File Formats, The PBM, PGM, PPM Formats, The Portable Network Graphics (PNG) Format.
10. Segmentation Fundamentals, Point Line and Edge Detection.
11. A Simple Non-contextual Technique: Thresholding, Contextual Techniques, Segmentation using Other Image Properties.
12. Morphological Image Processing Introduction, Basic Concepts, Fundamental Operations.
13. Compound Operations, Morphological Filtering, Greyscale Morphology.
14. Image Compression Introduction, Redundancy, Performance Characterisation, Lossless Compression Techniques, Lossy Compression Techniques, Compression of Moving Images.
15. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Reference Material:

1. Digital Image Processing by Rafael C. Gonzalez, Prentice Hall, 3rd Edition, (2008), ISBN 0-13-168728-x
2. Digital Image Processing a practical Introduction using Java by Nick Efford, Addison Wesley, (2000).
3. The Image Processing Handbook by John C. Russ, Taylor & Fransic, 5th Edition, (2007). ISBN 13: 978-0-8493-7254-4

Course Title: Fuzzy Logic

Course Code: CSEC-718
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: None

Course Objectives:

Fuzzy Logic is an important area having multiple applications in Computing. The course will introduce students with key concepts of Fuzzy Logic.

Course Syllabus:

Introduction Fuzziness, Examples of Fuzziness, Modeling of Fuzziness, Operations on Fuzzy Sets, Fuzziness as Uncertainty. Algebra of Fuzzy Sets. Fuzzy Quantities, Fuzzy Numbers, Fuzzy Intervals. t – Norms, Generators of t – Norms, Isomorphisms of t – Norms, Negations, t – Conorms, Strict De – Morgan Systems, Nilpotent De Morgan Systems, Non-uniqueness of Negations In Strict De Morgan Systems. Fuzzy Implications, Averaging Operators and Negations, Averaging Operators and Nilpotent t-Norms, De Morgan Systems With Averaging Operators, Power of t-Norms, Sensitivity of Connectives. Fuzzy Relations: Binary Fuzzy Relations, Operations On Fuzzy Relations, Approximate Reasoning, Approximate Reasoning In Expert Systems, Modulus Ponens. Universal Approximations: Fuzzy Rule Bases,Desing Methodologies, Approximation Capabilities. Partial Knowledge: Belief Functions, Indicence Algebras, Monotonicity, Beliefs,

Densities and Allocations, Möbius Transform, Reasoning with Belief Functions, Decision Making With Belief Functions.

Course Outline:

1. Fuzziness: Introduction, Examples of Fuzziness, Modeling of Fuzziness, Operations on Fuzzy Sets, Fuzziness as Uncertainty
2. Algebra of Fuzzy Sets: Boolean Algebra and Lattices, Equivalence Relations and Partitions, Composing Mappings, Isomorphism, and Homomorphisms, Alpha Cuts, Images of Alpha Level Sets.
3. Fuzzy Quantities, Fuzzy Numbers, Fuzzy Intervals.
4. Basic Connectives: t – Norms, Generators of t – Norms, Isomorphisms of t – Norms, Negations, t – Conorms, Strict De – Morgan Systems, Nilpotent De Morgan Systems, Non-uniqueness of Negations In Strict De Morgan Systems.
5. Fuzzy Implications, Averaging Operators and Negations, Averaging Operators and Nilpotent t-Norms, De Morgan Systems With Averaging Operators, Power of t-Norms, Sensitivity of Connectives.
6. Fuzzy Relations: Binary Fuzzy Relations, Operations On Fuzzy Relations, Approximate Reasoning, Approximate Reasoning In Expert Systems, Modulus Ponens.
7. Universal Approximations: Fuzzy Rule Bases, Desing Methodologies, Approximation Capabilities
8. Partial Knowledge: Belief Functions, Indicence Algebras, Monotonicity, Beliefs, Densities and Allocations, Möbius Transform, Reasoning with Belief Functions, Decision Making With Belief Functions.

References Material:

1. A First Course in Fuzzy Logic by Hung T. Nguyen and Elbert A. Walker, Chapman and Hall/CRC; 3rd Edition (October 6, 2005).ISBN-10: 1584885262
2. Introduction to the Basic Principles of Fuzzy Set Theory and some of its Applications Communication and Cognition, Gent, 1991
3. Fuzzy Set Theory and its Applications by H. J. Zimmermann, Springer; 4th Edition (October 15, 2001). ISBN-10: 0792374355
4. Fundamentals of Fuzzy Sets by Didier Dubois and HenriPrade, Springer; 1st Edition (January 1, 2000). ISBN-10: 079237732X

Course Title: Expert Systems

Course Code: CSEC-721
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course concentrates on an analysis of the architecture, knowledge and problem-solving style of expert system.

Course Syllabus:

Introduction to Expert Systems. Major Characteristics of Expert Systems. Knowledge

Representation. Prolog Programming. Developing Meta Interpreters in Prolog. Inference Techniques. MYCIN. Rule-Based Expert Systems. Backward-Chaining Rule-Based Systems. Designing Backward-Chaining Rule-Based Systems. Forward-Chaining Rule-Based Systems. Designing Forward-Chaining Rule-Based Systems. Frame-Based Expert Systems. Designing a Frame-Based Expert Systems.

Course Outline:

1. Introduction to Expert Systems.
2. Major Characteristics of Expert Systems.
3. Knowledge Representation.
4. Prolog Programming.
5. Developing Meta Interpreters in Prolog.
6. Inference Techniques.
7. MYCIN.
8. Rule-Based Expert Systems.
9. Backward-Chaining Rule-Based Systems.
10. Designing Backward-Chaining Rule-Based Systems.
11. Forward-Chaining Rule-Based Systems.
12. Designing Forward-Chaining Rule-Based Systems.
13. Frame-Based Expert Systems.
14. Designing a Frame-Based Expert Systems.

Reference Material:

1. Expert Systems: Design and Development by Durkin, J., Prentice Hall, New York, NY, 1994 or Latest Edition.
2. Introduction To Expert Systems by Peter Jackson, Addison-Wesley; 3rd Edition (December 23, 1998). ISBN-10: 0201876868
3. Expert Systems Programming: Practical Techniques for Rule-Based Systems by Ken Pedersen, Wiley; 1st Edition (May 8, 1989). ISBN-10: 0471600695
4. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Prentice Hall (April 1990). ISBN-10: 0134771001
5. An Introduction To Expert Systems by James P. Ignizio, Mcgraw-Hill College; (January 1, 1991). ISBN-10: 0079097855
6. Expert Systems by Nikolopoulos, CRC Press; 1st Edition (January 10, 1997). ISBN-10: 0824799275

Course Title: Intelligent Agents Technology

Course Code: CSEC-723
Course Structure: Lectures:3 / Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

After passing this course students will be able to understand about software agent technology including:

- What is agent technology?

- Technological contexts.
- Trends and drivers.
- Agent technologies and tools.
- Applications.
- Challenges.
- Technology roadmaps.

Course Syllabus:

Basics of Intelligent Agents. Intelligent Agents Application. Desktop Agents. Internet Agents. Web search Agents, Information Filtering Agents, Personalized Newspaper, Offline Delivery Agents, URL-minder, Bargain Finder. Intranet Agents. Mobile Agents. Technology of Intelligent Agents. Agent Machinery. Agent Content. Agent Access. Agent Security. Developing Agent Applications.

Course Outline:

1. Intelligent Agents: Attributes of Intelligent Agents, Task level Skills, Knowledge, Communication Skills, End user Taxonomy of Agents, Types of Agents: Desktop Agents, Internet Agents. Mobile agents, Intranet Agents.
2. Desktop Agents: Operating System Agents - An Intelligent Utility System Agent, Interface Agent, Application Agents, Email Agent, Search Agent, Application Suite Agents, Benefits of Desktop Agents.
3. Internet Agents: Web search Agents, Benefits of Search Agents, Information Filtering Agents, Benefits of Information Filtering Agents, Offline Delievery Agents, Benefits of offline Delivery Agents, Notification Agents, URL-minder, Benefits of Notification Agent.
4. Intranet Agents: Intranet Search Agents, Informational Filtering Agents, Collaboration Agents, Lotus Notes Agents, Process Automation Agents – Edify work force; A Process Automation Agent, Database Agents DSS Agent – A Database Agent, Mobile Agents – Cyber Agent; A Java based mobile Agent System, Tabriz AgentWare.
5. Technology of Intelligent Agents: the historical view, technical view, Intelligence & Agency, Machinery, Content, Access & Security, Development Model, Steps towards Automation, Steps Towards Agent-based Application.
6. Agent Machinery: Principles of Reasoning – Inferencing Systems, Rules of Inferencing, Sensors & Actors, RAISE: An Inferencing System for Agents, The Trouble with Rules, Adaptive Inferencing, Learning for Intelligent Agents –Sources of Data for Learning.
7. Agent Content: Knowledge Representation, Agent Communication, World Views –World views for Agents, Classes of World-Views, World Views Models for your business, Knowledge Representation & Agent Access, Intelligent Databases, An Agent Content Framework, Agent Communication Languages, The Knowledge Sharing Effort, Knowledge sharing & Manipulation Language (KQML), Agent Content Creation, Sources of Content in your Business.
8. Agent Access: A Framework for Intelligent Agent Access, Agent Access for Existing Applications –Wrappering, Client/Server Applications, Database & File System Interfaces, User Interface, User Access –Conversational User Interfaces, User Events & Actions, Mobile Agents, Mobile Agent Languages, Mobile Agent Principles, Motivations for Using Mobile Agents, Mobile Agent Scenario, Languages for Mobile Agents, Mobile Agent Issues, Internet Access, Access in your Business.

9. Agent Security: What does Security Do? Security for Agents, Security Basics, Delegation for Agents –Controlled Delegation, Limiting Resource Consumption, Security Issues for Mobile Agents –Delegation & Authentication, Agent Privacy, Security Minded Languages for Agents, Security for Mobile Agents, Trusting Agents – Testing & Training, Training Human Agents, Verification, Reputation.
10. Developing Agent Applications: Learning Interface Agents, Learning Agent Functional Architecture, Event Modeling, Learning Engine, Fact Interpretation, Observations, Instructions, Inference.

Reference Material:

1. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
2. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence by Gerhard Weiss, The MIT Press (July 31, 2000). ISBN-10: 0262731312
3. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
4. Intelligent Software Agents: Foundations and Applications by Walter Brenner, RüdigerZarnekow, Hartmut Wittig and A.S. Rudd, Springer, (July 31, 2012). ISBN-10: 3642804861
5. Agent Technology for E-Commerce by Maria Fasli, Wiley; 1st Edition (March 6, 2007). ISBN-10: 0470030305

Course Title: Stochastic Systems

Course Code: CSEC-726
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:
The course will introduce students with key concepts of Stochastic Systems.

Course Syllabus:
Overview of Probability. The Axioms of Probability. Repeated Trials. Random Variable. Distribution and Density Functions, Specific Random Variables, Conditional Distributions, Asymptotic Approximations for Binomial Random Variable. Functions of One Random Variable. Two Random Variables. Sequences of Random Variables. Stochastic Convergence and Limit Theorems, Random Numbers, Meaning and Generation. Statistics.

Course Outline:

1. Overview of Probability: Introduction, Definitions, Probability and Induction, Causality Versus Randomness.
2. The Axioms of Probability: Set Theory, Probability Space, Conditional Probability.
3. Repeated Trials: Combined Experiments, Bernoulli Trials, Bernoulli's Theorem and Games of Chance.
4. The Concept of a Random Variable: Introduction, Distribution and Density Functions, Specific Random Variables, Conditional Distributions, Asymptotic Approximations for

Binomial Random Variable.

5. Functions of One Random Variable: The Random Variable g(x), The Distribution of g(x), Mean and Variance, Moments, Characteristic Functions.
6. Two Random Variables: Bivariate Distributions, One Function of Two Random Variables, Two Functions of Two Random Variables, Joint Moments, Joint Characteristic Functions, Conditional Distributions, Conditional Expected Values.
7. Sequences of Random Variables: General Concepts, Conditional Densities, Characteristic Functions, and Normality, Mean Square Estimation, Stochastic Convergence and Limit Theorems, Random Numbers: Meaning and Generation.
8. Statistics: Introduction, Estimation, Parameter Estimation, Hypothesis Testing.

Reference Material:

1. Dynamics of Stochastic Systems by V. I. Klyatskin, Elsevier Science; 1st Edition (December 15, 2005). ISBN-10: 0444517960
2. Probability, Random Variables and Stochastic Processes by Athanasios Papoulis and S. Unnikrishna Pillai, McGraw-Hill Europe; 4th Edition (January 1, 2002). ISBN-10: 0071226613
3. Stochastic systems by George Adomian, Academic Press (May 28, 1983). ISBN-10: 012410956X

Course Title: Stochastic Processes

Course Code: CSEC-737
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:
The course will introduce students with key concepts of Stochastic Processes.

Course Syllabus:
Review of basic probability. Systems with Stochastic Inputs, The Power Spectrum, Discrete-Time Processes, Continuity, Differentiation, Integration, Shift Operators and Stationary Processes. Finite Markov Chains. Branching Processes. Renewal Theory. Markov Processes. Brownian Motion. Random Walks and Other Applications. Mean Square Estimation.

Course outline:

1. Review of basic probability: Sample space, event, conditional probability, independent events, Baye's formula, random variable, distribution, cumulative distribution, Bernoulli distribution, binomial distribution, Poisson distribution, geometric distribution, density function, exponential distribution, gamma distribution, expectation, variance, standard deviation, joint distribution, covariance, correlation, mean, moment generating function, Chebyshev's inequality, Law of large numbers, central limit theorem.
2. General Concepts: Definitions, Systems with Stochastic Inputs, The Power Spectrum, Discrete-Time Processes, Continuity, Differentiation, Integration, Shift Operators and Stationary Processes.
3. Finite Markov chains: basics, examples, 1-step and n-step transition probabilities, stationary distributions, classifying states, periodicity of classes, absorption of transient states, reversibility, ruin problem.

4. Branching processes: probability generating function, compound distribution, generations of offspring, extinction, total progeny, generalizations.
5. Renewal theory: sequence generating function, pattern generation, consecutive successes, mean number of trials, breaking even, mean number of occurrences, comparison of patterns, probability of winning, expected duration.
6. Markov processes: Poisson processes, extensions, pure birth processes, Yule process, pure death processes, birth and death processes, linear case, linear growth with immigration, M/M/infinity queue, power supply problem, stationary distributions, examples, absorption, continuous time Markov chains, n-state case.
7. Brownian motion: definition, no drift case, reaching a point, avoiding zero, returning to zero, drift.
8. Random Walks and Other Applications: Random Walks, Cyclostationary Processes, The Poisson Sum Formula, The Schwarz Inequality.
9. Mean Square Estimation: Introduction, Prediction.

Reference Material:

1. Stochastic Processes: with Applications to Reliability Theory by Toshio Nakagawa, Springer; 1st Edition (June 9, 2011). ISBN-10: 0857292730
2. Stochastic Processes with Applications by Rabi N. Bhattacharya and Edward C. Waymire, Society for Industrial & Applied (August 5, 2009).ISBN-10: 0898716896
3. Probability, Random Variables and Stochastic Processes by Athanasios Papoulis and S. UnnikrishnaPillai, McGraw-Hill Europe; 4th Edition (January 1, 2002). ISBN-10: 0071226613
4. Basic Stochastic Processes: A Course Through Exercises by ZdzislawBrzezniak, Tomasz Zastawniak, Springer (September 6, 2000). ISBN-10: 3540761756
5. Classical and Spatial Stochastic Processes by Rinaldo B. Schinazi, Birkhäuser; 1999 Edition (May 1, 1999). ISBN-10: 1461272033.

Course Title: Multimedia Databases

Course Code: ITEC-701
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Introduction to Multimedia Databases, Multimedia Data, The Human Sensory System and Multimedia, Introduction to SQL and Multimedia, Querying Multimedia Data, Modeling Multimedia Databases, Using Multimedia Metadata, Multimedia Database Architecture and Performance, Multimedia and the Internet, Quality-of-service Issues, Dealing with Text Databases, Content-dependent Metadata, Dealing with Image Databases, Dealing with Video Databases.

Course Outline:

1. Introduction to Multimedia Databases: Introduction, Essential of Database Systems, Multimedia Data, Multimedia Applications.
2. Multimedia Data: Multimedia Data Size, Real-time Nature of Multimedia, Problems with Semantic Nature of Multimedia Data.
3. The Human Sensory System and Multimedia: Human Information Processing, Human Brain

and Multimedia Information, The Senses, Converting Data into Sensory Perception.
4. An Introduction to SQL and Multimedia: Introduction to SQL, Methods Using PL/SQL Stored Procedures, Manipulating Large Objects.
5. Querying Multimedia Data: Manipulating Multimedia Data, Classification Problem.
6. Modeling Multimedia Databases: Issues of Designing Multimedia Database Management Systems, Semantic Data Modeling, Object-oriented Design, Object Methods, Object-relational Approach.
7. Using Multimedia Metadata: Classifying Metadata, Generating and Extracting Metadata, The Role of Metadata Standards, Digital Rights Management, Domain-dependent Metadata, Developing Ontologies.
8. Multimedia Database Architecture and Performance: Introduction to Multimedia Architecture Requirements, Performance Issues in Specific Implementations, Content Management.
9. Multimedia and the Internet: The Internet, Delivery of Multimedia Data, Media Streams, Network Protocols, User Datagram Protocol.
10. Quality-of-service Issues - Internet Service Models, Packets and Datagrams - Sequence and Loss, Network Architecture, Requirements of Applications Involving Multicasting and Interactivity.
11. Dealing with Text Databases: Querying Character Data Using SQL, Statistical Methods for Text Analysis, Querying Multimedia Text.
12. Content-dependent Metadata, Metadata Standards, Indexing Technologies for Text.
13. Dealing with Image Databases: Technologies for Image Processing, The Role of Feature Extraction, Retrieval Methods, Image Analysis and Object Recognition, Image Classification, Image Database Software, Developing Image Media Databases.
14. Dealing with Video Databases: Video Analysis and Segmentation, Storage of Video Objects, Disk Scheduling, Dealing with Moving Images, Metadata for Speech, Metadata for Video, Manipulating Video Data, Video Query Process, Video Applications.

Reference Material:

1. Multimedia Databases: An Object-Relational Approach by Lynne Dunckley, Pearson Education (January 31, 2003). ISBN-10: 0201788993
2. Multimedia Database Systems: Design and Implementation Strategies by Kingsley C. Nwosu, B. Thuraisingham and P. Bruce Berra, Springer; (October 28, 2011). ISBN-10: 146138060X
3. Principles of Multimedia Database Systems by V.S. Subrahmanian, Morgan Kaufmann Publishing Company, San Fransisco, CA. 1998. ISBN: 1558604669.
4. Distributed Multimedia Database Technologies Supported by MPEG-7 and MPEG-21 by HaraldKosch, CRC Press; 1st Edition (November 24, 2003). ISBN-10: 0849318548
5. Multimedia Data Mining: A Systematic Introduction to Concepts and Theory by Zhongfei Zhang and Ruofei Zhang, Chapman and Hall/CRC; 1st Edition (December 2, 2008). ISBN-10: 1584889667

Course Title: Distributed Database Systems

Course Code: ITEC-703
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: DBMS

Course Syllabus:

Distributed Data Processing, Distributed Database Systems, Design Issues, Distributed DBMS

Architecture. Distributed Database Design. Database Integration. Data and Access Control. Query Processing. Query Decomposition and Data Localization. Optimization of Distributed Queries. Multidatabase Query Processing. Transaction Management. Distributed Concurrency Control. Distributed DBMS Reliability. Data Replication.

Course Outline:

1. Distributed Data Processing, Distributed Database Systems, Data Delivery Alternatives, Promises of DDBSs, Complications Introduced by Distribution, Design Issues, Distributed DBMS Architecture.
2. Distributed Database Design: Top-Down Design Process, Fragmentation, Allocation, Data Directory.
3. Database Integration: Bottom-Up Design Methodology, Schema Matching, Schema Integration, Schema Mapping, Data Cleaning.
4. Data and Access Control: View Management, Data Security, Semantic Integrity Control.
5. Overview of Query Processing: Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing.
6. Query Decomposition and Data Localization: Query Decomposition, Localization of Distributed Data.
7. Optimization of Distributed Queries: Query Optimization, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization.
8. Multidatabase Query Processing: Issues in Multidatabase Query Processing, Multidatabase Query Processing Architecture, Query Rewriting Using Views, Query Optimization and Execution, Query Translation and Execution.
9. Transaction Management: Definition of a Transaction, Properties of Transactions, Types of Transactions.
10. Distributed Concurrency Control: Serializability Theory, Taxonomy of Concurrency Control Mechanisms, Locking-Based Concurrency Control Algorithms, Timestamp-Based Concurrency Control Algorithms, Optimistic Concurrency Control Algorithms, "Relaxed" Concurrency Control.
11. Distributed DBMS Reliability: Reliability Concepts and Measures, Failures in Distributed DBMS, Local Reliability Protocols, Distributed Reliability Protocols, Dealing with Site Failures, Network Partitioning, Architectural Considerations.
12. Data Replication: Consistency of Replicated Databases, Update Management Strategies, Replication Protocols, Group Communication, Replication and Failures, Replication Mediator Service.

Reference Material:

1. Principles of Distributed Database Systems by M. Tamer Özsu and Patrick Valduriez, Springer, 3rd Edition, (March 2, 2011). ISBN-10: 1441988335
2. Distributed Database Management Systems: A Practical Approach by Saeed K. Rahimi, and Frank S. Haug, Wiley-IEEE Computer Society Pr; 1st Edition (May 23, 2011). ASIN: B005CDYQSC
3. Distributed Systems: Principles and Paradigms by Andrew S. Tanenbaum and Maarten van Steen, Prentice Hall; US Edition (January 15, 2002). ISBN-10: 0130888931
4. Distributed Systems: Concepts and Design by Jean Dollimore, Tim Kindberg and George Coulouris, Addison Wesley; 4th Edition (May 20, 2005). ISBN-10: 0321263545

5. Distributed Database Systems by Chhanda Ray, Pearson (October 3, 2012). ASIN: B009NEMZ0W

Course Title: Formal Methods

Course Code: CSEC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
Modern software development inevitably requires the design and analysis of a number of different artifacts. Formal methods allow the mathematically precise formulation of some of these artifacts. This course is an introduction to the use of formal methods for the specification, design, and automatic analysis of software systems.

Course Syllabus:
Introduction to Formal methods, Introducing Z, Elements of Z, Logic, Using Predicates in Z, Schemas and Schema Calculus, Formal Reasoning, Rule-Based Programming, Graphical User Interface, Safety-Critical Protection System, Modeling Large Systems, Converting Z into Code.

Course Outline:

1. Formal methods: What are FM? What FM are not, When, How, and Why use FM? Popular Fallacies and Alternatives. Formal Methods and Project Management: Gathering Requirement, From Information Requirement to Formal Specifications, Validating Formal Specifications. [TB: Ch. 1,2,3]
2. Introducing Z: What is Z? Informal Requirements, Data Flow Diagrams, State Transition Diagram, State Transition Diagram, State Transition tables. Introducing schemas: Basic Types and Abbreviations, Axiomatic Descriptions, State Schemas, Operation Schemas, Implicit preconditions, Schema Calculus. [TB: Ch. 4,5, 6, 7]
3. Elements of Z: Sets and Types, Declarations, Variables, Expressions, Operators, Predicates, Equations and Laws. Structure: Tuple, Records, Relations, Tables, Databases, Pairs and Binary Relations, Functions, Sequences, Operators. [TB: Ch. 8,9]
4. Logic: Basic Predicates, Using Predicates in Z, Relations as Predicates, Logical Connectives, Logic and Natural Language, Quantifiers, Z and Boolean Types, Predicates and undefined Expressions. Synthesis: Set Comprehensives, Lambda Expressions, Formal Specifications, Conveniences and shortcuts, Modeling Systems and Change. [TB: Ch. 10, 11]
5. Schemas and schema calculus: Conjunctions and Disjunctions, Other Schema Operators. Schema types and Bindings: Generics & Free Types [TB: Ch. 12, 13,14]
6. Formal Reasoning: Calculation and proof, Laws, Checking Specifications, Preconditions, Formal Reasoning and Intuition, Machine-Checked proof. [TB: Ch.15]
7. Graphical User Interface: Events, Display and Dialogs, Selecting a Display, Changing Setting Value, Z and State Transition Systems, Changing the Machine State. [TB: Ch. 21]
8. Safety-Critical Protection System: Partition, Refinement, Enforcing the Safety Requirements. [TB: Ch. 22]
9. Modeling Large Systems: A Single Subsystem, Many Subsystems, Useful Idioms, Subsystems, Conditions, and Modes. [TB: Ch. 23].

10. Converting Z Specification into Code.

Reference Material:

1. Systems and Software Verification: Model-Checking Techniques and Tools. By B. Berard, M. Bidoit, A. Finkel, F. Laroussinie, A. Petit, L. Petrucci, and P. Schnoebelen, Springer, (2013). ISBN-10: 3642074782
2. The Way of Z: Practical Programming with Formal Methods by Jonathan Jacky, Cambridge University Press (November 28, 1996). ISBN-10: 0521559766
3. Z: An Introduction to Formal Methods by Antoni Diller, Wiley; 2nd Edition (July 27, 1994). ISBN-10: 0471939730
4. Model Checking by Edmund M. Clarke Jr., Orna Grumberg, Doron A. Peled , MIT Press, 1st Edition (1999). ISBN-13: 978-0262032704.
5. Reactive Systems: Modelling, Specification and Verification by Luca Aceto, Anna Ingólfsdóttir, Kim Guldstrand Larsen and Jiri Srba, Cambridge University Press (August 13, 2007). ISBN-10: 0521875463
6. Fundamentals of Algebraic Specifications: Equations and Initial Semantics, H. Ehrig & B. Mahr, Springer-Verlag (1985), ISBN 0-387-13718-1.
7. Algebraic Specifications in Software Engineering by I. Van Horebeek & J. Lewi, Springer; 1st Edition (December 19, 1989). ISBN-10: 3540516263

Course Title: Bioinformatics

Course Code: CSEC-724
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
Introduce students to the current bioinformatics concepts and their implementations.

Course Syllabus:
The genetic material. Gene structure and information content. Open reading frames, Introns and exons. Protein structure and function. The nature of chemical bonds. Electronegativity, Hydrophilicity and hydrophobicity. Molecular biology tool. Polymerase chain reaction (PCR), DNA sequencing. Genomic information content. Data Searches and Pairwise Alignments. Substitution Patterns. Estimating substitution numbers. Kimura's two-parameter model, Models with even more parameters, Substitutions between protein sequences. Variations in substitution rates between genes. Molecular clocks. Distance-Based Methods of Phylogenetics. Distance matrix methods. Character-Based Approaches to Phylogenetics: Parsimony, Strategies for faster searches, Consensus trees. Tree confidence. Molecular phylogenies. Genomics and Gene Recognition. Prokaryotic gene structure. GC-content. Prokaryotic gene density. Eukaryotic genomes. Eukaryotic gene structure. Open reading frames. GC-content. Gene expression. Transposition. Repetitive elements. Eukaryotic gene density. Protein Folding: Polypeptide composition. Secondary structure, Tertiary and quaternary structure, Protein folding, Structure prediction, Threading. Proteomics: From genomes to proteomes. Protein classification, Experimental techniques. Inhibitors and drug design. Ligand screening. Docking. Database screening. X-ray crystal structures. Empirical methods and prediction techniques. Postranslational modification prediction.

Course Outline:

1. Molecular Biology And Biological Chemistry: The Genetic Material: Nucleotides, Orientation, Base Pairing, The Central Dogma Of Molecular Biology. Gene Structure and Information Content: Promoter Sequences, The Genetic Code. Open Reading Frames, Introns and Exons. Protein Structure and Function: Primary Structure, Secondary, Tertiary and Quaternary Structure. The Nature of Chemical Bonds: Anatomy of An Atom, Valence. Electronegativity, Hydrophilicity and Hydrophobicity. Molecular Biology Tool: Restriction Enzymes, Gel Electrophoresis, Blotting, Hybridization and Microarrays, Cloning. Polymerase Chain Reaction (PCR), DNA Sequencing. Genomic Information Content: C Value Paradox, Reassociation Kinetics.
2. Data Searches and Pairwise Alignments: Dot Plots. Simple Alignments. Scoring. Gaps: Simple Gap Penalties, Origination and Length Penalties. Scoring Matrices. Dynamic Programming: The Needleman And Wunsch Algorithm. Local and Global Alignments: Global and Semi-Global Alignments, The Smith-Waterman Algorithm. Database Searches: BLAST and Its Relatives, Other Algorithms. Multiple Sequence Alignments.
3. Substitution Patterns: Patterns of Substitutions Within Genes: Mutation Rates. Functional Constraint.Synonymous Vs. Non-synonymous Changes, Indels and Psuedogenes, Substitutions Vs. Mutations, Fixation. Estimating Substitution Numbers: Jukes/Cantor Model, Transitions and Transversions. Kimura's Two-Parameter Model, Models With Even More Parameters, Substitutions Between Protein Sequences. Variations In Substitution Rates Between Genes. Molecular Clocks: Relative Rate Tests, Causes Of Rate Variation In Lineages. Evolution in Organelles.
4. Distance-Based Methods of Phylogenetics: History of Molecular Phylogenetics. Advantages to Molecular Phylogenies. Phylogenetic Trees: Terminology of Tree Reconstruction, Rooted and Unrooted Trees, Gene Vs. Species Trees, Character and Distance Data. Distance Matrix Methods: UPGMA. Estimation of Branch Lengths. Transformed Distance Method, Neighbor's Relation Method, Neighbor-Joining Methods. Maximum Likelihood Approaches. Multiple Sequence Alignments.
5. Character-Based Approaches to Phylogenetics: Parsimony: Informative and Uninformative Sites, Unweighted Parsimony, Weighted Parsimony. Inferred Ancestral Sequences. Strategies for Faster Searches: Branch and Bound, Heuristic. Consensus Trees. Tree Confidence: Bootstrapping, Parametric Tests. Comparison of Phylogenetic Methods. Molecular Phylogenies: The Tree of Life, Human Origins.
6. Genomics and Gene Recognition: Prokaryotic Genomes. Prokaryotic Gene Structure: Promoter Elements, Open Reading Frames, Conceptual Translation, Termination Sequences. GC-Content. Prokaryotic Gene Density. Eukaryotic Genomes. Eukaryotic Gene Structure: Promoter Elements, Regulatory Protein Binding Sites. Open Reading Frames: Introns And Exons, Alternative Splicing, Cpg Islands. GC-Content: Isochores, Codon Usage Bias, Gene Expression: Cdnas And Ests, Serial Analysis of Gene Expression (SAGE), Microarrays. Transposition. Repetitive Elements. Eukaryotic Gene Density.
7. Protein Folding: Polypeptide Composition: Amino Acids. Backbone Flexibility, Phi and Psi. Secondary Structure: Accuracy of Predictions, Chou-Fasman/GOR Method. Tertiary and Quaternary Structure: Hydrophobicity, Disulfide Bonds, Active Structures Vs. Most Stable Structures. Protein Folding: Lattice Models, Off-Lattice Models, Energy Functions and Optimization. Structure Prediction: Comparative Modeling, Threading: Reverse Protein Folding. Predicting RNA Secondary Structures.

8. Proteomics: From Genomes to Proteomes. Protein Classification: Enzyme Nomenclature, Families and Super-Families, Folds. Experimental Techniques: 2D Electrophoresis, Mass Spectrometry, Protein Microarrays. Inhibitors and Drug Design. Ligand Screening: Docking, Database Screening. X-Ray Crystal Structures. Empirical Methods and Prediction Techniques. Postranslational Modification Prediction: Protein Sorting, Proteolytic Cleavage, Glycosylation, Phosporylation and Sulfation.

References Material:

1. Fundamental Concepts of Bioinformatics by Dan E. Krane and Michael L. Raymer, Benjamin Cummings; 1st Edition (September 22, 2002). ISBN-10: 0805346333
2. Bioinformatics For Dummies by Jean-Michel Claverie Ph. D. and Cedric Notredame Ph.D., For Dummies; 2nd Edition (December 18, 2006). ISBN-10: 0470089857
3. Essential Bioinformatics by Jin Xiong, Cambridge University Press; 1 Edition (March 13, 2006). ISBN-10: 0521600820
4. Introduction to Bioinformatics by Arthur Lesk, Oxford University Press, USA; 3rd Edition (June 2, 2008). ISBN-10: 0199208042

Course Title: Service-Oriented Architecture

Course Code: ITEC-709
Course Structure: Lectures: 3/Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

By the end of this course students will be able to understand SOA, Service Orientation and Web Services. The will also be able to analyze and design business based on SOA principles.

Course Syllabus:

Introducing SOA. Web Services & Primitive SOA. Web Services & Contemporary SOA (Activity Management & Composition). Web Services & Contemporary SOA *(Advance Messaging, Metadata & Security).* Principles of Service-Orientation. Service Orientation & Contemporary SOA. SOA Delivery Strategies. Service Oriented Analysis. Service Modelling (Process). Service Oriented Design. WSDL-Related XML Schema Language. SOAP Language Basic, Service Interface Design Tools. Service Oriented Design Steps to Composing SOA. Considerations for Choosing Service Layers, Considerations for Positioning Core SOA Standards (Industry Standards, & SOA, XML & SOA, The WS-I Baisc Profile, WDSL & SOA, XML Schema & SOA, SOAP & SOA, Namespaces & SOA, UDDI & SOA) Considerations for Choosing SOA Extensions (Choosing SOA Characteristics, Choosing WS* Specifications, WS-BPEL & SOA). Entity Centric Business Service Design, Application Service Design, Service Design Guidelines.

Course Outline:

1. Introducing SOA; Fundamental SOA, Common Characteristics, Common Misperceptions about SOA: Common Tangible Benefits Of SOA, Common Pitfalls Of Adopting SOA.
2. Web Services & Primitive SOA: The Web Services Framework, Web Services, Service Descriptions (WSDL), Messaging (With SOAP).
3. Web Services & Contemporary SOA (Activity Management & Composition): Message

Exchange Patterns, Coordination, Atomic Transactions, Business Activities, Orchestration Choreographies.

4. Web Services & Contemporary SOA *(Advance Messaging, Metadata & Security)* Addressing Reliable Messaging, Correlation, Metadata Exchange, Notification & Eventing.
5. Principles of Service-Orientation: Service Orientation & The Enterprise, Anatomy of a Service Oriented Architecture, Common Principles of Service Orientation, How Services-Orientation Principles, Service Orientation & Object Orientation, Native Web Service Support for Service Orientation Principles.
6. Service Orientation & Contemporary SOA: Service Layer Abstraction, Application Service Layer, Business Service Layer, Orchestration Service Layer, Agnostic Services, Service Layer Configuration Scenarios.
7. SOA Delivery Strategies SOA Delivery Lifecycle Phases, Top Down Strategy, Bottom Up Strategy, Agile Strategy.
8. Service Oriented Analysis: Introduction, Benefits of a Business Centric SOA, Deriving Business Services, Deriving Business Services.
9. Service Modelling (Process): Introduction, Modelling Guidelines, Classifying Service Model Logic, Different Modelling Approaches.
10. Service Oriented Design: Introduction, WSDL-Related XML Schema Language, WSDL Language(Like Definitions, Types, Message & Part, Porttype, Interface, & Operation Elements, Input & Output-When Used With Operation, Binding, Input & Output-When Used With Binding, Service, Port & Endpoint, Import, Documentation), SOAP Language Basic (Envelop, Header, Body, Fault) Service Interface Design Tools.
11. Service Oriented Design Steps To Composing SOA, Considerations For Choosing Service Layers, Considerations For Positioning Core SOA Standards (Industry Standards, & SOA, XML & SOA, The WS-I Baisc Profile, WDSL & SOA, XML Schema & SOA, SOAP & SOA, Namespaces & SOA, UDDI & SOA) Considerations For Choosing SOA Extensions (Choosing SOA Characteristics, Choosing WS* Specifications, WS-BPEL & SOA).
12. Service Oriented Design: Overview, Entity Centric Business Service Design, Application Service Design, Service Design Guidelines.

Reference Material:

1. Service-Oriented Architecture (SOA): Concepts, Technology, and Design by Thomas Erl, Prentice Hall (August 12, 2005). ISBN-10: 0131858580
2. Service-Oriented Architecture (SOA): Concepts, Technology, and Design by Thomas Erl, Prentice Hall (August 12, 2005). ISBN-10: 0131858580
3. SOA Design Patterns by Thomas Erl, Prentice Hall PTR; 1st Edition (January 9, 2009)
4. Service-Oriented Architecture (SOA): A Planning and Implementation Guide for Business and Technology by Eric A. Marks and Michael Bell, Wiley; 1st Edition (April 28, 2006). ISBN-10: 0471768944
5. Applied SOA: Service-Oriented Architecture and Design Strategies by Michael Rosen, Boris Lublinsky, Kevin T. Smith and Marc J. Balcer, Wiley; 1st Edition (June 16, 2008). ISBN-10: 0470223650

Course Title: Advanced Web development
Course Code: CSEC-707
Prerequisites: Web Systems and Technologies.

Course Objectives:

To introduce students with Web Systems and Technologies Implement HTML5 coding solutions using HTML5 elements, attributes and values. Apply CSS33 functionality to Web documents using various properties, selectors and techniques. Integrate basic JavaScript coding into a Web page to create HTML5 APIs. Consider HTML5 and CSS33 techniques to apply to both traditional and mobile delivery platforms, including mobile apps .Transform traditional Web pages into mobile Web pages. Understanding PHP frameworks and advanced technologies. Something new in JQuery. Mobile websites and mobile apps development.

Course Syllabus:

Introduction to HTML5 and CSS33, Advanced concepts in HTML5 Structure Elements, Validating HTML5 Code, HTML5 APIs, Cross-Browser Compatible HTML5 Forms, New Form Elements in HTML5, HTML5 Global Attributes for Form Elements, Embedding JavaScript into HTML5 Documents, Cascading Style Sheets (CSS3), Style Guides, , CSS3 Positioning Schemes, The CSS3 Box Model, Introduction to CSS33, Introduction to Advanced CSS33 Techniques, CSS33 2D and 3D Transformations, CSS33 Transitions, CSS33 Animations, CSS33 User Interfaces, Creating Menus and Buttons with CSS33, Advanced PHP concepts, debugging and logging, Runtime error handling using PHP exception handling mechanism, Web services including SOAP,NU SOAP and WSDL. Popular frameworks including CakePHP, Yii, Zend and Codelgniter. Advanced JQuery concepts, JQuery functions, Validating User Input with JavaScript, Migration to Mobile Devices. The Web Development Trifecta.

Course Outline:

1. Advanced HTML5 concepts: Structure Elements, Validating HTML5 Code, The <video> Element, The <audio> Element, Introduction to HTML5 Forms, Cross-Browser Compatible HTML5 Forms, New Form Elements in HTML5, HTML5 Global Attributes for Form Elements.
2. HTML5 APIs, Document Object Model (DOM), The Canvas API, The Offline AppCache API, The Geolocation API, The Drag-and–Drop API, The File API, The History API, Retrieving Data with *XMLHttpRequest.*
3. Advanced CSS33 concepts: Cascading Style Sheets (CSS3), Style Guides, CSS3 and HTML, CSS3 Terms and Syntax, Applying CSS3 Styles, Page Layout with CSS3, CSS3 Positioning Schemes, The CSS3 Box Model.
4. Introduction to CSS33, CSS33 Selectors and Properties, CSS33 Background Properties, CSS33 Border Properties, CSS33 Font Properties, CSS33 Text Effects, Introduction to Advanced CSS33 Techniques, CSS33 2D and 3D Transformations, CSS33 Transitions, CSS33 Animations, CSS33 User Interfaces, Creating Menus and Buttons with CSS33.
5. Advanced JavaScript concepts: Learning JavaScript Design Patterns, Introduction to Object-Oriented JavaScript.
6. Advanced PHP concepts: functions, date and time , debugging and logging, string manipulation, database connectivity methods
7. PHP extensions and application repository –PEAR, Smarty Templates, code reuse, feeding a function, return data from a function, Runtime error handling using PHP exception handling mechanism, Send e-mail using SMTP.

8. Web services including SOAP, NU SOAP and WSDL, popular frameworks including CakePHP, Yii, Zend and Codelgniter.
9. Advanced JQuery concepts: Bind/Unbind, Live/Die, Ajax Queue/Sync, Setting up widgets in JQuery Namespace
10. Migration to Mobile Devices, Mobile Web Sites vs. Mobile Apps, Designing Web Sites for Mobile Devices, Page Layout for Mobile Devices, Navigation and Hyperlinks for Mobile Devices, Images and Mobile Design, Validating and Testing Mobile Web Pages, Responsive Web Design.

Course Title: Big Data Analysis
Course Code: CSEC-714
Credit Hours: 3
Course Objectives:
At the end of this course, the student will become familiar with the fundamental concepts of Big Data management and analytics; will become competent in recognizing challenges faced by applications dealing with very large volumes of data as well as in proposing scalable solutions for them; and will be able to understand how Big Data impacts business intelligence, scientific discovery, and our day-to-day life.
Course Syllabus:
Introduction to Big Data, Defining Big Data, Delivering Business benefit from Big Data, Storing Big Data, Analyzing your data characteristics, Overview of Big Data stores, Selecting Big Data Stores, Processing Big Data, Integrating disparate data stores, Employing Hadoop MapReduce, The building blocks of Hadoop MapReduce, Handling streaming data, Tools and Techniques to Analyze Big Data, Abstracting Hadoop MapReduce jobs with Pig, Performing ad hoc Big Data querying with Hive, Creating business value from extracted data, Developing a Big Data Strategy, Employing Hadoop MapReduce, Defining a Big Data strategy for your organization, Enabling analytic innovation, Implementing a Big Data solution.

Reference Material:
1. Big Data: A Revolution that Will Transform how We Live, Work, and Think, Kenneth Cukier and Viktor Mayer-Schönberger, Latest Edition
2. Data-Intensive Text Processing with MapReduce, Morgan & Claypool Publishers, Latest Edition.
3. Learning Spark: Lightning-Fast Big Data Analysis, Andy Konwinski, Holden Karau, Matei Zaharia, and Patrick Wendell, Latest Edition
4. Anand Rajaraman and Jeff Ullman, Mining of Massive Datasets, Cambridge Press, Latest Edition
5. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques. Latest Edition

Course Title: Cloud Computing
Course Code: CSEC-715
Credit Hours: 3
Prerequisite: Computer Networks

Course Objectives:

This course gives an introduction to cloud computing and related techniques, issues, ecosystem and case studies. Students will learn and understand about such fundamental distributed computing "concepts" for cloud computing, how these techniques work inside today's most widely-used cloud computing systems and various research papers will be studied.

Course Syllabus:

Overview of Distributed Computing, Emergence of Cloud Computing, Global Nature of the Cloud, Cloud-Based Service Offerings, Grid Computing , Reliability of Cloud Model, Benefits of Cloud Model, Legal Issues, Key Characteristics of Cloud Computing, Challenges for the Cloud. The Evolution of Cloud Computing. Web Services Delivered from the Cloud: Communication-as-a-Service (CaaS), Infrastructure-as-a-Service, Monitoring-as-a-Service (MaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Storage: HDFS, NAAS, SAN, Distributed Graph Processing, MapReduce , MapReduce Paradigm, MapReduce Examples, Emerging Paradigms, Distributed Graph Processing, Hadoop Scheduling, Dominant-Resource Fair Scheduling, Building Cloud Networks. Virtualization. Federation, Presence, Identity, and Privacy in the Cloud. Security in the Cloud. Common Standards in Cloud Computing. End-User Access to Cloud Computing. Mobile Internet Devices and the Cloud.

Reference Material:

1. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, Latest Edition
2. Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton, Recursive Press, Latest Edition
3. Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide by David S. Linthicum, Addison-Wesley Professional, Latest Edition
4. Cloud Computing Bible by Barrie Sosinsky, Wiley, Latest Edition

Course Title: Machine Learning
Course Code: CSEC-701
Credit Hour: 3
Prerequisites: None

Course Objectives:

In this course, student will learn about the most effective machine learning techniques, and gain practice implementing them and getting them to work. More importantly, student will learn about

not only the theoretical underpinnings of learning, but also gain the practical know-how needed to quickly and powerfully apply these techniques to new problems.

Course Syllabus:

This course provides a broad introduction to machine learning, data mining, and statistical pattern recognition. Topics include: (i) Supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks). (ii) Unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning). (iii) Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI). The course will also draw from numerous case studies and applications, so that you'll also learn how to apply learning algorithms to building smart robots (perception, control), text understanding (web search, anti-spam), computer vision, medical informatics, audio, database mining, and other areas.

Course Outline:

Following is a tentative syllabus for the class:

1. Introduction to machine learning [TB, Chapter 1].
2. Linear regression [RB1, Chapter 3, Section 3.1; RB2, Chapter 3, Section 3.1,3.2].
3. Gradient Descent as general parameter Learning/optimization approach [TB, Chapter 4]
4. Logistic regression, One-vs-all classification, Regularization. [Handout 2; RB1, Chapter 4 and RB2, Chapter 4]
5. Neural Networks. (TB, Chapter 4)
6. Practical advice for applying learning algorithms: How to develop, debugging, feature/model design, setting up experiment structure
7. Probability and Bayesian Analytics. [Handout 3]
8. Naive Bayes. (TB, Chapter 6)
9. Support Vector Machines (SVMs) and the intuition behind them. [RB 1, Chapter 7]
10. Unsupervised learning: clustering and dimensionality reduction.
11. Anomaly detection.
12. Probabilistic Graphical Models: Bayesian Belief Networks [RB, Chapter 8]
13. Probabilistic Graphical Models: Learning from Data [RB, Chapter 8]
14. Probabilistic Graphical Models: EM algorithm [RB 9]
15. Hidden Markov Models [RB Chapter 13]

Reference Material:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning. Springer, 2006.
2. Tom Mitchell, Machine Learning. McGraw-Hill, 1997. [Text Book (TB)]
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning. Springer, 2009

Course Title: Soft Computing
Course Code: CSEC-732
Credit Hours: 3

Course Objectives:
Soft computing is a collection of methodologies, which aim to exploit tolerance for imprecision, uncertainty and partial truth to achieve tractability, robustness and low cost solutions. It is the use of inexact solutions to computationally hard tasks such as the solution of NP-complete problems, for which there is no known algorithm that can compute an exact solution in polynomial time. Soft computing differs from conventional (hard) computing in that, unlike hard computing, it is tolerant of imprecision, uncertainty, partial truth, and approximation. In effect, the role model for soft computing is the human mind.

Course Syllabus:
Overview of Soft Computing, Probabilistic Graphical Models, Bayesian Networks, Inferencing in Graphical Models, Swarm Intelligence, Ant Colony Optimization, Particle Swarm Optimization, Cat Swarm Optimization, Convergence Analysis, Neural Networks, Deep Learning, Convolutional Neural Networks, Relational Learning, Tensor Factorization, Ensemble Methods.

Reference Material:

1. "Fundamentals of Computational Swarm Intelligence", John Wiley & Sons 2011, Andries P.Engelbrecht
2. "Deep learning", MIT Press Cambridge (EE.UU.) 2016, Ian Goodfellow, Yoshua Bengio, Aaron Courville
3. Probabilistic graphical models principles and techniques", MIT Press Cambridge, Mass. 2012, Daphne Koller, Nir Friedman
4. Research Articles/Handouts will be provided in the class.

Course Title: Advanced Artificial Intelligence

Course Code: CSEC-717
Course Structure: Lectures: 3/Labs: 0
Credit Hours: **3**
Prerequisites:
Course Objectives:
This course will introduce the key principles in artificial intelligence. It will cover simple representation schemes, problem solving paradigms, constraint propagation, and search strategies. Areas of application such as knowledge representation, natural language processing, expert systems, vision and robotics will be explored. The Prolog programming language will also be introduced.

Course Syllabus:
Introduction to AI, Turing Test, Strong AI vs Weak AI, Heuristics, Applications and Methods, History of AI. Uninformed Search: Search in IS, Genrate-and-Test Paradigm, Blind Search Algorithm. Informed Search: Heuristics, The Best-First Search, The Beam Search, The A* Search, The Bidirectional Search. Search Using Game: Game Trees and Minimum, Game Theory. Logic in AI: Logic and Representation, Propositional Logic, Predicate Logic, Other Logics. Knowledge

Representation: Search Tree, Production System, Objects, Frames, Scripts & the Conceptual Dependency System, Semantic Networks, Recent Approaches, Agents. Prolog Programming. Production Systems: Strong Methods vs. Weak Methods, Production System and Inference Methods, Stochastic Processes and Markov Chain. [Uncertainty in AI: Fuzzy Sets, Fuzzy Logic, Fuzzy Inference, Probability Theory and Uncertainty. [Expert Systems: Characteristics of ES, Knowledge Engineering, Knowledge Acquisition, Classical ES, Case-Based Reasoning. Neural Networks: Introduction, The Perceptron Learning Rule, Back propagation, Discrete Hopfield Networks, Application Areas. Evolutionary Computation: Simulated Annealing, Genetic Algorithms, Genetic, Genetic Programming. Natural Language Processing: History of NLP, Syntax and Formal Grammars, Syntax and Formal Grammar, Statistical Parsing, Hidden Markov Model, Wordnet, Question Answering System. Automated Planning: Planning Terminology, Planning as Search, Hierarchical Planning, Case-Based Planning, Planning Approaches to Learning System. Advanced Computer Games: Rote Learning and Generalization, Signature Table and Book Learning , Programing Methods, Search in Machines

Course Outline:

1. Introduction: Turing Test, Strong AI vs Weak AI, Heuristics, Applications and Methods, History of AI. [TB: Ch. 1]
2. Uninformed Search: Search in IS, Genrate-and-Test Paradigm, Blind Search Algorithm. [TB: Ch. 2],
3. Informed Search: Heuristics, The Best-First Search, The Beam Search, The A* Search, The Bidirectional Search. [TB: Ch. 3]
4. Search Using Game: Game Trees and Minimum, Game Theory. [TB: Ch. 4]
5. Logic in AI: Logic and Representation, Propositional Logic, Predicate Logic, Other Logics. [TB: Ch. 5]
6. Knowledge Representation: Search Tree, Production System, Objects, Frames, Scripts & the Conceptual Dependency System, Semantic Networks, Recent Approaches, Agents.
7. Prolog Programming [Online Resources]
8. Production Systems: Strong Methods vs. Weak Methods, Production System and Inference Methods, Stochastic Processes and Markov Chain. [TB: Ch. 7].
9. Uncertainty in AI:. Fuzzy Sets, Fuzzy Logic, Fuzzy Inference, Probability Theory and Uncertainty. [TB: Ch. 8]
10. Expert Systems: Characteristics of ES, Knowledge Engineering, Knowledge Acquisition, Classical ES, Case-Based Reasoning. [TB: Ch. 9].
11. Neural Networks: Introduction, The Perceptron Learning Rule, Back propagation, Discrete Hopfield Networks, Application Areas. [TB: Ch. 10]
12. Evolutionary Computation: Simulated Annealing, Genetic Algorithms, Genetic, Genetic Programming. [TB: CH. 11]
13. Natural Language Processing: History of NLP, Syntax and Formal Grammars, Syntax and Formal Grammar, Statistical Parsing, Hidden Markov Model, Wordnet, Question Answering System. [TB: Ch. 12]
14. Automated Planning: Planning Terminology, Planning as Search, Hierarchical Planning, Case-Based Planning, Planning Approaches to Learning System.[TB: Ch. 13]

Reference Material

1. Artificial Intelligence in the 21st Century by Stephen Lucci by Danny Kopec, Mercury Learning and Information (May 18, 2012). ISBN-10: 1936420236

2. Artificial Intelligence: A Modern Approach, 2nd Edition, by Russell and Norvig, Prentice Hall
3. Artificial Intelligence: A Systems Approach by M. Tim Jones, Jones and Bartlett Publishers, Inc; 1st Edition (December 26, 2008). ISBN-10: 0763773379

Course Title: Advanced Human Computer Interaction
Course Code: CSEC-713
Credit Hours: 3
Prerequisite: Human Computer Interaction

Course Objective
This course provides an overview advanced topics of human-computer interaction, Moreover course introduces students to design thinking and the basic practices of interaction design. It will cover the importance of human-computer interaction/interface design, iterative design, input/output techniques, how to design and evaluate interfaces, and research topics. The aim is to identify the important research issues, and to ascertain potentially fruitful future research directions in relation to the multimodal emotion analysis and to human-computer interaction.
Course Syllabus
Accessibility and Assistive Technologies, Affective Interaction, Future Interfaces, Human Factors for Digital Health, Persuasive Games ,Physical Computing and Prototyping, Socio-technical Systems, interaction Design, Mobile and ubiquitous, Evaluation techniques, Programming of Interactive systems(user interfaces), User-Centered Design Methods, Situated interaction, User modeling, Multimodal interaction, Intelligent systems, Affective computing, Cognitive interaction, Software Architectures for User Interfaces

Reference Material:
1. Interaction Design: Beyond Human-Computer Interaction by Jenny Preece (Author), Helen Sharp (Author), Yvonne Rogers, Latest Edition.
2. Modern Statistical Methods for HCI, **Robertson**, Judy, **Kaptein**, Maurits Latest Edition
3. Handbook of Research on Human-Computer Interfaces, Developments, and Applications
4. João Rodrigues ,Pedro Cardoso Jânio Monteiro and Mauro Latest Edition.
5. Affective Computing (MIT Press) by Rosalind W. Picard
6. Designing the User Interface: Strategies for Effective Human-Computer Interaction , Latest Edition
7. Alan Dix, Janet Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction Latest Edition

Course Title: Advanced Topics in Wireless Networks
Course Code: ITEC-707
Credit Hour: 3
Prerequisite: Computer Networks

Course Objectives:

The advent of wireless and wired networks convergence and as the Internet is increasingly becoming the tool for a wide range of technical, economical and industrial applications, resources management becomes very crucial and vital issue for any future networks. The objectives of this course are to focus on resource management and performance analysis in transporting multimedia traffic in wireless communication networks. Topics include: traffic characteristics, connection admission control, packet scheduling, access control, and mobility and handoff management.

Course Outline:

Introduction to Radio Resource Management for Wireless Networks, Resource Management for Circuit-Switched Services , Traffic Modeling , Access Control and Admission Control , Mobility Management and Handoff Management , MAC and Packet Transmission Scheduling , Resource Management in Ad Hoc Networks, Applications: Resource Management in Packet Access, CDMA2000 & WCDMA (i.e., UMTS) Systems, Qos and QoE, Internet of Things (IOT) ,WRAN and CRAN, Vehicular Adhoc Network

Reference Material:

8. J. Zander and S.-L. Kim, Radio Resource Management for Wireless Networks, Artech House Publishers, latest Edition
9. S. Kyriazakos and G. Karesos, Practical Radio Resource Management in wireless networks, Latest Edition.
10. T. Janevski, Traffic Analysis and Design of Wireless IP Networks, Latest Edition Jamalipour, The Wireless Mobile Internet, Wiley, Latest Edition
11. M. Hassan and R. Jain, High Performance TCP/IP Networking, Latest Edition
12. T. S. Rappaport, Wireless communications, Principles and Practice, Latest Edition
13. M. Schwartz, Broadband Integrated Networks, Latest Edition

Course Title: Advanced Web Engineering

Course Code: CSEC-731
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course is aimed to provide students with conceptual understanding required to develop web applications and web services according to international standards**.**

Course Syllabus:

The Need for Web Engineering. Web Effort Estimation. Web Productivity Measurement and Benchmarking. Web Quality. Web Usability. Web System Reliability and Performance. Web Application Testing. Process Improvement in Small Settings. Conceptual Modeling of Web Applications. Model-Based Web Application Development. W2000: A Modeling Notation for Complex Web Applications. Statistics Analysis. W3C Web Content Accessibility Guidelines. Internationalization. Classroom Group Assignements: Instructors are advised to ask students to review the Current Status of W3C Specifications: HTML, CSS, Best Practices for Authoring HTML, Web Fonts, SMIL, Media Access, Timed Text, SVG, Web Real Time Communication, Audio, Mobile Web Authoring, Device Independence Authoring, CSS Mobile, SVG Tiny,

XHTML For Mobile, Mobile Web Applications, Mobile Web for Social Development, Geospatial, Accessible Rich Internet Applications (WAI-ARIA), DOM, DOM events, Declarative Web Applications, JavaScript APIs, Mobile Web Applications, WICD, Widgets, XBL, Web Components, Web Performance. [W3C website]

Course Outline:

1. The Need for Web Engineering: Introduction, Web Applications Versus Conventional Software, The Need for an Engineering Approach, Empirical Assessment [TB:Ch.1]
2. Web Effort Estimation: Introduction. Effort Estimation Techniques, Measuring Effort Prediction Power and Accuracy, Which Is the Most Accurate Prediction Technique? Case Study: Data Validation, Variables and Model Selection, Extraction of effort Equation Model Validation. [TB:Ch.2]
3. Web Productivity Measurement and Benchmarking: Introduction, Productivity Measurement Method, Case Study: Productivity Measure Construction, Productivity Analysis. [TB:Ch.3]
4. Web Quality: Different Perspectives of Quality, Evaluating Web Quality using WebQEM, Case Study: Evaluating the Quality of Two Web Applications: External Quality Requirements, Designing and Executing the Elementary Evaluation, Designing and Executing the Partial/Global Evaluation, Analysis and Recommendations. [TB:Ch.4]
5. Web Usability: Principles and Evaluation Methods: Introduction, Usability in the Software Lifecycle, Web Usability, Web Usability Criteria, Evaluation Methods, Automatic Tools To Support Evaluations, Evaluation of the DEI Application: Design Inspection, Web Usage Analysis.[TB:Ch. 5]
6. Web System Reliability and Performance: Introduction, Web Application Services, Applications Predominantly Dynamic, Testing Loop Phase, Performance Improvements, Case Study: Service Characterization and Design, Testing Loop Phase, System Consolidation and Performance Improvement. [TB:Ch.6]
7. Web Application Testing: Introduction, Web Application Testing: Challenges and Perspectives, Web Application Representation Models, Unit Integration and System Testing of a Web Application, Strategies for Web Application Testing, Tools for Web Application Testing. [TB:Ch.7]
8. An Overview of Process Improvement in Small Settings: Initiating SPI Efforts, Process Improvement Cycle, Process Assessments, Implementation in Small Settings. [TB:Ch.8]
9. Conceptual Modeling of Web Applications: The OOWS Approach: Introduction, A Method to Model Web Applications, A Strategy To Develop the Web Solution, Case Study: *Valencia CF Web Application.* [TB:Ch.9]
10. Model-Based Web Application Development: The OOHDM approach, Building an Online CD Store with OOHDM, From Design to Implementation, Discussion and Lessons Learned. [TB:Ch.10]
11. W2000: A Modeling Notation for Complex Web Applications: Introduction, Modeling Elements, Models, Example Application: Information Model, Navigation Model, Presentation Model, 4 Service Model. [TB:Ch.11]
12. Statistics Analysis: Describing Individual Variables, Types of Variables, Descriptive Statistics, The Normal Distribution, Overview of Sampling Theory, Other Probability Distributions, Identifying Relationships in the Data: Chi-Square Test for Independence,

Correlation Analysis, Regression Analysis Analysis of Variance (ANOVA), Comparing Two Estimation Models. [TB:Ch.12]

13. W3C Web Content Accessibility Guidelines: Introduction to Web Accessibility, Essential Components of Web Accessibility, How People with Disabilities Use the Web, Improving the Accessibility of Your Web Site, Managing Accessibility, Evaluating Web Accessibility. Standards, guidelines, and techniques for making accessible websites: WCAG, ATAG, UAAG, WAI-ARIA. [W3C website]
14. Internationalization: Internationalization of Web Design and Applications, Internationalization of Web Architecture, Internationalization of XML, Internationalization of Web Services. [W3C website]

Classroom Group Assignments: Instructors are advised to ask students to review the Current Status of W3C Specifications: HTML, CSS, Best Practices for Authoring HTML, Web Fonts, SMIL, Media Access, Timed Text, SVG, Web Real Time Communication, Audio, Mobile Web Authoring, Device Independence Authoring, CSS Mobile, SVG Tiny, XHTML For Mobile, Mobile Web Applications, Mobile Web for Social Development, Geospatial, Accessible Rich Internet Applications (WAI-ARIA), DOM, DOM events, Declarative Web Applications, JavaScript APIs, Mobile Web Applications, WICD, Widgets, XBL, Web Components, Web Performance. [W3C website]

Reference Material:

1. Web Engineering: A Practioner's Approach by Roger Pressman and David Lowe, McGraw-Hill Science/Engineering/Math; 1st Edition (January 22, 2008). ISBN-10: 0073523291
2. Web Engineering by Emilia Mendes and Nile Mosley, Springer; Softcover reprint of hardcover 1st Edition. 2006 edition (November 9, 2010). ISBN-10: 3642066453
3. W3C Online Resources

Course Title: Agent Based Modeling

Course Code: CSEC-708
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Introduction to agent based modeling. Introduction to Net Logo. Complexity in Social Worlds. Net Logo Commands. Net Logo Procedures. Model properties (Why agent-based objects?, Agents, environments, and timescales).Biological systems: fireflies, flocking, slime mold, bees, ants (flocking behavior slime mold).Biological systems: predator/prey, debugging (Verification and validation).Social systems: segregation, Schelling, Micro motives and Macro behavior. A self-forming neighborhood model. Cellular automata. Critical phenomena. Sand piles. Current research topics in Agent Based Modeling.

Reference Material:

10. *Agent-Based Models*, Nigel Gilbert, SAGE Publications, 2008

Course Title: Business Process Management Trends & Technologies

Course Code: ITEC-710
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course will cover topics fundamentals and principles of Business Process Management. The course is designed to achieve following objectives:

- Understand the key terms and concepts in BPM
- Learn the major methodologies and techniques for implementing BPM
- Discover the various technologies that support BPM
- Learn what a BPM management and process-centric organization is and how it
- works
- Understand the metrics and measurements critical to managing processes
- Learn how to identify critical processes

Course Syllabus:

Introduction d BPM, Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization. Evolution of Enterprise Systems Architectures. Business Process Modeling. Process Orchestrations. Process Choreographies. .Modeling in BPMN. Properties of Business Processes. Workflow Management Architectures, Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes. Business Process Management Methodology.Business Process Management Technologies.

Course Outline:

1. Introduction: Motivation and Definitions, Business Process Lifecycle, Classification of Business Processes, Goals, Structure, and Organization.
2. Evolution of Enterprise Systems Architectures: Traditional Application Development, Enterprise Applications and their Integration, Enterprise Modeling and Process Orientation, Workflow Management, Enterprise Services Computing.
3. Business Process Modeling: Foundation, Conceptual Model and Terminology, Abstraction Concepts, From Business Functions to Business Processes, Activity Models and Activity Instances, Process Models and Process Instances, Process Interactions, Modeling Process Data, Modeling Organization, Modeling Operation, Business Process Flexibility**,** Architecture of Process Execution Environments.
4. Process Orchestrations: Control Flow Patterns, Petri Nets, Event-driven Process Chains, Workflow Nets, Graph-Based Workflow Language, Business Process Model and Notation.
5. Process Choreographies: Motivation and Terminology, Development Phases, Process Choreography Design, Process Choreography Implementation, Service Interaction Patterns, Choreography Modeling in BPMN.
6. Properties of Business Processes: Data Dependencies, Object Lifecycle Conformance, Structural Soundness, Soundness, Relaxed Soundness, Weak Soundness, Lazy Soundness, Soundness Criteria Overview.
7. Business Process Management Architectures: Workflow Management Architectures,

Flexible Workflow Management, Web Services and their Composition, Advanced Service Composition, Data-Driven Processes: Case Handling.

8. Business Process Management Methodology: Dependencies between Processes, Methodology Overview, Phases in Detail.
9. Business Modeling Specifications
10. Six Sigma and Lean
11. BPM Implementation and Governance
12. BPM Technology (BPM Suites)

Reference Material:

1. Business Process Management: Concepts, Languages, Architectures by Mathias Weske, Springer; 2nd Edition(May 3, 2012). ISBN-10: 3642286151.
2. Business Process Management Common Body Of Knowledge by Yvonne Lederer Antonucci, et. al., CreateSpace Independent Publishing Platform (March 8, 2009). ISBN-10: 1442105666
3. Business Process Change: A Guide for Business Managers and BPM and Six Sigma by Paul Harmon (2007) Professionals (2nd edition). Morgan Kaufmann Publishers.
4. Process Management: A Guide for the Design of Business Processes by Jörg Becker, Martin Kugeler and Michael Rosemann, Springer; 2nd Edition (January 21, 2011). ISBN-10: 3642151892
5. Business Process Management, 2nd Edition: Practical Guidelines to Successful Implementations by John Jeston and Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
6. Process Management: Practical Guidelines to Successful Implementation by T.S. Malik, Global India Publications Pvt Ltd; 1st Edition (December 31, 2009). ISBN-10: 9380228368
7. Business Process Management: Practical Guidelines to Successful Implementations by John Jeston & Johan Nelis, Butterworth-Heinemann; 2nd Edition (March 24, 2008). ISBN-10: 0750686561
8. BPMN Method and Style with BPMN Implementer's Guide: A structured approach for business process modeling and implementation using BPMN 2.0 by Bruce Silver, Cody-Cassidy Press (October 17, 2011). ISBN-10: 0982368119
9. Workflow Modeling: Tools for Process Improvement and Application Development, 2nd Edition by Alec Sharp and Patrick McDermott, Artech House; 2nd Edition (October 31, 2008). ISBN-10: 1596931922
10. Process Analysis and Improvement: Tools and Techniques by Seppanen, Marvic S., Kumar, Sameer & Chandra, Charu (2005). McGraw-Hill
11. Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals (The MK/OMG Press) by Paul Harmon and Business Process Trends, Morgan Kaufmann; 2nd Edition (July 27, 2007). ISBN-10: 0123741521

Course Title: Computer Vision

Course Code: CSEC-722
Course Structure: Lectures: 3 / Labs: 0
Credit Hours: 3
Prerequisites: Linear Algebra

Course Objectives:
The course concentrates on the knowledge of Computer Vision and its importance in Computing area having multiple applications.

Course Syllabus:
Introduction to Computer Vision, Image formation, Processing, Feature Detection and Matching, Alignment, Image Stitching, Dense Motion Estimation, Structure from Motion, Recognition, Computational Photography, Stereo Correspondence, 3D Reconstruction, Image-based Rendering, Statistical Texture Description, Methods Based on Spatial Frequencies, Laws' Texture Energy Measures, Texture Recognition Method Applications.

Course Syllabus:

1. Computer Vision an Introduction.
2. Image formation.
3. Image Processing.
4. Feature Detection and Matching.
5. Feature-based Alignment.
6. Image Stitching.
7. Dense Motion Estimation.
8. Structure from Motion.
9. Recognition.
10. Computational Photography.
11. Stereo Correspondence.
12. 3D Reconstruction.
13. Image-based Rendering.
14. Statistical Texture Description, Methods Based on Spatial Frequencies, Co-occurrence Matrices, Edge Frequency, Primitive Length (Run Length).
15. Laws' Texture Energy Measures, Fractal Texture Description, Multiscale Texture Description – Wavelet Domain Approaches, other Statistical Methods of Texture Description, Syntactic Texture Description Methods, Shape Chain Grammars, Graph Grammars, Primitive Grouping in Hierarchical Textures, Hybrid Texture Description methods, Texture Recognition Method Applications.

Reference Material:

1. Computer Vision Algorithms and Applications by Richard Szeliski, Springer, (2011), ISBN-13: 978-1848829343
2. Image Processing, Analysis, and Machine Vision by Milan Sonka, CL Engineering, 3rd Edition, (2008), ISBN-13: 9780495082521
3. Computer Vision: Models, Learning, and Inference by Dr Simon J. D. Prince, Cambridge University Press, (2012), ISBN-13: 978-1107011793

Course Title: Enterprise Data Center Design and Methodology

Course Code: ITEC-705

Course Structure: Lectures: 3/Labs: 0

Credit Hours: **3**

Prerequisites: None

Course Objectives:

The course is aimed to introduce students with the essential knowledge about Data Center and methodologies that optimizes availability, scalability, and performance for that environment and provides centralized management services.

Course Syllabus:

Introduction to Data Centers, Application Architecture Models, Data Center Architecture, Data Center Services. Data Center Requirements. **S**erver Architecture. Application Architectures. Data Center Design. Network Infrastructure. Power Distribution. **D**ata Center Security. Server Load-Balancing. Designing the Data Center Infrastructure. Integrating Security into the Infrastructure. Server Performance Metrics. Server Capacity Planning. Performance Metrics of Data Center Devices.

Course Outline:

1. Overview of Data Centers: Introduction to Data Centers, Application Architecture Models, Data Center Architecture, Data Center Services.
2. Data Center Requirements: Data Center Pre-requisites, Budget Constraints, Selecting Geographical Location, Retrofitting.
3. Server Architecture: Network Attachment, Client and Server Packet Processing, TCP and Server Applications, UDP and Server Applications, Server Availability, Configuring a Web Server, Network Architecture Design Options.
4. Application Architectures: Taxonomy of Applications and Hosted Servers, Integration of Applications, Multitier Applications, Network Architecture Considerations, Multitier Design.
5. Data Center Design: Characteristics of an Outstanding Design, Guidelines for Planning a Data Center, Types of Server Farms and Data Centers, Data Center Topologies, Fully Redundant Layer 2 and Layer 3 Designs, Fully Redundant Layer 2 and Layer 3 Designs with Services, Design and Plan against Vandlism, Data Center Case Studies.
6. Network Infrastructure: Modular Cabling Design, Points of Distribution, Internet Access, Best Practices.
7. Power Distribution: Estimating Power Needs, UPS, Generators, UPDs, ESD.
8. Data Center Security: The Need for a Secure Data Center, Vulnerabilities and Common Attacks, Network Security Infrastructure, Security Fundamentals, Data Center Security Framework.
9. Server Load-Balancing: Introduction to Load Balancing, Key Concepts of Load Balancing, Redundancy Protocol, Connection and Session State Failover, Generic Load Balancer Architecture.
10. Designing the Data Center Infrastructure: Topology Overview, Switching Paths, Using VLANs to Virtualize the Physical Data Center Infrastructure, Link Redundancy and Load Distribution, Spanning-Tree Considerations, Internal Redundancy Considerations, Over view of Layer 2 & Layer 3 Data Center Design refrence to Infrastucture, Using OSPF in Data Center Design, Using EIGRP in Data Center Design, Layer 3 Configuration.
11. Integrating Security into the Infrastructure: Defining Security Zones, Internet Edge,

Campus Core, Intranet Server Farms, Server-Farm Design Alternatives, Management Network.

12. Server Performance Metrics: Benchmarking, Aspects of System Performance, Factors Impacting CPU Performance, SPEC Benchmarking.
13. Server Capacity Planning: Server Sizing and Capacity Planning, Identifying the Slowest Link, Capacity Planning for Servers.
14. Performance Metrics of Data Center Devices: Traffic Patterns Overview, Performance Metrics Overview, Load Balancer and SSL Offloader Metrics.
15. Best Practices in IT: Defining Best Practices, Deploying Best Practices, Benefits of BP, Systems Management BP, Servers Cluster BP, Data Storage BP, Network Management BP, Documentation Best Practices.

Reference Material:

1. Data Center Fundamentals by Mauricio Arregoces and Maurizio Portolani, Cisco Press (December 14, 2003). ISBN-10: 1587050234
2. Administering Data Centers: Servers, Storage, and Voice over IP by Kailash Jayaswal, Wiley; 1st Edition (November 28, 2005). ISBN-10: 047177183X
3. The Datacenter as a Computer: An Introduction to the Design of Warehouse-Scale Machines by Urs Hoelzle and Luiz Andre Barroso, Morgan and Claypool Publishers; 1st Edition (May 29, 2009).ISBN-10: 159829556X

Course Title: Information Security

Course Code: ITEC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None
Course Syllabus:

Introduction to Information Security, The Need for Security, Legal, Ethical, and Professional Issues in Information Security, Risk Management, Planning for Security, Security Technology, Security Technology, Cryptography, Physical Security, Implementing Information Security, Security and Personnel, Information Security Maintenance and eDiscovery.

Course Outline:

1. Introduction to Information Security: History of IS, What is Security, CNSS Security model, Component of Information Systems, Balancing Information Security and Access, Approaches to Information Security Implementation, The Security System Development Life Cycle, Security Professionals and the Organizations, Communities of Interest.
2. The Need for Security: Business Need, Threats, Attacks, Secure Software Development.
3. Legal, Ethical, and Professional Issues in Information Security: Laws and Ethics in Information Security, International Laws and Legal Bodies, Ethics and Information Security, Codes of Ethics and Professional Organizations, International Agencies.
4. Risk Management: Introduction to RM, Risk Identification, Risk assessment, Risk Control Strategies, Selecting a risk Control Strategy, Quantitative VS qualitative Risk Control Practices, Risk Control Practices.
5. Planning for Security: Information Security Planning and Governance, Information Security Policies, Standards, and Governance, Information Security Blue Prints,

Continuity Strategies.

6. Security Technology: Firewalls, VPNs, and Wireless: Access Control, Firewalls, Protecting Remote Connections.
7. Security Technology: Intrusion Detection and Prevention Systems and Other Security Tools: Intrusion Detection and Presentation Systems, Honeyspots, Honeynets, and Padded Cell Systems, Scanning and Analysis Tools, Biometric Access Control.
8. Cryptography: Foundations of Cryptography, Cipher Methods, Cryptographic Algorithms, Cryptography Tools, Protocols for secure Communications, Attack on Cryptosystems.
9. Physical Security: Physical Access Controls, Fire Security and Safety, Failure of Supporting Utilities and Structural Collapse, Interception of Data, Considerations for Physical Security.
10. Implementing Information Security: Information Security Project Management, Technical Aspects of Implementation, Nontechnical Aspects of Implementation, Information Security Certifications.
11. Security and Personnel: Positioning and Staffing Function, Credentials of Information Security Professionals, Employment Policies and Practices, Security Considerations for Non-employees.
12. Information Security Maintenance and eDiscovery: Security Management Maintenance Models, Digital Forensics.

[Instructors need to devise a contents delivery plan]

Reference Material:

1. Principles of Information Security Michael E. Whitman and Herbert J. Mattord, Course Technology; 4th Edition (January 1, 2011). ISBN-10: 1111138214
2. Information Systems Security Professional Study Guide by James M. Stewart, Mike Chapple, and Darril Gibson, Sybex; 6th Edition (July 10, 2012). ISBN-10: 1118314174
3. Information Security: An Integrated Collection of Essays by Marshall D. Abrams, Harold J. Podell, Sushil Jajodia, Ieee Computer Society (September 1994). ISBN-10: 0818636610
4. Secrets and Lies: Digital Security in a Networked World by Bruce Schneier, Wiley; 1st Edition (January 30, 2004).
5. Information Security Management Handbook By Harold F. Tipton, Micki Krause, Auerbach Publications; 6th Edition (March 17, 2008). ISBN-10: 1420067087

Course Title: Information Theory

Course Code: CSEC-725
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Probability and Statistics

Course Objectives:

The course will introduce students with key concepts of Information Theory.

Course Syllabus:

Information Sources. Pair Processes. Block Independent Channels. Entropy. The Entropy Ergodic Theorem. Distortion and Approximation. Approximating Random Vectors and Processes. Distortion and Entropy. Relative Entropy. Information Rates. Distortion and Information. Ergodic Theorems for Densities. Source Coding Theorems. Asynchronous Block Codes, Sliding-Block

Source Codes, Geometric Interpretation, Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Course Outline:

1. Information Sources: Probability Spaces and Random Variables, Random Processes and Dynamical Systems, Distributions, Standard Alphabets, Expectation, Asymptotic Mean Stationarity, Ergodic Properties.
2. Pair Processes: Channels, Codes, and Couplings, Pair Processes, Channels, Stationarity Properties of Channels, Extremes: Noiseless and Completely Random Channels, Deterministic Channels and Sequence Coders, Stationary and Sliding-Block Codes, Block Codes, Random Punctuation Sequences, Memoryless Channels, Finite-Memory Channels, Output Mixing Channels.
3. Block Independent Channels, Conditionally Block Independent Channels, Stationarizing Block Independent Channels, Primitive Channels, Additive Noise Channels, Markov Channels, Finite-State Channels and Codes, Cascade Channels, Communication Systems, Couplings, Block to Sliding-Block: The Rohlin-Kakutani Theorem.
4. Entropy: Entropy and Entropy Rate, Divergence Inequality and Relative Entropy, Basic Properties of Entropy, Entropy Rate, Relative Entropy Rate, Conditional Entropy and Mutual Information, Markov Approximations, Relative Entropy Densities.
5. The Entropy Ergodic Theorem: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, The Asymptotic Equipartition Property.
6. Distortion and Approximation: Distortion Measures, Fidelity Criteria, Average Limiting Distortion, Communications Systems Performance, Optimal Performance, Code Approximation.
7. Approximating Random Vectors and Processes, The Monge/Kantorovich/Vasershtein Distance. Variation and Distribution Distance, Coupling Discrete Spaces with the Hamming Distance, Process Distance and Approximation, Source Approximation and Codes, d-bar Continuous Channels.
8. Distortion and Entropy: The Fano Inequality, Code Approximation and Entropy Rate, Pinsker's and Marton's Inequalities, Entropy and Isomorphism, Almost Lossless Source Coding, Asymptotically Optimal Almost Lossless Codes, Contents xv, Modeling and Simulation.
9. Relative Entropy: Divergence, Conditional Relative Entropy, Limiting Entropy Densities, Information for General Alphabets, Convergence Results.
10. Information Rates: Information Rates for Finite Alphabets, Information Rates for General Alphabets, A Mean Ergodic Theorem for Densities, Information Rates of Stationary Processes, The Data Processing Theorem, Memoryless Channels and Sources,
11. Distortion and Information: The Shannon Distortion-Rate Function, Basic Properties, Process Definitions of the Distortion-Rate Function, The Distortion-Rate Function as a Lower Bound, Evaluating the Rate-Distortion Function.
12. Ergodic Theorems for Densities: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, Ergodic Theorems for Information Densities.
13. Source Coding Theorems:Source Coding and Channel Coding, Block Source Codes for AMS Sources, Block Source Code Mismatch, Block Coding Stationary Sources, Block Coding AMS Ergodic Sources Subadditive Fidelity Criteria.
14. Asynchronous Block Codes, Sliding-Block Source Codes, Geometric Interpretation,

Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Reference Material:

1. Entropy and Information Theory by Robert M. Gray, Springer; 2nd Edition. Edition (February 3, 2011). ISBN-10: 1441979697
2. Information and Coding Theory by Gareth A. Jones, J.Mary Jones, Springer; 2000 Edition (July 31, 2000). ISBN-10: 1852336226
3. Information Theory And Evolution by John Scales Avery, World Scientific Publishing Company; 2nd Edition (July 16, 2012). ISBN-10: 9814401234
4. Elements of Information Theory by Thomas M. Cover, Joy A. Thomas, Wiley-Interscience; 2nd Edition (July 18, 2006). ISBN: 0-471-24195-4

Course Title: Intelligent Multi Agent Systems

Course Code: CSEC-736
Course Structure: Lectures: 3/Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:

Intelligent Multi Agent Systems is an important area having multiple applications in Computing. The course will introduce students with key concepts and knowledge of Intelligent Multi Agent Systems.

Course Syllabus:

Basics of Intelligent Agents, Multi agent Systems, Agent Interaction Protocols, Distributed Problem Solving & Planning, Distributed Planning, Search Algorithm for Agents, Distributed Rational Decision Making, Learning in Multi agent Systems, Computational Organization Theory, Formal Methods in Distributed Artificial Intelligence (DAI), Industrial and Practical Applications of DAI, Design: The Conceptual Context, The Process, System Implementation, System Operation, Development Tools. Groupware and Computer Supported Cooperative Work. Distributed Models for Decision Support.Concurrent Programming for DAI.

Course Outline:

1. Intelligent Agents: What are Agents, Intelligent Agents, Agents& Expert Systems, Abstract Architecture for Intelligent Agents, Concrete Architecture for Intelligent Agents, Agent Programming, METATEM Multi Agent systems.
2. Multi agent Systems: Characteristics of Multi agent Environment, Agent Communications, Knowledge Query & Implementation Language (KQML), Knowledge Interchange Format (KIF), Ontologies.
3. Agent Interaction Protocols: Coordination & Cooperation Protocol, Contract-net, blackboard systems, Multi agent belief Maintenance, Market Mechanism.
4. Distributed Problem Solving & Planning: Task Structure, Task Sharing, Result Sharing.
5. Distributed Planning: Centralized Planning for Distributed Plan, Distributed Planning for Centralized Plans, Distributed Planning for Distributed Plans, Distribution Plan Representation & Execution.

6. Search Algorithm for Agents: Filtering Algorithm, Hyper Resolution Based Consistency Algorithm, Asynchronous Backtracking & Weak Commitment Search, Path Finding Problem: Asynchronous Dynamic Programming, A*, Moving Target Search, Real Time Bidirectional Search, Real Time Multi Agent System.
7. Distributed Rational Decision Making: Evaluation Criteria, Voting, Auctions, Bargaining, General Equilibrium Market Mechanism, Contract Nets, Coalition Formation.
8. Learning in Multi agent Systems: General Characterization, Learning & Activity Coordination, Learning About & From Other Agents, Learning & Communication.
9. Computational Organization Theory: Organization, Computational Organization Theory, Modeling Organizations Concepts, Agent and Agency, Organizational Design, Task, Technology, Dynamics, Methodological Issues: Virtual Experiments and Data Collection, Validation and Verification, Computational Frameworks.
10. Formal Methods in DAI (Distributed Artificial Intelligence): Logic-Based Representation and Reasoning, Cognitive Primitives, BDI Implementations: Coordination, Communications; Social Primitive; Tools and Systems: Direct Implementations & Partial Implementations, Traditional Approaches.
11. Industrial and Practical Applications of DAI: Overview of the Industrial Life-Cycle, Use of Agents in the Life Cycle, Agents in Product Design, Agents in Planning and Scheduling, Agents in Real-Time Control, Industry Constrains in the Life Cycle of an Agent-Based System: Requirements, Positioning, and Specification, Design: The Conceptual Context, Design: The Process, System Implementation, System Operation, Development Tools.
12. Groupware and Computer Supported Cooperative Work: Groupware, Computer Supported Cooperative Work, Aspects of Groupware, Keepers, Coordinators, Communicators, Team-Agents, Agent Models, Multi-Aspect Groupware, Social and Group Issues in Designing Groupware Systems, Supporting Technologies and Theories, Keepers, Coordinators, Communicators, Team-Agents, Other Taxonomies of Groupware, Space/Time Matrix, Application Area, Groupware and Internet, Internet as Infrastructure Internet as Presumed Software.
13. Distributed Models for Decision Support: Decision Support Systems, The Decision Support Problem, Knowledge-Based Decision Support, Distributed Decision Support Models, An Agent Architecture for Distributed Decision Support Systems, Information Model, Knowledge Model, Control Model, Application Case Studies, Environmental Emergency Management, Energy Management, Road Traffic Management.
14. Concurrent Programming for DAI: Defining Multi-agent Systems, Actors, Semantics of Actors, Equivalence of Actor Systems, Actors and Concurrent Programming, Representing Agents as Actors, Mobility of Actors, Resource Model, Agent Ensembles, Customizing Execution Contexts, Interaction Protocols, Coordination, Naming and Groups.

Reference Material:

1. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence by Gerhard Weiss, The MIT Press (July 31, 2000). ISBN-10: 0262731312
2. Design of Agent-Based Models by Tomas Salamon, Tomas Bruckner (September 1, 2011). ISBN-10: 8090466117
3. Intelligent Software Agents: Foundations and Applications by Walter Brenner, RüdigerZarnekow, Hartmut Wittig and A.S. Rudd, Springer; Softcover reprint of the original 1st Edition (July 31, 2012). ISBN-10: 3642804861

4. Agent Technology for E-Commerce by Maria Fasli, Wiley; 1st Edition (March 6, 2007). ISBN-10: 0470030305

Course Title: Knowledge Management Systems & Technologies

Course Code: IT-5841
Course Structure: Lectures:3 / Labs: 0
Credit Hours: 3
Prerequisites: None
Course Objectives:

By the end of the course, students should be able to:

- Appraise current thought on knowledge management in the light of contemporary debates on knowledge productivity, strategic capability and organizational learning;
- Apply theories of knowledge management relevant to current workplace practice;
- Apply the tools and techniques of knowledge management.

Course Syllabus:

History and paradigms of knowledge management. Types of knowledge. Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents. Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies. KM Processes: Discovery/ Detection, Capture and Codification, Organization, Sharing, transfer, Acquisition, Verification, Utilization, Creation, Reuse. KM Frameworks and Models. KM Frameworks and Models. Knowledge Capture and Codification. Knowledge Codification. Knowledge Taxonomies. Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence. Strategic and Practical Implications of Knowledge Capture and Codification. Knowledge Sharing and Communities of Practice. Knowledge Application. The Role of Organizational Culture. Knowledge Management Tools. Knowledge Management Strategy. The Value of Knowledge Management. Organizational Learning and Organizational Memory. The KM Team. The KM Profession, The Ethics of KM.

Course Outline:

1. History and paradigms of knowledge management; Types of knowledge: Explicit Knowledge, Tacit Knowledge, Embedded Knowledge, Embrained knowledge, Embodied knowledge, Encoded knowledge, Encultured knowledge; Organizational Internal & External Knowledge; Managers' Knowledge; Personal knowledge. Knowledge Economy: Knowledge Revolution, Globalization, Knowledge Economy, Knowledge Workers, Knowledge Artifacts, Knowledge Agents; Knowledge Management: Definitions, Knowledge management Cycles, Benefits of KM, Implications for KM, KM Core Competencies.
2. KM Processes: Knowledge Discovery/ Detection, Knowledge Capture and Codification, Knowledge Organization, Knowledge Sharing, Explicit Knowledge Sharing, Knowledge transfer, Knowledge Acquisition, Knowledge Verification, Knowledge Utilization, Knowledge Creation, Knowledge Reuse;
3. KM Frameworks and Models: The SECI Model, Alen Frost's Model, Boisot's KM Model, Hedlund's KM Model, Earl's KM Model, Carayannis's KM Model, Wiig's KM Model, Edvinsson's Model of Intellectual Capital, Snowden's KM Model, Inkpen & Dinur's KM

Model.

4. KM Frameworks and Models: Van Buren's Model of IC Management, Bukowitz & Williams's KM Model, Gamble & Blackwell's KM Model, Demerest's KM Model, Frid's KM Model, Stankosky & Baldanza's KM Framework, Kogut & Zander's KM Model, Botha et. al. KM Model, Integrated Knowledge Management Model.
5. Knowledge Capture and Codification: Tacit Knowledge Capture at the Individual, Group, and Organizational Levels, xplicit Knowledge Codification, Cognitive Maps, Decision Trees, Knowledge Taxonomies, The Relationships among Knowledge Management, Competitive Intelligence, Business Intelligence, and Strategic Intelligence; Strategic and Practical Implications of Knowledge Capture and Codification
6. Knowledge Sharing and Communities of Practice: Sociograms and Social Network Analysis, Knowledge-Sharing Communities, Types of Communities, Roles and Responsibilities in CoPs, Knowledge Sharing in Virtual CoPs, Obstacles to Knowledge Sharing, Strategic and Practical Implications of Knowledge Sharing.
7. Knowledge Application: Knowledge Application at the Individual Level, Characteristics of Individual Knowledge Workers, Bloom ' s Taxonomy of Learning Objectives, Task Analysis and Modeling, Knowledge Application at the Group and Organizational Levels, Knowledge Reuse, Knowledge Repositories, E-Learning and Knowledge Management Application, Strategic & Practical Implications of Knowledge Application.
8. The Role of Organizational Culture: Different Types of Cultures, Organizational Culture Analysis, The Effects of Culture on Individuals, Organizational Maturity Models, KM Maturity Models, CoP Maturity Models, Transformation to a Knowledge-Sharing Culture, Impact of a Merger on Culture, Impact of Virtualization on Culture, Strategic and Practical Implications of Organizational Culture.
9. Knowledge Management Tools: Knowledge Capture and Creation Tools, Content Creation Tools, Data Mining and Knowledge Discovery, Blogs, Mashups, Content Management Tools, Folksonomies and Social Tagging/Bookmarking, Personal Knowledge Management (PKM), Knowledge Sharing and Dissemination Tools, Groupware and Collaboration Tools, Wikis, Social Networking, Web 2.0, and KM 2.0, Knowledge Acquisition and Application Tools, Intelligent Filtering Tools, Adaptive Technologies, Strategic and Practical Implications of KM Tools and Techniques.
10. Knowledge Management Strategy: Developing a Knowledge Management Strategy, Knowledge Audit, Gap Analysis, The KM Strategy Road Map, Balancing Innovation and Organizational Structure, Types of Knowledge Assets Produced.
11. The Value of Knowledge Management: KM Return on Investment (ROI) and Metrics, The Benchmarking Method, The Balanced Scorecard Method, The House of Quality Method, The Results-Based Assessment Framework, Measuring the Success of Communities of Practice.
12. Organizational Learning and Organizational Memory: How Do Organizations Learn and Remember? Frameworks to Assess Organizational Learning and Organizational Memory, The Management of Organizational Memory, Organizational Learning, The Lessons Learned Process, Organizational Learning and Organizational Memory Models, A Three-Tiered Approach to Knowledge Continuity.
13. The KM Team: Major Categories of KM Roles, Senior Management Roles, KM Roles and Responsibilities within Organizations, The KM Profession, The Ethics of KM.

Reference Material:

1. Essentials of Knowledge Management: Concepts, Theories and Practices by M. A. Pasha & S. Pasha, Innovators Knowledge Services (2012). ISBN:978-969-9791-04-8
2. Knowledge Management In Theory And Practice by Kimiz Dalkir, The MIT Press; 3rd Edition (March 4, 2011). ISBN-10: 0262015080
3. The Knowledge Management Toolkit: Orchestrating IT, Strategy, and Knowledge Platforms by Amrit Tiwana, Prentice Hall; 2nd Edition (August 29, 2002). ISBN-10: 013009224X
4. Principles of Knowledge Management: Theory, Practice and Cases by Elie Geisler and Nilmini Wickramasinghe, M.E.Sharpe (January 15, 2009). ISBN-10: 0765613220
5. Knowledge Management: Concepts, Methodologies, Tools and Applications (6-volume set) by Murray E. Jennex, IGI Global; Reprint edition (August 10, 2007). ISBN-10: 1599049333

Course Title: Multimedia Systems Theory & Principles

Course Code: CSEC-716
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course introduces students with theory and principles of multimedia contents constituting multimedia system.

Course Syllabus:

Introduction to Multimedia and Tools, Graphics and Image Data Representations, Color in Image and Video, Basics of Digital Audio, Lossless Compression Algorithms, Lossy Compression Algorithms, Image Compression Standards, Basic Video Compression Techniques, MPEG Video Coding MPEG-1, 2, 4-7; Basic Audio Compression Techniques, MPEG Audio Compression.

Course Outline:

1. Introduction to Multimedia: What is Multimedia? Multimedia and Hypermedia, Overview of Multimedia Software Tools. [TB1: Ch. 1]
2. Graphics and Image Data Representations: Graphics/Image Data Types, Popular File Formats. [TB1: Ch. 3]
3. Color in Image and Video: Color Science, Color Models in Images, Color Models in Video Fundamental Concepts in Video: Types of Video Signals, Analog Video, Digital Video. [TB1: Ch. 4, 5]
4. Basics of Digital Audio: Digitization of Sound, MIDI: Musical Instrument Digital Interface, Quantization and Transmission of Audio. [TB1: Ch. 6]
5. Lossless Compression Algorithms: Introduction, Basics of Information Theory, Run-Length Coding, Variable-Length Coding (VLC), Dictionary-Based Coding, Arithmetic Coding, Lossless Image Compression. [TB1: Ch. 7]
6. Lossy Compression Algorithms: Distortion Measures, The Rate-Distortion Theory, Quantization, Transform Coding, Wavelet-Based Coding, Wavelet Packets. [TB1: Ch. 8]
7. Image Compression Standards: The JPEG Standard, The JPEG2000 Standard, The JPEG-LS Standard. [TB1: Ch. 9]
8. Basic Video Compression Techniques: Introduction to Video Compression, Video Compression Based on Motion Compensation, Search for Motion Vectors, H.261, H.263.

[TB1: Ch. 10]
9. MPEG Video Coding MPEG-1 and 2. [TB1: Ch. 11]
10. MPEG Video Coding MPEG-4, 7. [TB1: Ch. 12]
11. Basic Audio Compression Techniques: ADPCM in Speech Coding, G.726 ADPCM, Vocoders. [TB1: Ch. 13]
12. MPEG Audio Compression: Psychoacoustics, MPEG Audio. [TB1: Ch. 13]

Reference Material:

1. Fundamentals of Multimedia by Z. M. Li and M. S. Drew, Prentice Hall (2004), ISBN: 0-13-127256-X
2. Digital Multimedia by N. Chapman and J. Chapman. 2nd Edition, Wiley 2004, ISBN: 0-470-85890-7
3. The Technology of Video and Audio Streaming by David Austerberry, Focal Press; 2nd Edition (2004). ISBN-10: 0240805801
4. Multimedia Security: WaTermarking, Steganography, and Forensics by Frank Y. Shih, CRC Press; 1st Edition (2012), ISBN-10: 1439873313
5. Multimedia Computing by Daniel Cunliffe and Geoff Elliott, Lexden Publishing Ltd (2005). ISBN-10: 1904995055
6. Multimedia Foundations: Core Concepts for Digital Design by Vic Costello, Ed Youngblood and Susan Youngblood, Focal Press; 1st Edition (2012). ISBN-10: 0240813944

Course Title: Natural Language Processing

Course Code: CSEC-720
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Objective:

Natural language processing (NLP) is one of the most important technologies of the information age. Understanding complex language utterances is also a crucial part of artificial intelligence. Applications of NLP are everywhere because people communicate most everything in language: web search, advertisement, emails, customer service, language translation, radiology reports, etc. There are a large variety of underlying tasks and machine learning models behind NLP applications. Upon completing, you will be able to recognize NLP tasks in your day-to-day work, propose approaches, and judge what techniques are likely to work well. This course will cover the fundamental concepts in NLP.

Course Syllabus:

This course covers a range of topics in computational linguistics/natural language processing, including its introduction to Regular Expressions, Text Normalization, Edit Distance, N- gram Language Models, Naive Bayes and Sentiment Classification, Logistic Regression, Vector Semantics, Neural Networks and Neural Language Models, Part-of-Speech Tagging, Sequence Processing with Recurrent Networks, Formal Grammars of English/Urdu, Syntactic Parsing, etc.

Course Outline:

1. Introduction [TB1, Ch. 1]
2. Regular Expressions, Text Normalization, and Edit Distance: Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance, etc. [TB1, Ch. 2]
3. N-gram Language Models: N Grams, Evaluating Language Models, Generalization and Zeros, Smoothing, etc. [TB1, Ch.3]
4. Naive Bayes and Sentiment Classification: Naïve Bayes Classifiers and their training with examples, Its optimization for sentiment analysis and for other text classification, etc. [TB1, Ch.4]
5. Logistic Regression: Classification: The sigmoid; Learning in Logistics Regression; The Cross Entropy loss function; Gradient Descent, Regularization, etc. [TB1, Ch. 5]
6. Vector Semantics: Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF Weighting terms in the vector, etc. [TB1, Ch. 6]
7. Neural Networks and Neural Language Models: Units, The XOR problem, Feed Forward Neural Network, Training Neural Nets, etc. [TB1, Ch. 7]
8. Part-of-Speech Tagging: Word Classes, Penn POS Tagset, POS Tagging, HMM POS Tagging, etc. [TB1, Ch. 8]
9. Sequence Processing with Recurrent Networks: Simple Recurrent Networks, Applications of RNNs, Deep Networks, Managing Context in RNNs, etc. [TB1, Ch. 9]
10. Formal Grammars of English/Urdu: Constituency, Context Free Grammars, Rules of English/Urdu, Treebanks, etc. [TB1, Ch. 10]
11. Syntactic Parsing: Ambiguity, CKY Parsing, Partial Parsing, etc. [TB1, Ch. 11]

Reference Material:

1. Daniel Jurafsky and James H. Martin. 2018. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Third Edition. Prentice Hall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural Language Processing. MIT Press.
3. Steven Bird. 2009. Natural Language Processing with Python. O'Reilly. (Free on SearchWorks)
4. Philipp Koehn. 2010. Statistical Machine Translation. Cambridge.
5. Yoshua Bengio. 2009. Learning Deep Architectures for AI. Technical Report. (Free from Stanford network)
6. Frederick Jelinek. 1998. Statistical Methods for Speech Recognition. MIT Press.
7. James Allen. 1995. Natural Language Understanding. Benjamin/Cummings, 2ed. Psycholinguistics: Tanenhaus & Trueswell (2006), Human Sentence Processing website

Course Title: Grammar Engineering

Course Code: CSEC-733
Course Structure: Lectures: 3/ Lab: 1
Credit Hours: 4
Prerequisites:

Course Objective:
Natural language processing (NLP) enables computers to make use of data represented in human language (including the vast quantities of data available on the web) and to interact with computers on human terms. Applications from machine translation to speech recognition and web-based information retrieval demand both precision and robustness from NLP technology. Meetings these demands will require better hand-built grammars of human languages combined with sophisticated statistical processing methods. This course focuses on the implementation of linguistic grammars, drawing on a combination of sound grammatical theory and engineering skills.
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Course Syllabus:
Introduction, LFG, Templates, C & F description, Agreement, Determiners, Rules & alternations, Adjuncts, Obliques, Prepositions, Pronouns, Punctuation, Generation & Optimality, Complements, Uncertainty, Imperatives, Finite-State Morpholog, Free Word Order and the Shuffle Operator, Coordination

Course Outline:

1. 1.Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:
1. Crouch, Dick, Mary Dalrymple, Ronald M. Kaplan, Tracy Holloway King, John T. Maxwell III, und Paula Newman (2008). XLE Documentation. Palo Alto: Palo Alto Research Center.
2. Butt, Miriam, Tracy Holloway King, Maria-Eugenia Nino and Fred-erique Segond. 1999. A Grammar Writer's Cookbook. CSLI Publications.
3. Dalrymple, Mary. 2001. Lexical-Functional Grammar. Academic Press.
4. Kaplan, Ronald M. und John T. Maxwell III (1995). Constituent Coordination in Lexical-

5. Functional Grammar. In Dalrymple, Mary, Ronald M. Kaplan, John T. Maxwell III, und Annie
6. Zaenen (eds.)(1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications. First published in Proceedings of COLING-88, vol. 1 (1988). Budapest.
7. Kaplan, Ronald M. und Annie Zaenen (1989). Long-distance Dependencies, Constituent Structure, and Functional Uncertainty. In Baltin, Mark und Anthony Kroch (eds.), Alternative
8. Conceptions of Phrase Structure, pp. 17-42. Chicago University Press. Republished in Dalrymple et al. (eds.) (1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications.
9. Kaplan, Ronald M., John T. Maxwell III, Tracy Holloway King, und Dick Crouch (2004). Integrating Finite-state Technology with Deep LFG Grammars. Proceedings of the Workshop on Combining Shallow and Deep Processing for NLP. Proceedings of ESSLLI 2004.

Course Title: Reliability Engineering

Course Code: SEEC-701
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:

Introduction to Reliability Engineering. The Need for Reliable Software. Software Reliability Engineering Concepts. Basic Definitions. Software Reliability and System Reliability. The Dependability Concept. Reliability Modeling. Availability Modeling. Statistical Reliability Models for Software Reliability. Best Current Practices of software Reliability Engineering. Software Metrics for Reliability Assessment. Software Testing and Reliability. Software Reliability Tools. Review of Reliability Theory. Analytical Techniques and Basic Statistics for Reliability Engineering. Current research topics in Reliability Engineering.

Course Outline:

1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:

1. An Introduction to Reliability and Maintainability Engineering, Ebeling, C. E., Waveland Press, Inc., second edition. 2009 (ISBN 1-57766-625-9)
2. IEEE Recommended Practice in Software ReliabilityHandbook of Software Reliability Engineering by Michael R. Lyu. Published by IEEE Computer Society Press and McGraw-Hill Book Company, 2008

Course Title: Software Configuration Management

Course Code: SEEC-702
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:

Management of the SCM Process. Organizational Context for SCM. Constraints and Guidance for the SCM Process. Planning for SCM. SCM Plan. Surveillance of Software Configuration Management. Software Configuration Identification. Identifying Items to Be Controlled. Software Library. Software Configuration Control. Requesting, Evaluating, and Approving Software Changes. Implementing Software Changes. Deviations and Waivers. Software Configuration Status Accounting. Software Configuration Status Information. Software Configuration Status Reporting. Software Configuration Auditing. Software Functional Configuration Audit. Software Physical Configuration Audit. In-process Audits of a Software Baseline. Software Release Management and Delivery. Software Building. Software Release Management. Software Configuration Management Tools.Current research topics in Software Configuration Management.

Course Outline:

1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic
6. Prepositions. [TB2 Ch. 8 & TB3]
7. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
8. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
9. Complements, xcomp and comp. [TB2 Ch. 13]
10. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
11. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
12. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
13. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
14. Project

Reference Material:

1. Software Configuration Management Patterns: Effective Teamwork, Practical Integration by Stephen P. Berczuk, Brad Appleton, 2003

Course Title: Software Measurement and Metrics

Course Code: SEEC-703
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:
Introduction to quality control and planning needs (Measurement Concepts, Measurement as a support process, Review Metrics Models and Standards). Measurement goals (Formulating problem and goal statement, Prioritize information needs and objectives, Formalize measurement goals). Specify Measures (Identify questions and indicators, Identify data elements, Operational definitions for measures). Specify Data Collection and Storage Procedures. Sources of data. How to collect and store the measurement data? Specify Analysis Procedures. Potential data analyses. Methods and tools for measuring software. Develop software measurement reporting. Current research topics in Software Measurement and Metrics.

Reference Material:
1. Metrics and Models in Software Quality Engineering, Stephen H. Kan, Addison Wesley, 2003
2. Measuring the Software Process, Anita Carleton, William A. Florac, Addison-Wesley 1999
3. The Big Book of Six Sigma training Games, Chris Chen and Hadley Roth, McGraw-Hill, 2005

Course Title: Software Risk Management

Course Code: SEEC-704
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Syllabus:
What is risk and risk management?. Motivation for risk management. Reasons we don't do risk management. SEI's Risk Management paradigm. Identifying and recording software risk. Risk Taxonomy. Tools and methods for identifying and recording risks. Analyzing and classifying risks. Complex project management theory. Software Risk Identification. Software Risk Analysis. Software Risk Planning. Software Risk Monitoring. Software Qualitative Risk Analysis. Quantitative Risk Analysis. Risk management and the SDLC. Risk management in CMM. Other useful tools for successful risk management. Current research topics in Software Risk Management.

Reference Material:
1. Software Engineering Risk Management by Dale Walter Karolak, 1995, ISBN9780818671944
2. Applied Software Risk Management: A Guide for Software Project Managers by C. Ravindranath Pandian, 2006, ISBN 9780849305245
3. Software Risk Management by Boehm, Barry, W. IEEE Computer Society Press, ISBN 10: 0818689064

Course Title: Speech Recognition and Synthesis

Course Code: CSEC-735
Course Structure: Lectures: 3/ Lab: 0
Credit Hours: 3
Prerequisites:

Course Objective:
This course offers an in-depth introduction to automatic speech recognition (ASR), the problem of automatically extracting text from human speech. This class will cover many theoretical and practical aspects of machine learning techniques that are employed in large-scale ASR systems. Apart from teaching classical algorithms that form the basis of statistical speech recognition, this class will also cover the latest deep learning techniques that have made important advances in achieving state-of-the-art results for speech recognition.

Course Syllabus:
This course is an introduction to automatic speech recognition, speech synthesis, and dialogue systems, from the computer science and linguistics (rather than EE) perspective. Focus on understanding of key algorithms including the noisy channel model, Hidden Markov Models (HMMs), GMM (Gaussian Mixture Model) acoustic models, A* and Viterbi decoding, N-gram language modeling, unit selection synthesis, dialogue architectures, and the role of linguistic knowledge (esp. phonetics, intonation, pronunciation variation, disfluencies, emotion).

Course Outline:
1. Overview of Course, Intro to Probability Theory, and ASR Background: N-gram Language Modeling J+M New Chapter 4: N-grams
2. TTS: Background (part of speech tagging, machine learning, classification, NLP) and Text Normalization J+M New Chapter 7: Phonetics , J+M New Chapter 8 Speech Synthesis, pages 1-10 , J+M New Chapter 5 Word Classes and Part-of-Speech Tagging, pages 1-36, but skip section 5.6 , Optional Advanced Reading: Chapter 4 "Text Segmentation and Organisation" from Taylor, Paul. 2007. Chapter 5 "Text Decoding" from Taylor, Paul. 2007.
3. TTS: Grapheme-to-phoneme, Prosody (Intonation, Boundaries, and Duration) and the Festival software J+M New Chapter 8, pages 10-25 , Read sections 1, 2, 3, 4, 5, and 6.1 and 6.1.1 from Alan Black's lecture notes on TTS and Festival. , Festival manual (used as Festival's scripting language): Introduction to Scheme for C Programmers, from Cal Tech. Optional Advanced Reading: Chapter 6 "Prosody Prediction from Text" from Taylor, Paul. 2007.
4. TTS: Waveform Synthesis (Diphone and Unit Selection Synthesis) J+M New Chapter 8, pages 25-end Optional Advanced Reading: Chapter 16 "Unit Selection Synthesis" from Taylor, Paul. 2007. Optional Advanced Reading: Optional: Section 7 from Alan Black's lecture notes on TTS and Festival. Optional Advanced Reading: The rest of Section 6 of Alan Black's lecture notes
5. ASR: Noisy Channel Model, Bayes, HMMs, Forward, Viterbi J+M New Chapter 6: Hidden Markov Models, pages 1-20 J+M New Chapter 9: Automatic Speech Recognition, pages 1-12

6. ASR: Feature Extraction and Acoustic Modeling, Evaluation J+M New Chapter 9: Automatic Speech Recognition pages 12-31, 31-45 J+M New Chapter 10: Speech Recognition: Advanced Topics pages 11-16
7. ASR: Learning (Baum-Welch) and Disfluencies J+M New Chapter 9: Automatic Speech Recognition 46-52 , J+M New Chapter 10: Speech Recognition: Advanced Topics pages 1-11

Reference Material:

1. The new edition of Jurafsky and Martin. 2007. Speech and Language Processing.
2. Selected chapters from Taylor, Paul. 2007. Text-to-Speech Synthesis
3. Some papers from the literature

Course Title: Telecom Management

Course Code: ITEC-706
Course Structure: Lectures: 3/Labs: 0
Credit Hours: **3**
Prerequisites: **Computer Networks**
Course Objectives:
The course provides the understanding of the operation and management of a telecommunication business.
Course Syllabus:
Introduction to Telecommunication Management and Planning. Telecommunication Strategic Planning. Developing Requirements and Specifications. Managing Long-Distance Services. Managing Internet Services. Managing PBX and Key Telephone Equipment. Managing Automatic Call Distributors. Managing Voice Processing Equipment. Managing Local Area Network and Internets. Managing Wide Area Networks. Managing Video and Audio Conferencing Equipment. Managing Convergence. Developing a Telecommunication Operations Plan. Disaster Prevention and Recovery. Telecommunications Project Management. Managing Telecommunications Security.
Course Outline:

1. Introduction to Telecommunication Management and Planning
2. Telecommunication Strategic Planning
3. Developing Requirements and Specifications
4. Managing Long-Distance Services
5. Managing Internet Services
6. Managing PBX and Key Telephone Equipment
7. Managing Automatic Call Distributors
8. Managing Voice Processing Equipment
9. Managing Local Area Network and Internets
10. Managing Wide Area Networks
11. Managing Video and Audio Conferencing Equipment
12. Managing Convergence
13. Developing a Telecommunication Operations Plan
14. Disaster Prevention and Recovery

15. Telecommunications Project Management
16. Managing Telecommunications Security

Reference Material:

1. The Irwin Handbook of Telecommunications Management by James Harry Green, McGraw-Hill; 3rd Edition (March 22, 2001). ISBN-10: 0071370587
2. Telecom Management Crash Course : A Telecom Company Survival Guide by P. J. Louis, McGraw-Hill Professional; 1st Edition (June 1, 2002). ISBN-10: 0071386203
3. The Essentials of Telecommunications Management: A Simple Guide to Understanding a Complex Industry by Jayraj Ugarkar, AuthorHouse (March 29, 2010). ISBN-10: 1434397254

Course Title: Telecommunication Systems

Course Code: ITEC-704
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: Computer Networks

Course Objectives:

The course provides an in-depth investigation of telecommunications system concepts and Terminology. The course covers the most popular telecommunication networks and forthcoming technologies.

Course Syllabus:

Communication Channel and the Communication Network Technologies. Digital Telephony. Switching and Signaling Systems. Switching Fabric Interfaces and ICs, Optics and the Future. Cellular Systems. Fixed Wireless Access Technologies. Digital Subscriber Loop. Transmission Techniques. Telecommunication Systems Testing. Embedded Systems Design for Telecommunications.

Course Outline:

1. Communication Channel and the Communication Network: Introduction and Development of Telecommunications, Signals in Communication, Characteristics of the Communication Channel, The Communication Networks, Enabling Technologies.
2. Digital Telephony: From Analog to Digital, Advantages and Disadvantages of Digital Techniques, PCM Techniques and Standards, Low Bit-Rate Voice Coding, Voice over the Internet, Devices for Digital Telephony.
3. Switching and Signaling Systems Switching, Circuit Switching and Packet Switching, Signaling Systems, Digital Exchanges, Private Branch Exchanges and Key Phone Systems, Merging Data and Voice, Packet Switching Systems, Switching Fabric Interfaces and ICs, Optics and the Future.
4. Cellular Systems: Advantages and Constraints of Wireless Access, Basic Components of Wireless Access, Cellular System Operation, The Cellular Radio Environment, Frequency Assignment and Multiple Access Schemes for Cellular Systems, Capacity of Cellular Systems, First Generation Cellular Systems and Standards, Second Generation Cellular Systems and Standards, Third Generation Cellular Systems and Standards, Mobile Device Hardware, Architecture, and Implementation, Technological Trends.
5. Fixed Wireless Access: Access Technologies, WLL Technologies Primarily for Voice Provision, Broadband Fixed Wireless Access Systems, Enabling Technologies.

6. Digital Subscriber Loop: Signal Impairment and the Channel Length, DSL Techniques, Different Versions of DSL, Spectral Consideration in DSL, Operation of DSL, DSL Chip Sets, ISO Seven-Layer Model, ATM, and DSL Systems, End-to-End ADSL Systems and Standards.
7. Transmission Techniques.
8. Telecommunication Systems Testing: Transmission Line Behavior, Decibel Measurements, Basic TDM Techniques and Digital Transmission Systems, Plesiochronous Higher-Order Digital Multiplexing, Synchronous Digital Multiplexing, Optical Networks, Emerging Technologies.
9. Embedded Systems Design for Telecommunications: AMR Speech Codecs and the GSM Environment, Digital Signal Processor Architecture, AD6526 Multiprocessor Architecture, AMR Speech Codec, Algorithmic Complexity of the AMR Speech Codec, Implementation considerations of AMR Speech Codec and porting the Code.

Reference Material:

1. Essentials of Modern Telecommunications Systems by Nihal Kularatna and Dileeka Dias, Artech House (May 2004). ISBN-10: 1580534910
2. The Irwin Handbook of Telecommunications by James Harry Green, McGraw-Hill; 5th Edition (October 26, 2005). ISBN-10: 0071452222
3. Telecommunications Essentials: The Complete Global Source for Communications Fundamentals, Data Networking and the Internet, and Next-Generation Networks by Lillian Goleniewski, Addison-Wesley Professional; 1st Edition (January 5, 2002). ISBN-10: 0201760320
4. Fundamentals of Communications Systems by Michael Fitz, McGraw-Hill Professional; 1st Edition (June 27, 2007). ISBN-10: 0071482806

Course Title: Text Processing and Data Analysis

Course Code: CSEC-734
Course Structure: Lectures: 3/Labs: 1
Credit Hours: 4
Prerequisites: None

Course Objectives:

The processing and analysis of large datasets has become a regular task in sciences. This introductory course into the scripting language PERL provides the basis for designing rapid, reproducible and scalable solutions to this problem. The scripting language PERL is an intuitive and powerful tool for developing custom-tailored solutions for problems ranging from basic data handling and management up to the design of complex workflows and novel algorithms for data analysis. In this course we will introduce the basic concepts of PERL, making you familiar with the various data types and the general structure of PERL scripts, but also with the basic concepts of a structured and standardized data analysis. Based on specific examples from NLP we will guide you through the implementation of first algorithms in PERL aiding in the solution of your particular data analysis problems.

Course Syllabus:

Background, Introduction to Perl, Scalar Data, Built in Functions, Arrays, Functions, Writing Safe Code, Control Structures, File Input / Output, Introduction to Text Processing, Text Processing Functions, Loop Control, Hashes, DBM Databases, Advanced Sorting, Regular Expressions, Environment Variables, CGI-Programming, Process Management, References and Data Structures, Graphics, Javascript

Course Outline:

1. Course goals, syllabus, and introduction to Perl. [TB1, Ch 1]
2. Scalar data [TB1, Ch 2]
3. Lists and arrays [TB1, Ch 3]
4. Subroutines [TB1, Ch 4]
5. Hashtables, Input/Output [TB1, Ch 5-6]
6. HTML (Internet)
7. Files and directories [TB1, Ch 11-12]
8. Modules, basic CGI [TB1, Ch 13]
9. Regular expressions [TB1, Ch 7]
10. Regular expressions (cont.) [TB1, Ch 8-9]
11. More control structures, strings, sorting [TB1, Ch 10-15]
12. Simple databases; DBI, DBM [TB1, Ch 16]
13. Internet tools, processes, advanced topics [TB1, Ch 14, 17]

Reference Material:

1. Learning Perl by Randal L. Schwartz and Tom Phoenix, 3rd edition, known as the Llama book.
2. Programming Perl by Larry Wall, Tom Christiansen, and Jon Orwant, 3rd edition, known as the Camel book.
3. CPAN: Comprehensive Perl Archive Network. Online, at http://www.cpan.org/
4. Perl Cookbook by Tom Christiansen and Nathan Torkington, known as the Cookbook.
5. Mastering Perl/Tk by Stephen Lidie and Nancy Walsh

Course Title: Virtualization in Cloud Computing

Course Code: ITEC-711
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

This course gives an inside look as traditional physical data centers evolve and morph into virtual entities and cloud environments. Students will learn in-depth details and considerations for planning, designing, and migrating to Virtualized Data Centers (VDCs) and cloud environments. They will learn to design VDC and cloud infrastructures, maintaining the most robust and elastic computing, network, and storage environments.

Course Syllabus:

Virtualization, Virtualization Types, Virtualization Management, Cloud Computing, Service Models, Cloud Adoption and Barriers, Return on Investment and Cloud Benefits; Typical Design Patterns and Use Cases, Design Patterns, Cloud Use Cases, Deployment Models, IaaS as a

Foundation, Cloud Consumer Operating Model. Data Center Architecture and Technologies. IT Services. The Cisco Cloud Strategy. Cloud Management Reference Architecture. Cloud Service Fulfillment. Cloud Service Assurance. Billing and Chargeback. Technical Building Blocks of IaaS. Automating and Orchestration Resources. Cloud Capacity Management. Case Study - Hybrid Cloud: Cisco Cloud Enablement Services, Company Profile, Business Goals, Cloud Strategy, Cloud Maturity, IT Platform, Cloud Reference Model, Private Cloud Services, Orchestration and Automation Transition Architecture, Telco Solution, Solution, Out-of-the-Box Services, Diggit Service Requirements.

Course Outline:

1. Virtualization: Virtualization Types, Virtualization Management, Cloud Computing, Service Models, Cloud Adoption and Barriers, Return on Investment and Cloud Benefits; Typical Design Patterns and Use Cases, Design Patterns, Cloud Use Cases, Deployment Models, IaaS as a Foundation, Cloud Consumer Operating Model.
2. Data Center Architecture and Technologies: Architecture, Architectural Building Blocks of a Data Center, Design Evolution, Virtual PortChannel (vPC), Layer 2 Multi-Pathing (L2MP), Network Services and Fabric Evolution in the DC, Service Assurance, Evolution of the Services Platform.
3. IT Services: Classification of IT Services and Information, Four Cornerstones of Cloud Economics.
4. The Cisco Cloud Strategy: A Brief History of IT Service Delivery, The Cisco Cloud Strategy: An Overview, Infrastructure Evolution to Support Cloud Services.
5. Cloud Management Reference Architecture: Standards, TMF eTOM, IT Infrastructure Library (ITLI), ITU-T TMN, Building Cloud Models Using Standards, Integration of Management Systems/Functions.
6. Service Fulfillment: Cloud Fulfillment Using ITILV3, Cloud End-to-End Service Provisioning Flow, Service Orchestration, Cloud End-to-End Architecture Model.
7. Service Assurance: Cloud Assurance Flow Using the ITIL Process, Cloud End-to-End Monitoring Flow, Service Assurance Architecture.
8. Billing and Chargeback: Billing and Chargeback Terminology, Cloud Consumers and Providers, Cloud Services Billing Considerations, Cloud Order-to-Cash Process Flow, Billing and Charging Architecture.
9. Technical Building Blocks of IaaS: IaaS Service Composition, Developing and Offering Cloud Products, Persisting Service Data.
10. Automating and Orchestration Resources: Building the Cloud, Adding Services to the Cloud, Creation and Placement Strategies, Service Life Cycle Management.
11. Cloud Capacity Management: Tetris and the Cloud, Cloud Capacity Model, Demand Forecasting, Procurement in the Cloud.
12. Case Study - Hybrid Cloud: Cisco Cloud Enablement Services, Company Profile, Business Goals, Cloud Strategy, Cloud Maturity, IT Platform, Cloud Reference Model, Private Cloud Services, Orchestration and Automation Transition Architecture, Telco Solution, Solution, Out-of-the-Box Services, Diggit Service Requirements.

Reference Material:

1. Cloud Computing: Automating the Virtualized Data Center by Venkata Josyula, Malcolm Orr and Greg Page, Cisco Press; 1st Edition (December 9, 2011). ISBN-10: 1587204347.
2. IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach by Mickey Iqbal, Mithkal Smadi, Chris Molloy, and Jim Rymarczyk, Mc Press; 1stEdition (January 1, 2011). ISBN-10: 1583473548
3. Microsoft Private Cloud Computing by Aidan Finn, Hans Vredevoort, Patrick Lownds, and Damian Flynn, Sybex; 1stEdition (July 10, 2012). ISBN-10: 1118251474
4. Advanced Server Virtualization: VMware and Microsoft Platforms in the Virtual Data Center by David Marshall , Wade A. Reynolds, and Dave McCrory, Auerbach Publications; 1st Edition (May 17, 2006). ISBN-10: 0849339316
5. Data Center Virtualization: A practical guide to successful deployments of a Virtualized Data Center Infrastructure by Sukento Sukirya, Pete Gore, Brian Clay, and Pierre Vachon, Cisco Press (December 14, 2003). ISBN-10: 1587050234

Course Title: Information Privacy and Security

Course Code: ITCC-702
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Overview of e-security: Threats, risks, consequences, Sources of threats, Attacks classification, Preventive measures, remedial measures, Cryptography for e-security: Historical perspective, Confusion vs. diffusion, Stream ciphers vs. block ciphers, Keys and key management, Key exchange (peer to peer, peer - key server - peer), Diffie Helman key sharing scheme, Symmetric key cryptography vs asymmetric key cryptography, Trapdoor functions, GPG: Overview of GPG, Commands and CLI, GPG trust model, GUI – KGPG, Seahorse, Frontends – Kleopatra, enigmail 2, Practical applications: PKI, CA. X509 certificates, SSL/TLS, HTTPS, IPV6 and IPSEC, Proxies and Firewalls, Misc. techniques: Encryption using non-cryptographic tools (vi, zip), Authentication principles and methods, Passwords, two-factor authentication, One-way encryption, Steganography, Hamming, Chaffing and Winnowing, Management aspects: System Administration policies, Security audit, Penetration testing and ethical hacking, Mandatory Access control, Discretionary Access Control, Monitoring and logging tools

Reference Materials:

1. William Stallings, Cryptography and network security, Pearson Education.
2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone , Handbook of Applied Cryptography, CRC Press.
3. Margaret Cozzens, Steven J Miller, The mathematics of encryption, American Mathematical Society

Course Title: Cryptography

Course Code: ITCC-703
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:
Elementary number theory: Prime numbers, Factoring, Modular arithmetic, Fermat's & Euler's theorems, gcd, Euclid's algorithm, Discrete logarithm problem, Public key encryption: Public key crypto systems, RSA algorithm, Elliptic Curve cryptography, Hash digests: Properties of cryptographic hash functions, Merkle Damgard construction, md family, sha family, Digital signatures, sha3, Block ciphers: Block cipher principles, Feistel networks, S boxes and P boxes, Block cipher modes of operation, DES, 3DES, AES, Interactive Proofs, Zero-Knowledge Proofs, Zero-Knowledge Proofs of Knowledge, Non-Interactive Zero-Knowledge Proofs, Secure Protocols, Two-Party Secure Computation, Multiparty Secure Computation, Chosen Ciphertext Security

Reference Materials:
1. The course materials will consist of research papers related to each topic.

Course Title: Advanced Database Management Systems

Course Code: ITCC-704
Course Structure: Lectures: 3/ Labs: 0
Credit Hours: 3
Pre-requisites: None

Course Objectives:
Make Students fully understand the concepts and technical issues of Database Administration, Management System and can Administrator Huge Database implemented in a DBMS.

Course Syllabus:
Overview Of Database Systems, The Relational Model, Relational Algebra, Evaluating Relational Operators, A Typical Relational Query Optimizer, Overview Of Transaction Management, Parallel And Distributed Databases, Object-Database Systems, Deductive Databases, Data Warehousing And Decision Support, Data Mining, Information Retrieval And Xml Data, Spatial Data Management, Advanced Topics: Advanced Transaction Processing, Data Integration, Mobile Databases, Main Memory Databases, Multimedia Databases, Geographic Information Systems, Temporal Databases, Biological Databases, Information Visualization ..

Course Outline:
1. Overview of Database Systems: A Historical Perspective, File Systems versus a DBMS, Advantages of a DBMS, Levels of Abstraction in a DBMS, Queries in a DBMS, Transaction Management, Structure of a DBMS. [Ch. 1]

2. The Relational Model: Introduction to the Relational Model, Integrity Constraints over Relations, Enforcing Integrity Constraints, Querying Relational Data, Logical Database Design: ER to Relational, Introduction to Views [Ch. 3]
3. Relational Algebra: Introduction to Relational Algebra, Introduction to Relational Calculus [Ch. 4]
4. Evaluating Relational Operators: The' Selection Operation, General Selection Conditions, The Projection Operation, The Join Operation, The Set Operations, Aggregate Operations, The Impact of Buffering [Ch. 14]
5. A Typical Relational Query Optimizer: Translating SQL Queries into Algebra, Estimating the Cost of a Plan, Relational Algebra Equivalences, Enumeration of Alternative Plans, Nested Subqueries, The System R Optimizer, Other Approaches to Query Optimization [Ch. 15]
6. Overview Of Transaction Management: The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock-Based Concurrency Control, Performance of Locking, Transaction Support in SQL, Introduction to Crash Recovery.[Ch. 16]
7. Parallel And Distributed Databases: Introduction, Architectures for Parallel Databases, Parallel Query Evaluation, Parallelizing Individual Operations, Parallel Query Optimization, Introduction to Distributed Databases, Types of Distributed Databases, Distributed DBMS Architectures, Storing Data in a Distributed DBMS, Distributed Catalog Management, Distributed Query Processing, Updating Distributed Data, Distributed Transactions, Distributed Concurrency Control, Distributed Recovery [Ch. 22]
8. Object-Database Systems: Introduction, Structured Data Types, Operations on Structured Data, Encapsulation and ADTs, Inheritance, Objects, aIDs, and Reference Types, Database Design for an ORDBMS, ORDBMS Implementation Challenges, OODBMS, Comparing RDBMS, OODBMS, and ORDBMS [Ch. 23]
9. Deductive Databases: Introduction to Recursive Queries, Datalog, Theoretical Foundations, Recursive Queries with Negation, From Datalog to SQL, Evaluating Recursive Queries [Ch. 24]
10. Data Warehousing And Decision Support: Introduction to Decision Support, OLAP: Multidimensional Data Model, Multidimensional Aggregation Queries, Implementation Techniques for OLAP, Data 'Warehousing, Views and Decision Support, View Materialization, Maintaining Materialized Views. [Ch. 25]
11. Data Mining: Introduction to Data Mining, Counting Co-occurrences, Mining for Rules, Tree-Structured Rules, Clustering, Similarity Search over Sequences, Incremental Mining and Data Streams, Additional Data Mining Tasks.
12. Information Retrieval and Xml Data: Colliding Worlds: Databases, IR, and XML, DBMS versus IR Systems, Introduction to Information Retrieval, Indexing for Text Search, Web Search Engines, Managing Text in a DBMS, A Data Model for XML, XQuery: Querying XML Data, Efficient Evaluation of XML Queries. [Ch. 27]
13. Spatial Data Management: Types of Spatial Data and Queries, Applications Involving Spatial Data, Introduction to Spatial Indexes, Indexing Based on Space-Filling Curves, Region Quad Trees and Z-Ordering: Region Data, Grid Files, R Trees: Point and Region Data, Issues in High-Dimensional Indexing [Ch. 28]

14. Advanced Topics: Advanced Transaction Processing, Data Integration, Mobile Databases, Main Memory Databases, Multimedia Databases, Geographic Information Systems, Temporal Databases, Biological Databases, Information Visualization [Ch. 29]

Reference Material:

1. Database Management Systems, 3rd Edition by Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill; 3rd edition (August 14, 2002). ISBN-10: 0072465638
2. Advanced Database Systems by Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T. Snodgrass, V.S. Subrahmanian, Roberto Zicari, Morgan Kaufmann; 1st Edition (May 15, 1997). ISBN-10: 155860443X
3. XQuery by Priscilla Walmsley ISBN: 0596006349 (Chapter 1-8)
4. Spatial Databases: With Application to GIS by Hilippe Rigaux. ISBN: 1558605886 (Chapter 2, 6)
5. Advanced Database Systems by Carlo Zaniolo, Stefano Ceri (Chapter 5, 6)
6. Foundations of Semantic Web Technologies by Pascal Hitzler. ISBN: 142009050X (Chapter 5, 6)
7. Principles of Distributed Database Systems by Ozsu, M. Tamer. ISBN: 0136597076 (Chapter "Introduction", "Architecture" and "Parallel Databases")
8. Hadoop: The Definitive Guide byTom White. ISBN: 1449389732 (Chapter 1, 2, 5, 6)
9. An Advanced Course in Database Systems: Beyond Relational Databases by S. W. Dietrich and S. D. Urban, Prentice Hall, 2005. ISBN-10: 0130428981
10. Database Systems: A Practical Approach to Design, Implementation and Management by Thomas M. Connolly and Carolyn E. Begg, Addison-Wesley; 5th Edition (2009). ISBN-10: 0321523067
11. Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber and Jian Pei, Morgan Kaufmann; 3rd Edition (2011). ISBN-10: 0123814790
12. Data Mining: Concepts, Models, Methods, and Algorithms by Mehmed Kantardzic, Wiley-IEEE Press; 2nd Edition (2011). ISBN-10: 0470890452
13. Data Warehousing Fundamentals for IT Professionals by Paulraj Ponniah, Wiley; 2nd Edition (2010). ISBN-10: 0470462078

Course Title: Parallel Processing: Algorithms and Architectures-I

Course Code: CSEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: Advanced Algorithm of Analysis

Course Objectives:

The course covers the needed perspective, taxonomy, and analysis tools for the understanding key concepts of parallel processing. It also delimits the models of parallel processing which has become quite important in recent years.

Course Syllabus:
Introduction to Parallelism. Types of parallelism. Parallel Algorithms. Parallel Algorithm Complexity. P RAM and Basic Algorithms. Shared-Memory Algorithms. Sorting and Selection Networks. Circuit-Level Examples. Sorting on a 2-D Mesh or Torus. Routing on a 2-D Mesh or Torus. Numerical 2-D Mesh Algorithms. Other Mesh-Related Architectures.

Course Outline:
1. Introduction to Parallelism: Why parallel processing? Parallel processing ups and downs, Types of parallelism: A taxonomy, Constraints of parallel processing, Effectiveness of parallel processing. Introduction to Parallel Algorithms: Some simple computations, some simple architectures, Algorithms for a linear array, Algorithms for a binary tree, Algorithms for a 2D mesh, Algorithms with shared variables.
2. Parallel Algorithm Complexity: Asymptotic complexity, Algorithm optimality and efficiency, Complexity classes, Parallelizable tasks and the NC class, Parallel programming paradigms, Solving recurrences. Models of Parallel Processing: Development of early models, SIMD versus MIMD architectures, Global versus distributed memory, The PRAM shared-memory model, Distributed-memory or graph models, Circuit model and physical realizations.
3. PRAM and Basic Algorithms: PRAM submodels and assumptions, Data broadcasting, Semigroup or fan-in computation, Parallel prefix computation, Ranking the elements of a linked list, Matrix multiplication. More Shared-Memory Algorithms: Sequential rank-based selection, A parallel selection algorithm, A selection-based sorting algorithm, Alternative sorting algorithms, Convex hull of a 2-D point set, Some implementation aspects.
4. Sorting and Selection Networks: What is a sorting network? Figures of merit for sorting networks, Design of sorting networks, Batcher sorting networks, Other classes of sorting networks, Selection networks. Other Circuit-Level Examples: Searching and dictionary operations, A tree-structured dictionary machine, Parallel prefix computation, Parallel prefix networks, The discrete Fourier transform, Parallel architectures for FFT.
5. Sorting on a 2-D Mesh or Torus: Mesh-connected computers, Theshearsort algorithm, Variants of simple shearsort, Recursive sorting algorithms, A non-trivial lower bound, Achieving the lower bound,
6. Routing on a 2-D Mesh or Torus: Types of data routing, Useful elementary operations, Data routing on a 2-D array, Greedy routing algorithms, Other classes of routing algorithms, Wormhole routing
7. Numerical 2-D Mesh Algorithms: Matrix multiplication, Triangular system of equations, Tridiagonal system, Arbitrary system of linear equations, Graph algorithms, Image-processing algorithms
8. Other Mesh-Related Architectures: Three or more dimensions, Stronger and weaker connectivities, Meshes augmented with non-local links, Meshes with dynamic links, Pyramid and multi-grid systems, Meshes of trees

Reference Material:
1. Introduction to Parallel Processing: Algorithms and Architectures by Behrooz Parhami, Springer; (2006) ISBN-10: 0306459701

2. Parallel Algorithms and Architectures by Michel Cosnard and Denis Trystram, Intl Thomson Computer Pr (Sd) (September 1996). ISBN-10: 0534946070
3. Parallel Processing and Parallel Algorithms: Theory and Computation by Seyed H Roosta, Springer; 1st Edition (December 10, 1999). ISBN-10: 0387987169
4. Introduction to Parallel Algorithms by Joseph JaJa, Addison-Wesley Professional; 1stEdition (April 3, 1992). ISBN-10: 0201548569

Course Title: Parallel Processing: Algorithms and Architectures-II

Course Code: CSEC-729
Course Structure: Lectures: 3/Labs: 0
Credit Hours:3
Prerequisites: Parallel Processing: Algorithms and Architectures - I

Course Objectives:
The course is the 2nd part of the Parallel Processing. It continue covering the needed perspective, taxonomy, and analysis tools for the understanding key concepts of parallel processing. It also delimits the models of parallel processing which has become quite important in recent years.

Course Syllabus:
Hypercubes and Their Algorithms. Sorting and Routing on Hypercubes. Sampler of other Networks: Performance parameters for networks, Star and pancake networks, Ring-based networks, Composite or hybrid networks, Hierarchical (multi-level) networks, Multi-stage interconnection networks. Emulation and Scheduling. Data Storage, Input, and Output. Reliable Parallel Processing. Shared-Memory MIMD Machines. Data-Parallel SIMD Machines.

Course Outline:
1. Hypercubes and Their Algorithms: Definition and main properties, Embeddings and their usefulness, Embedding of arrays and trees, A few simple algorithms, Matrix multiplication, Inverting a lower triangular matrix.
2. Sorting and Routing on Hypercubes: Defining the sorting problem, Bitonic sorting, Routing problems on a hypercube, Dimension-order routing, Broadcasting on a hypercube, Adaptive and fault-tolerant routing. Other Hypercubic Architectures: Modified and generalized hypercubes, Butterfly and permutation networks, Plus-or-minus-2i network, The cube-connected cycles, Shuffle and shuffle-exchange networks.
3. Sampler of Other Networks: Performance parameters for networks, Star and pancake networks, Ring-based networks, Composite or hybrid networks, Hierarchical (multi-level) networks, Multi-stage interconnection networks. Emulation and Scheduling: Emulations among architectures, Distributed shared memory, The task scheduling problem, A class of scheduling algorithms, Some useful bounds for scheduling, Load balancing and dataflow systems

4. Data Storage, Input, and Output: Data access problems and caching, Cache coherence protocols, Multi-threading and latency hiding, Parallel I/O technology, Redundant disk arrays, Interfaces and standards.
5. Reliable Parallel Processing: Defects, faults, failures, Defect-level methods, Fault-level methods, Error-level methods, Malfunction-level methods, Degradation-level methods. System and Software Issues: Coordination and synchronization, Parallel programming, Software portability and standards, Parallel operating systems, Parallel file systems, Hardware/software interaction
6. Shared-Memory MIMD Machines: Variations in shared memory, MIN-based BBN Butterfly, Vector-parallel Cray Y-MP, Latency-tolerant Tera MTA, CC-NUMA Stanford DASH, SCI-based Sequent NUMA-Q. Message-Passing MIMD Machines: Mechanisms for message passing, Reliable bus-based Tandem NonStop, Hypercube-based nCUBE3, Fat-tree-based Connection Machine, Omega-network-based IBM SP2, Commodity-driven Berkeley NOW.
7. Data-Parallel SIMD Machines: Where have all the SIMDs gone? The first supercomputer: ILLIAC IV, Massively parallel Goodyear MPP, Distributed Array Processor (DAP), Hypercubic Connection Machine, Multi-connected MasPar MP-2. Past, Present, and Future: Milestones in parallel processing, Current status, issues, and debates, TFLOPS, PFLOPS, and beyond, Processor and memory technologies, Interconnection technologies, The future of parallel processing.

Reference Material:

1. Introduction to Parallel Processing: Algorithms and Architectures by BehroozParhami, Springer; (2006). ISBN-10: 0306459701
2. Parallel Algorithms and Architectures by Michel Cosnard and Denis Trystram, Intl Thomson Computer Pr (Sd) (September 1996). ISBN-10: 0534946070
3. Parallel Processing and Parallel Algorithms: Theory and Computation by Seyed H Roosta, Springer; 1st Edition (December 10, 1999). ISBN-10: 0387987169
4. Introduction to Parallel Algorithms by Joseph JaJa, Addison-Wesley Professional; 1st Edition (April 3, 1992). ISBN-10: 0201548569

Course Title: Research Methodology

Course Code: SEEC-705
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Syllabus:

Introduction to Research. Objectives of Research. Importance of Research Methodology in Research Study. Types of Research. Steps in Conducting Research. What is Literature Review? Why need for Literature Review. Types of Literature Review. Systematic Literature Review Protocol. Problem Statement and Problem formulation. Criteria for selecting a problem. Identifying Types of variables in Research. Types of hypothesis. Identifying Target Population. Types of Sampling. Sampling Techniques. Quantitative Research Methods. Scientific Methods.

Design of Quantitative Surveys. Techniques to Conduct Quantitative Methods. Introduction to Qualitative Research. Qualitative Research Methods. Data Analysis and Theory in Qualitative Research Articles. Introduction to Mixed Methods Research. Design of Mixed Methods Research. Evaluation of Mixed Methods Research. Case Study. How to Conduct a Case Study. Case Study Protocol. Importance and Benefits of Case Study. Types of Statistical Tests to Conduct Data Analysis. Data Analysis Tools. Introduction to SPSS. Hands on Practice of SPSS. How to Define variables in SPSS. How to Record Collected Data in SPSS. Types of Tests via SPSS including Regression. Correlation. Cross tabulation and others. How to write Good Research Proposal. Contents of Thesis. Important Elements of Research Thesis.

Reference Material:

1. Research design: Qualitative, quantitative and mixed methods approaches, Creswell, J. W. Thousand Oaks, CA: Sage,4th Ed. 2014

Course Title: Swarm Intelligence

Course Code: CSEC-709
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

The course is aimed to provide students' knowledge of up-to-date efficient variants of different meta heuristics together with their potential applications. Also to develop the interest of students in both research and development.

Course Syllabus:

Introduction to swarm intelligence and key principles, From real to virtual ants, Introduction to mobile robotics, unsupervised multi-agent machine-learning, Collective movements in natural societies, Multi-level modeling of self-organized systems, Combined modeling, Division of labor and task-allocation mechanisms, Market-based and threshold-based algorithms, Aggregation and segregation, Distributed structure building.

Course Outline:

1. Introduction to swarm intelligence and key principles (e.g., self-organization, stigmergy), natural and artificial examples, computational and embedded SI. Foraging, trail laying/following mechanisms. Open-space, multi-source foraging experiments: biological data and microscopic models.
2. From real to virtual ants: Ant System (AS), the first combinatorial optimization algorithm based on ant trail/following principles. Application to a classical operational research problem: the Travel Salesman Problem (TSP). From AS to Ant Colony Optimization (ACO). Ant-based algorithms (ABC, Ant-Net) applied to routing in telecommunication networks. Definitive assignment of course projects.
3. Introduction to mobile robotics: basic hardware and software concepts centered around the differential drive vehicle used in the course (e-Puck). Introduction to control architecture

for mobile robots with special focus on reactive control architectures.

4. Introduction to unsupervised multi-agent machine-learning techniques for automatic design and optimization: terminology and classification, Genetic Algorithms (GA) and Particle Swarm optimization (PSO). Comparison between both techniques in theory and practice.
5. Application of machine-learning techniques to automatic control design and optimization in single-robot and multi-robot experiments. Specific issues for automatic control design and optimization in collective systems (e.g., credit assignment problems, noise resistance).
6. Collective movements in natural societies; focus on flocking phenomena. Collective movements in artificial systems: Reynolds' virtual agents (Boids) and experiments with multi-robot systems (flocking, formation).
7. Multi-level modeling of self-organized robotic systems: microscopic and macroscopic models; Markov formalism; linear and nonlinear micro-to-macro mapping, model analysis.
8. Combined modeling and machine-learning methods for control optimization. Diversity and specialization metrics.
9. Division of labor and task-allocation mechanisms, part I: threshold-based algorithms.
10. Division of labor and task-allocation mechanisms, part II: market-based algorithms and comparisons between threshold-based and market-based algorithms. A short tutorial on sensor networks, networked robotic systems and their relation with Swarm Intelligence.
11. Aggregation and segregation. Social insects, data clustering algorithms, and collective robotics experiments.
12. Distributed structure building in natural and artificial systems.

Reference Material:

1. Computational Intelligence: An Introduction, Andries Engelbrecht, Wiley, 2007
2. “Swarm Intelligence: From Natural to Artificial Systems", E. Bonabeau, M. Dorigo, and G. Theraulaz, Santa Fe Studies in the Sciences of Complexity, Oxford University Press, 1999. ISBN: 0195131592

Course Title: Evolutionary Computation

Course Code: CSEC-710
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:

It is intended as a fundamental introduction, as well as a survey of the many aspects of evolutionary algorithms (EAs), in particular GA, GP, ES, and will concentrate on the basic concepts of representation, operators and overall control, followed by examples of the use of these concepts in important applications. As such, this course will not do much in-depth study of any one area. Rather the course is intended as a good introduction for those who have had no exposure to EC and as a stepping stone for those interested in more specific areas.

Course Syllabus:
Evolutionary Computation, Genetic Algorithms, Genetic Programming, Swarm Intelligence, Ant Colony Optimization, Particle Swarm Optimization, Multi Objective Optimization, Neighboring Algorithms, Co-Evolution, Differential Evolution

Course Outline:

1. Introduction to Evolutionary Computation, Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, A simple evolutionary algorithm.
2. Search Operators, Recombination/Crossover for strings (e.g., binary strings), e.g., one-point, multi-point, and uniform crossover operators, Mutation for strings, e.g., bit-flipping, Recombination/Crossover and mutation rates, Recombination for real-valued representations, e.g., discrete and intermediate recombination, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc, Why and how a recombination or mutation operator works?
3. Selection Schemes, Fitness proportional selection and fitness scaling, Ranking, including linear, power, exponential and other ranking methods, Tournament selection, Selection pressure and its impact on evolutionary search
4. Search Operators and Representations, Mixing different search operators, An anomaly of self-adaptive mutations, The importance of representation, e.g., binary vs. Gray coding, Adaptive representations
5. Evolutionary Combinatorial Optimization, Evolutionary algorithms for TSPs, Evolutionary algorithms for lecture room assignment, Hybrid evolutionary and local search algorithms
6. Co-evolution, Cooperative co-evolution, Competitive co-evolution
7. Niching and Speciation, Fitness sharing (explicit and implicit), Crowding and mating restriction
8. Constraint Handling, Common techniques, e.g., penalty methods, repair methods, etc. Analysis, Some examples
9. Genetic Programming, Trees as individuals, Major steps of genetic programming, e.g., functional and terminal sets, initialization, crossover, mutation, fitness evaluation, etc. Search operators on trees, Automatically defined functions, Issues in genetic programming, e.g., bloat, scalability, etc., Examples
10. Multi objective Evolutionary Optimization, Pareto optimality, Multi objective evolutionary algorithms
11. Learning Classifier Systems, Basic ideas and motivations, Main components and the main cycle, Credit assignment and two approaches
12. Theoretical Analysis of Evolutionary Algorithms, Schema theorems, Convergence of EAs, Computational time complexity of EAs, No free lunch theorem

Reference Material:

1. Evolutionary Computation: A Unified Approach, Ken De Jong, 2006.
2. How to Solve It: Modern Heuristics, Z. Michalewicz and D. B. Fogel, Springer, 2000.
3. Computational Intelligence: An Introduction, Andries Engelbrecht, Wiley, 2007

Course Title: Computational Intelligence

Course Code: CSEC-711
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course is aimed to provide students' knowledge of up-to-date efficient variants of different meta heuristics together with their potential applications. Also to develop the interest of students in both research and development.

Course Syllabus:
Optimization, Constrained, unconstrained optimization, Parameter space, function space, and fitness space, Local and global optima, Multi-objective optimization, Classification / Learning, Classification (Supervised Learning), Clustering (Unsupervised Learning), Reinforcement Learning, Control Systems, Expert Systems

Course Outline:

1. Introduction to Computational Intelligence topics, Fundamental concepts
2. Introduction to Evolutionary Computing, Evolutionary computation terms, Canonical genetic algorithm
3. Evolutionary computation variations, Evolutionary programming and Evolution strategies
4. Implementation of Evolutionary Computing
5. Swarm Intelligence, Particle Swarm Optimization
6. Classification, Learning, and Adaptation, Supervised, Unsupervised, Reinforcement Learning
7. Data partitioning and Cross Validation, Error metrics: Mean squared error, receiver operating characteristic curves, Neural Networks and Evolutionary Computation: Explanation and Sensitivity Analysis
8. Neural Networks Implementation, Evolutionary and swarm-based neural networks
9. Fuzzy sets,Membership functions, linguistic variables
10. Fuzzy Logic, Fuzzy set operators, Fuzzy rule-based systems
11. Fuzzification, defuzzification
12. Fuzzy control
13. Evolving fuzzy rule systems
14. Basic ANN Code
15. Neuro-fuzzy systems
16. Fuzzy-GA systems
17. Support Vector Machines
18. Probabilistic reasoning: Bayesian reasoning and Dempster-Shafer theory
19. Bayesian belief networks
20. Fuzzy belief networks
21. Evolving belief networks
22. Artificial Immune Systems

Reference Material:

1. Russell Eberhart and Yuhui Shi - Computational Intelligence: Concepts to

Implementations (2007)
2. Fakhreddine Karray and Clarence de Silva - Soft Computing and Intelligent Systems Design (2004)
3. Andries Engelbrecht - Computational Intelligence: an Introduction (2007
4. Amit Konar - Computational Intelligence: Principles, Techniques, and Applications (2005)
5. Vojislav Kecman - Learning and Soft Computing: Support Vector Machines, Neural Networks, and Fuzzy Logic Models (2001)

Course Title: Fog Computing

Course Code: CSEC-712
Course Structure: Lectures: 3
Credit Hours: 3
Prerequisite:

Course Objectives:

This course is designed to give a multitude of technologies that comprise the modern concept of Fog and Edge computing, their applications, architectures, and technologies. Fog Computing is an emergent architecture for computing, storage, control, and networking that distributes these services closer to end users along the cloud-to-things continuum. It covers both mobile and wire line scenarios, traverses across hardware and software, resides on network edge but also over access networks and among end users, and includes both data plane and control plane.

Course Syllabus:

This course gives an introduction to Fog Computing, IoT and related techniques, issues, Fog Computing Architectures, Feasible Service Models of Fog Computing Architecture, Fog Computing Applications: Smart city, Smart health, Smart Building, Internet of Energy and Smart Transportation. Other topics of content include Fog/IoT Data storage and Management, Real-time streaming data processing, Data analytics, Resource-constrained devices management and optimization, Scheduling for Fog infrastructures, Reliability, Security and Privacy, privacy challenges and solutions. Students will also learn and understand about Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit, Common Standards in Fog Computing: The Open Fog Consortium, Standards of Application Development, Building and simulating of use-Case Studies in Smart Health / Smart Cities / Smart Government /Smart Industrial Environments/Industry 4.0.

Course Outline:

1. Overview: From Cloud to Fog, Potentials, trends, and prospects in edge technologies: Fog, cloudlet, mobile edge, and micro data centers
2. Overview: From IT to loT to IoE, Basic attributes and challenges for IoE
3. Fog/Edge Computing Computing Architectures, Feasible Service Models of Fog/Edge Computing Architecture
4. Fog/Edge Computing Applications: Smart city, Smart health, Smart Building, Internet of Energy, smart transportation
5. Fog/Edge/IoT Data storage and Management, Real-time streaming data processing, Data

analytics

6. Resource-constrained devices management and optimization
7. Scheduling for Fog/Edge infrastructures
8. Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit:
9. Components of iFogsim: physical components and logical components, Module placement policies,
10. Installation of iFogSim, Building Simulation with iFogSim, Creation of physical and logical components
11. Application Case Studies: a latency-sensitive online game, Intelligent Surveillance through Distributed Camera Networks, Performance Evaluation
12. Example Scenarios: Sensors with different tuple emission rate, Send specific number of tuples from a sensor, Connect lower level Fog devices with nearby gateways, Mobility of a Fog device, Make Cluster of Fog devices, Simulation of a Placement Policy
13. Common Standards in Fog Computing: The Open Fog Consortium, Standards of Application Development
14. Building and simulating a Use-Case Study in Smart Health / Smart Cities / Smart Government / Smart Industrial Environments / Industry 4.0
15. Fog/Edge/IoT Reliability, Security and Privacy, Fog/Edge privacy challenges and solutions

Reference Material:

1. Internet of Things principals and paradigms, edited by Rajkumaar Buyya, AmirVahid, ISBN 978-0-12-805395-9
2. Fog Computing Concepts, Frameworks and Technologies by mahmood Zaigham (Ed. 2018), ISBN 978-3-319-94890-4
3. Fog and Edge Computing: Principles and Paradigms, edited by Rajkumar Buyya, Satish Srirama, Wiley Press
4. The Rise of Fog Computing in the Digital Era, edited by K. G. Srinivasa, Pankaj Lathar, G. M. Siddesh, ISBN 152256070X, 9781522560708
5. https://www.openfogconsortium.org/resources/#use-cases
6. Fog of everything: energy-efficient networked computing architectures, research challenges, and a case study (https://ieeexplore.ieee.org/document/7921687/)
7. FOCAN: A Fog-supported Smart City Network Architecture for Management of Applications in the Internet of Everything Environments (https://arxiv.org/abs/1710.01801)
8. iFogSim: A Toolkit for Modeling and Simulation of Resource Management Techniques in Internet of Things, Edge and Fog Computing Environments (https://arxiv.org/abs/1606.02007)
9. Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit
10. Building a Sustainable Internet of Things: Energy-Efficient Routing Using Low-Power Sensors Will Meet the Need (https://www.researchgate.net/publication/323491668_Building_a_Sustainable_Internet_of_Things_Energy-Efficient_Routing_Using_Low-Power_Sensors_Will_Meet_the_Need)
11. Fog computing job scheduling optimization based on bees swarm (https://www.tandfonline.com/doi/abs/10.1080/17517575.2017.1304579?journalCode=teis20)
12. Priority based scheduling in Fog Computing

13. Mobility aware Application Scheduling in Fog Computing
14. Data Storage and management in fog/edge Computing - webcourse https://webcourse.cs.technion.ac.il/236826/Winter2017-2018/ho/WCFiles/Data%20storage%20and 20management%20in%20Fog%20-%20final%20.pptx
15. https://www.cds.net/blog/2018/03/fog-computing-and-iot/
16. FogStore: Toward a Distributed Data Store for Fog Computing (https://arxiv.org/pdf/1709.07558)
17. An architecture for Load Balancing Techniques for Fog Computing https://pdfs.semanticscholar.org/24e5/022d0b6775f460159dd1a96d63ec4fbb4f68.pdf
18. Multiobjective optimization for computation offloading in Fog Computing https://ieeexplore.ieee.org/document/8168252/\
19. An overview of Fog Computing and its security issues, Security and privacy issues of fog

Curriculum

of

PhD Computer Science



Department of Computer Science & Information Technology

University of Sargodha

(Applicable from Fall-2018)

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Curriculum

for

PhD Computer Science Program

PhD(CS) Program's Rationale

PhD is highest degree awarded in an academic discipline and is the most satisfying and rewarding educational experience. Students work closely with a faculty member, performing original research, and tackling challenging and unsolved problems. A PhD is a long, in depth research exploration of one topic. By long we're typically talking about 3-5 years. By in depth we mean that at the end of the PhD you will be the world expert or close to it in your particular area. You will know more than your advisor about your particular research area. You will know about your research than anyone at your department. By one we mean that by the last couple years of your PhD, you will typically be working on only one narrow problem. The PhD is not about breadth, it is about depth the MS and BS degrees are about breadth not depth. The main requirement in the MS and BS degrees is often a large numbers of courses. A PhD program at CSIT, UOS typically requires 18 credit hours of course work.

Program Goals
The goals of the CS PhD Program are to:

- Provide students with a deep understanding of fundamentals as well as important current applications and research, emphasize learning at the research frontier so they can develop theory, methodology and experimental skills to investigate and solve state of the art technological issues, and be successful professionals.
- Provide technical and system support to dedicated and innovative scholars to continue their cutting-edge research, and participate in the advancement of the discipline.
- Provide ties to alumni to enhance their opportunities for continued learning and leadership, establish liaison with Industry to advise and to provide research opportunities to Temple graduates and the CS Department.

Minimum Criteria for Admission in Ph.D Computer Science

Admission requirement:
For admission into the PhD program at CS & IT department, the minimum CGPA 3.0 (out of 4.0 in the Semester System) or First Division (in the Annual System) in M.Phil/M.S/Equivalent degree in Computer Science or related disciplines.

Subject Test:

A subject test conducted by the department or as decided by the university must be cleared prior to admission for the PhD Program. The student must have a score of 70% in subject test for securing admission in PhD or as per university rules and HEC guidelines.

Course Work:

Course work of 18 credit hours preferably in the first year is required to be completed and followed by a comprehensive examination for granting candidacy as PhD researcher.

Comprehensive Examination

The student becomes eligible to appear in the Comprehensive Examination after passing the PhD coursework with a minimum CGPA of 3.0 or as per university rules.

Research Work

The student can start work on PhD thesis only after

Passing the Comprehensive Exam, AND

Acceptance/defense of synopsis by the Graduate Studies Committee.

PhD Dissertation

The PhD Dissertation must contain original research work.

Plagiarism Test

The Plagiarism Test shall be conducted on the Dissertation before its submission to foreign experts.

Foreign Expert Evaluation:

The PhD dissertation must be evaluated by at least two PhD experts from technologically/ academically advanced foreign countries in addition to local Committee members or as per university rules and HEC guidelines.

Open Defense:

An open defense of Dissertation is essential part of PhD Program after positive evaluation.

PhD Computer Science Electives

S No	Course Code	Course Title	Credit Hours
1	CSEC-801	Special Topics in Natural Language Engineering	3(3+0)
2	CSEC-802	Special topics in Grammar Engineering	3(3+0)
3	CSEC-803	Advanced Topics in Formal Methods	3(3+0)
4	CSEC-804	Special Topics in Cluster & Grid Computing	3(3+0)
5	CSEC-805	Advanced topics in Parallel Processing	3(3+0)
6	CSEC-806	Special Topics in Distributed Computing	3(3+0)
7	CSEC-807	Special Topics in Open Source Software	3(3+0)
8	CSEC-808	Advanced Research Methods	3(3+0)
9	CSEC-809	Evolutionary Computation	3(3+0)
10	CSEC-810	Special Topics in Machine Learning	3(3+0)
11	CSEC-811	Special Topics in Artificial Intelligence	3(3+0)
12	CSEC-812	Advanced Optimization Methods	3(3+0)
13	CSEC-813	Special Topics in Data Mining	3(3+0)
14	CSEC-814	Peer-To-Peer Systems	3(3+0)
15	CSEC-815	Ubiquitous Information Interaction	3(3+0)
16	CSEC-816	Evolution and Re-Engineering	3(3+0)
17	CSEC-817	Program Comprehension and Reverse Engineering	3(3+0)
18	CSEC-818	Software Refactoring	3(3+0)
19	CSEC-819	Advance Software Architecture	3(3+0)
20	CSEC-820	Category Theory	3(3+0)
21	CSEC-821	Concrete Mathematics	3(3+0)
22	CSEC-822	Number Theory and Cryptography	3(3+0)
23	CSEC-823	Harmonic Analysis	3(3+0)
24	CSEC-824	Randomized Algorithms	3(3+0)
25	CSEC-825	Spectral Graph Theory	3(3+0)
26	CSEC-826	Wavelets	3(3+0)
27	CSEC-827	Information Theory I	3(3+0)
28	CSEC-828	Special Topics in Big Data Analysis	3(3+0)
29	CSEC-829	Advance topics in Fog Computing	3(3+0)
30	CSEC-834	Advance topics in Cloud Computing	3(3+0)

Note: PhD students may take course(s) from MS(CS/IT/SE) elective courses pool

Course Title: Advanced Topics in Formal Methods

Course Code: CSEC-803
Course Structure:
Credit Hours: 3
Prerequisites:

Course Objectives:
The objective of the course is the study of the most important among the qualities of software: correctness. Correctness will be studies looking at the conceptual perspective as well as the realization perspective. Modeling and verification of both static (data) and dynamic (processes) aspects will be considered. The various topics will be treated emphasizing methodological, theoretical and practical facets. The course will introduce various forms of logic (first-order logic, temporal logics, fixpoint logics), techniques and tools for automated verification. After the successful completion of the course the student will have acquired techniques and methods for proving correctness of programs and conceptual models.

Course Syllabus:
First Order Logic and Set theory.
Set theory and first order logic form the foundations of mathematics and formal reasoning. We will cover the syntax and semantics of first-order logic, basic model theory, basic proof theory, Godel's completeness theorem, the compactness theorem, the Lowenheim-Skolem theorems, Godel's incompleteness theorem, and non-standard models. We will cover aspects of axiomatic set theory. We will discuss how logic is used to model and reason about computation.

1. Un-decidability and Decision Procedures. A long standing goal in mathematics and computer science is to automate proof discovery and mathematical reasoning. We will cover basic un-decidability results. We will also discuss recent developments in decision procedures, including the DPLL algorithm for deciding SAT (Boolean Satisfiability) and the SMT (Satisfiability modulo theories) framework.

2. Reactive Systems. Reactive systems are non-terminating systems that interact with an environment. To reason about such systems, we will study various temporal logics and calculi, automata on infinite objects, the notions of safety and liveness, and the theory of refinement.

3. Tools and Applications. We will discuss current verification tools, including interactive theorem provers, SMT solvers, and model checkers. We will discuss applications to hardware verification, software verification, databases, and security.

Reference Material:

1. Handbook of Automated Reasoning, Volume II by Alan J.A. Robinson and Andrei Voronkov, 2001.
2. Verification, Model Checking, and Abstract Interpretation By Ranjit Jhala and David Schmidt, 2011.
3. Language and Automata Theory and Applications: by Adrian Horia Dediu, Armand Mihai Ionescu and Carlos Martin-Vide, 2009.
4. Decision Procedures: An Algorithmic Point of View by Daniel Kroening, Ofer Strichman and R.E.

Bryant, 2008.
5. Model-Based Testing of Reactive Systems: Advanced Lectures by Manfred Broy, Bengt Jonsson, Joost-Pieter Katoen and Martin Leucker, 2005.
6. Verification of Reactive Systems: Formal Methods and Algorithms by Klaus Schneider 2003.
7. Temporal Verification of Reactive Systems: Safety by Zohar Manna and Amir Pnueli, 1995.

Course Title: Special Topics in Cluster & Grid Computing

Course Code: CSEC-804
Course Structure:
Credit Hours: 3
Prerequisites:

Course Objectives:
The purpose of the course is to provide basic knowledge on the most important principles, methods, tools, systems, standards, etc. behind these two evolving basic technologies. Detailed description of the topic of the course is beyond the scope of this article.

Course Syllabus:
Introduction to distributed and high-performance computing. Basic terms: distributed computing, HPC, HPCC, network computing, Internet computing, cluster, grid, meta-computing, middleware, etc; milestones of the history, some representative applications. Classification: Taxonomies, MPP, SMP, CC-NUMA, cluster: dedicated high performance (HP), high availability (HA), CoPs, PoPs, CoWs; distributed, on-demand, high-throughput, collaborative, data-intensive computing. Basics of communication media and protocols: TCP/IP, Internet2, QoS, ATM, Fast Ethernet, etc. Programming models: Message passing, client-server, peer-to-peer, broker computing, code shipping, proxy computing, mobile agents. Toolkit and OO systems. Higher level communication: Light-weight communication, sockets, standard APIs, active messages. Storage and file problems: Network RAM, RAID and software RAID. Distributed File systems: NFS, AFS, OSF-DSF, RSF. Message passing standards: PVM (Parallel Virtual Machine), MPI (Message Passing Interface). Object-oriented defacto standards CORBA and DCOM. Java-based methods: JVM, RMI, Bytecode, Applet and Servlet, JavaBean and JavaSpaces, Jini. Grid toolkit approach: Globus Hourglass concept, communication, resource and process management, data access, security. Object-oriented approach: Legion Language support, component wrapping, program support, resource management. Security: Confidentiality, integrity and availability. Authentication, authorization, assurance, auditing, accounting. Scheduling: Algorithms, policies and techniques, high performance and high throughput schedulers, resource scheduling. Grid monitoring: Tasks, types, architecture, components

Reference Material:

1. Grid Computing: Techniques and Applications By Barry Wilkinson, 2011.
2. High Performance Cluster Computing: Architectures and Systems, Vol. 1 by Rajkumar Buyya, 1999.
3. Distributed and Parallel Systems: In Focus: Desktop Grid Computing by Peter Kacsuk, Robert

Lovas, Zsolt Nemeth.
4. GRID AND CLUSTER COMPUTING By C. S. R. PRABHU, 2008.
5. Grid Computing Models By D. Janakiram.
6. Fundamentals of Grid Computing: Theory, Algorithms and Technologies by Frederic Magoules. 2009.

Course Title: Advanced Topics in Parallel Processing

Course Code: CSEC-805
Course Structure:
Credit Hours: 3
Prerequisites:
Course Objectives:

The major objective of this course is to develop structural intuition of how the hardware and the software work, starting from simple systems to complex shared resource architectures; to provide guidelines about how to write and document a software package; to familiarize the audience with the main parallel programming techniques and the common software packages/libraries.

Course Syllabus:
Different topics related to parallel and systolic computations will be covered at various levels of details. Example of such topics are: architectures of parallel processors and vlsi computational networks, languages and programming environments for parallel systems, the design and analysis of parallel and systolic algorithms, reconfigurable and data driven processor arrays, complexity measures of vlsi computations, and the application of parallel processors to supercomputing.

Reference Material:

1. Parallel Processing for Scientific Computing (Software, Environments and Tools) by Michael A. Heroux, Padma Raghavan and Horst D. Simon, 2006.
2. Encyclopedia of Parallel Computing (Springer Reference) by David Padua. 2011
3. Parallel Processing and Parallel Algorithms: Theory and Computation by Seyed H Roosta, 1999.

Course Title: Special Topics in Distributed Computing

Course Code: CSEC-806
Course Structure:
Credit Hours: 3
Prerequisites:

Course Objectives:

Be able to understand and develop distributed computing systems. Topics include principles of naming and location, atomicity, resource sharing, concurrency control and other synchronization, deadlock detection and avoidance, security, distributed data access and control, integration of operating systems and computer networks, distributed systems design, consistency control, and fault tolerance.

Course Syllabus:

Building correctly functioning, performance-oriented, reliable and secure distributed systems, especially in web-based environments using Java and XML; study the design principles of distributed systems and their application to the modern networked environment; fundamental distributed systems theory including group communication, synchronization, concurrency control, load balancing and scheduling, replication, fault-tolerance, and network security; client/server systems, middleware and middleware-based systems, network computing, and networked file systems.

Topical Areas: The course will examine issues related to replication, fault tolerance, consistency, scalability, isolation and privacy in large-scale distributed systems. The course will include an in-depth coverage of cloud computing strategies to process voluminous data. Other topics include Concurrency and Synchronization, concurrency control, deadlock detection and avoidance, security, distributed data access and control, integration of operating systems and computer networks, distributed systems design, consistency control, and fault tolerance.

Reference Material:

1. Distributed Systems: Concepts and Design by , G. Coulouris, J. Dollimore, and T. Kindberg, 4th edition.
2. Distributed Systems by Sape Mullender, 2nd edition.
3. Distributed Systems: Principles and Paradigms by Andrew S. Tanenbaum and Maarten van Steen

Course Title: Special Topics in Open Source Software

Course Code: CSEC-807
Course Structure:
Credit Hours: 3
Prerequisites:

Course Objectives:
Throughout the last decade, the phenomenon of open source software has evolved from what was once a technical curiosity into a mainstay of routine business practice. The emergence of production quality systems such as Linux, MySQL, and Apache have allowed for open source technologies to be viable options for firms choosing to develop their own information technology infrastructure. The distinctive nature of open source communities, firms, and technologies, however, gives rise to issues that are profoundly different from those encountered when a system is acquired from a traditional vendor.

Course Syllabus:
In this course, we will examine the issues associated with open source technologies, with a focus on understanding the implications for businesses that are interested in using them. Through a combination of readings, presentations, discussion and hands-on projects, we will examine: the characteristics of key open source technologies (Linux, MySQL, Apache, et al), the nature of open source communities, their development processes, the evolving structure of the open source industry.

Reference Material:

1. The Business and Economics of Linux and Open Source, by Martin Fink, published by Prentice Hall PTR, 2003.
2. The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary, by Eric S. Raymond, published by O'Reilly & Associates, Inc., 2001.

Course Title: Advanced Research Methods

Course Code: CSEC-808
Course Structure:
Credit Hours:
Prerequisites:

Course Objectives:
The primary objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis.

Course Syllabus:
What is Research?, Types of Research, Why Research, Significance & Status of Research in Computer Science. Steps in Research: Having grounding in Computer Science, Major Journals & Publication in Computer Science, Major Research areas of Computer Science, Identification, selection & Formulation of research problem, Hypothesis formulation, Developing a research proposal, Planning your research, The wider community, Resources and Tools, How engineering research differs from scientific research, The role of empirical studies. Introduction to Formal Models and Computability: Turing Machine & Computability, Undecidability, Diagonalization and Self-Reference, Reductions. Introduction to Basic Techniques for Designing Algorithms: Divide-and-Conquer, Dynamic Programming, Greedy. Analysis of Algorithms. Complexity Theory: Resources and Complexity Classes, Relationship between Complexity Classes, Reducibility and Completeness, P vs NP problems. Qualitative Reasoning: Qualitative Representations, Representing Quantity, Representing Mathematical Relationship, Ontology, State, Time and Behaviors, Space and Shape, Compositional Modeling, Domain Theories, and Modeling Assumptions, Qualitative Reasoning Techniques, Model Formulation, Causal Reasoning, Simulation, Comparative Analysis, Teleological Reasoning, Data Interpretation, Planning, Spatial Reasoning, Simulation: What is simulation? How a simulation model works? Time & randomness in simulation. Applications of simulations. Research Data: What is data, Mathematical statistics and computer science views on data analysis, Methods for finding associations: regression and pattern recognition, Method for aggregation and visualization: principal components and clustering, Hypothesis testing. Literature Survey: Finding out about your research area, Literature search strategy, Writing critical reviews, Identifying venues for publishing your research. Writing Papers and the Review Process: Preparing and presenting your paper. The conference review process, Making use of the referees' reports, The journal review process, Group exercise in reviewing research papers. Ethical issues and Professional Conduct Ethics in general, Professional Ethics, Ethical Issues that Arise from Computer Technology, General Moral Imperatives, More Specific Professional Responsibilities, Organizational Leadership Imperatives.

Reference Material:

1. Research Methods by Francis C. Dane, Brooks/ Cole Publishing Company, California.
2. Basic of Qualitative Research by Juliet Corbin & Anselm Strauss, Sage Publications (2008).
3. The Nature of Research: Inquiry in Academic Context by Angela Brew, Routledge Falmer (2001).
4. Research Methods by Ram Ahuja, Rawat Publications (2001)
5. The Computer Science and Engineering Handbook by (Editor-in-Chief) By Allen B. Tucker, jr. CRC Press, A CRC Handbook Published in co-operation with A (only relevant parts of chapters of Chapter-2, Chapter-3, Chapter-4 Chapter-9,Chapter-10 & Chapter-32).

Course Title: Evolutionary Computation

Course Code: CSEC-809
Course Structure:
Credit Hours: 3
Prerequisites:

Course Objectives:
Evolutionary Computation can be considered as a sub-field of Artificial Intelligence. Evolutionary algorithms use Nature as a metaphor and are inspired in the principles of natural selection and genetics. These algorithms have been applied successfully for solving difficult problems across a broad spectrum of fields, including engineering, economics and finance, architecture, design, automatic programming, art generation, and many others. In this course, you will learn the basic working principles of these algorithms.

Course Syllabus
What is Evolutionary Computation? Historical perspective. Major classes of Evolutionary Algorithms. Local vs global search methods. Simple genetic algorithms. Major methods for selection, recombination, mutation, and replacement. Representations and design of operators. Evolution strategies. The 1/5 rule. Self-adaptation of mutation step sizes. Representations. Design of operators. Using problem specific information. Genetic programming. Interactive Evolutionary Computation. Constraint handling. Finding multiple optima. Multi-objective optimization. Basic GA theory. Limitations of simple EAs. Problem difficulty and the NFL theorem. Goldberg's decomposition for competent GAs. Parameter setting in EAs. Performance assessment. Basic ideas of Estimation of Distribution Algorithms.

Reference Material:

1. Genetic Algorithms in Search, Optimization and Machine Learning by David E. Goldberg, Addison-Wesley, 1989 or Latest Edition.
2. Introduction to Evolutionary Computing by A. E. Eiben and J. E. Smith, Springer, 2003.
3. Evolutionary Computation 1: Basic Algorithms and Operators edited by T. Bäck, D. B. Fogel, Z. Michalewicz, 2000
4. Evolutionary Computation 2: Advanced Algorithms and Operators edited by T. Bäck, D. B. Fogel, Z. Michalewicz, 2000.

5. Essentials of Metaheuristics by Sean Luke, 2010.
6. A Field Guide to Genetic Programming by Riccardo Poli, William Langdon, and Nicholas McPhee.

Course Title: Special Topics in Machine Learning

Course Code: CSEC-810
Course Structure: Lecture: 3/ Lab: 0
Credit Hour: 3
Prerequisite: Linear Algebra/ Probability Theory

Course Objectives:
This course covers several modern machine-learning topics at an advanced level. The current list of possible topics includes deep learning, maximum-margin methods, kernel methods, graphical models and Monte Carlo methods. The theoretical and mathematical underpinnings of these topics will be discussed along with their role in modern machine learning by reading and discussing recent publications.

Course Syllabus:

Generative and Discriminative Learning, Graphical Models: Representations, Learning and Inference, Hidden Markov Models, Latent Dirichlet Allocation, Collaborative Filtering, Maximum-margin methods, Kernel Methods, Deep Learning.

Reference Material:

1. Pattern Recognition and Machine Learning by Chris Bishop, 2006
2. Kernel Methods for Pattern Analysis by John Shawe-Taylor & Nello Cristianini [Text Book]
3. Gaussian Processes for Machine Learning byCarl Edward Rasmussen & Christopher Williams [Reference Book]
4. Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond by Bernhard Schlkopf & Alex Smola [Reference Book]
5. Probabilistic Graphical Models: Principles and Techniques by Daphne Koller & Nir Friedman

Course Title: Special Topics in Artificial Intelligence

Course Code: CSEC-811

Course Structure: Lecture: 3/ Lab: 0

Credit Hour: 3

Prerequisite: Introduction of Artificial Intelligence

Course Objectives:
The students should obtain advanced theoretical knowledge and technical skills on the topics covered in the course. The course will enable students to carry out advanced research projects on topics within artificial intelligence and apply the knowledge to complex intelligent system design and development. Upon completion of the course the candidate should be able to:

- Discuss advanced theoretical and technical issues in artificial intelligence.
- Apply knowledge for complex intelligent system design and development.
- Carry out advanced research on artificial intelligence.

Course Syllabus:

The course covers advanced theoretical and technical issues in artificial intelligence. It will focus on some selected topics and applications, such as artificial life, agent and multi-agent systems, graphical models, advanced neural networks, genetic algorithms and programming, natural language processing, case-based reasoning, cognitive science, and neuro-computing.

Reference Material:

1. Artificial Intelligence: A Modern Approach (3rd edition) by Russell, S. and Norvig, P., Prentice Hall, 2009.
2. Most of the course will be taught by using research paper on topics

Course Title: Advanced Optimization Methods
Course Code: CSEC-812
Course Structure: Lecture: 3/ Lab: 0
Credit Hour: 3
Prerequisite: Linear Algebra/Multivariate Calculus

Course Objectives:
This course introduces the principal algorithms for linear, network, discrete, nonlinear, dynamic optimization and optimal control. Emphasis is on methodology and the underlying mathematical structures. Topics include the simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton's method, heuristic methods, and dynamic programming and optimal control methods.

Course Syllabus:

The course takes a unified view of optimization and covers the main areas of application and the main optimization algorithms. It covers the following topics: Linear optimization, Robust optimization, Network flows, Discrete optimization, Dynamic optimization, Nonlinear optimization.

Reference Material:

1. Introduction to Linear Optimization by Bertsimas, Dimitris, and John Tsitsiklis. Athena Scientific, 1997 or Latest Edition.
2. Numerical Optimization: Theoretical and Practical Aspects, By Joseph-Frédéric Bonnans, Jean Charles Gilbert, Claude Lemarechal, Claudia A. Sagastizábal, Springer Science & Business Media, 2006.

Course Title: Special Topics in Data Mining
Course Code: CSEC-813
Course Structure: Lecture: 3/ Lab: 0
Credit Hour: 3
Prerequisite: Introductory Data Mining Course

Course Objectives:
Data Mining is one of the hottest fields in Computer Science. Data has been accumulating throughout the computer age in many forms, including database systems, spreadsheets, text files, and recently web pages. Data mining aims to search through data for hidden relationships and patterns in your data. This is a special topic course on data mining. We will cover advanced topics such as large-scale data mining using Map-reduce, similarity search (including minwise hashing and locality sensitive hashing), mining data streams, mining social networks, relational data mining, and matrix factorization methods for data mining. This course will be highly beneficial to students whose research interests are in database, data mining, bio-informatics, information retrieval, decision science and artificial intelligence, and also to those who may need to apply data mining to any application.

Course Syllabus

This is a seminar course that will focus on recent developments of advanced data mining techniques and their applications to various problems. After the introductory lectures, subsequent classes will mainly based on research papers. Topics will include: Large-scale Data Mining, Mining Data Streams, Mining Social Networks, Relational Data Mining, Tree/Graph Mining, Privacy-preserving Data Mining, High-Dimensional Data Clustering, Web Applications (including advertising, recommendation, and summarization).

Reference Material:
1. Data mining: concepts and techniques Han, Jiawei, Jian Pei, and Micheline Kamber. . Elsevier, 2011.
2. Mining of Massive Datasets by Anand Rajaraman, Jeffrey David Ullman. 2011.
3. Ethical Data Mining Applications for Socio-Economic Development by Hakikur Rahman, Isabel Ramos, 2013.
4. The latest research articles on the topics will be presented.

Course Title: Peer-To-Peer Systems

Course Code: CSEC-814

Course Structure: Lecture: 3/ Lab: 0

Credit Hour: 3

Prerequisite:

Course Objectives:
Peer-to-peer systems have recently gained a lot of attention in the social, academic, and commercial communities. One of the early driving forces behind the peer-to-peer concept is that there are many PCs in homes and offices that lie idle for large chunks of time. This course will introduce the state of the art knowledge about peer to peer systems.

Course Syllabus:

Overview of P2P Systems and brief history; Taxonomy of P2P Networks/Systems and Analysis of popular P2P Systems; Analysis of unstructured P2P Systems; Analysis of structured P2P Systems; Search Efficiency; P2P-based content delivery; Security and Reliability; Replication in peer-to-peer systems; Anonymity in peer-to-peer systems; Social, Legal and Privacy aspects of P2P Systems.

Reference Material:

1. Peer-to-Peer Systems and Applications by Ralf Steinmetz and Klaus Wehrle, 2005.
2. Peer-to-Peer : Harnessing the Power of Disruptive Technologies by Andy Oram, 2001.
3. Handbook of Peer-to-Peer Networking, by Xuemin Shen, Heather Yu, John Buford, Mursalin Akon, 2010.
4. Peer-to-Peer Computing: Applications, Architecture, Protocols, and Challenges by Yu-Kwong Ricky Kwok, 2011.
5. The latest research articles on the topics will be presented.

Course Title: Ubiquitous Information Interaction

Course Code: CSEC-815

Course Structure: Lecture: 3/ Lab: 0

Credit Hour: 3

Prerequisite: Introductory Data Mining Course

Course Objective:
The purpose of this course is to introduce students with: the objectives and the historical development of the field of ubiquitous computing; development in new materials; fundamentals of sensor technology

and sensor networks; design of new (often embedded) interactive artefacts; context aware and adaptive systems; middleware for fine-grained distributed systems; analysis and coordination of complex systems; new styles of interaction, e.g. tangible interfaces; most important applications in the field; general implications of the field.

Course Syllabus:

Information Interaction; Seminal ideas of ubiquitous computing; Tangibility and Embodiment; Social computing; Privacy; Critical and cultural perspectives; Mobility and Spatiality; Mobile Technology in the Messy Now; Infrastructure; Seams, seamlessness, seamfulness; Evaluating Interaction of Ubicomp systems.

Reference Material:

1. Ubiquitous Computing: Smart Devices, Environments and Interactions, By Stefan Poslad. 2011.
2. Ubiquitous Computing: Design, Implementation and Usability by Yin-Leng Theng and Henry Duh 2007.
3. Bringing Iterative Design to Ubiquitous Computing: Interaction Techniques By Rafael A. Ballagas. 2008.
4. The latest research articles on the topics will be presented.

Course Title: Evolution and Re-Engineering

Course Code: CSEC-816

Course Structure: Lecture: 3/ Lab: 0

Credit Hour: 3

Prerequisite:

Course Objectives:

The objective of the course is to examine the set of tools and techniques that allow a smooth re-engineering of old legacy systems to new more maintainable systems that use more appropriate and robust advanced technologies (i.e. Object-Oriented, Network-Centric).

Course Syllabus:

Introduction: Challenges of evolution, Legacy systems; Evolution Process: Laws of software evolution, Evolution models, Testing in the context of evolution, Metrics for evolution; Evolution Activities: Concepts of, and techniques for activities e.g. Reverse engineering, Re-factoring, Program Transformation, Visualization; Re-engineering techniques: Code restructuring, Source code analysis, Architecture Recovery; Topics in re-engineering research.

Reference Material:

1. Modernizing Legacy Systems: Software Technologies, Engineering Processes, and Business Practices by Seacord, Plakosh, Lewis, Addison-Wesley ISBN 0321118847, 2003.
2. Aspect-Oriented Software Development by Filman, Elrad, Clarke, Aksit, Addison-Wesley ISBN 0321219767, 2004
3. Refactoring: Improving the Design from Existing Code, Addison-Wesley ISBN 0201485672, 2000.
4. Successful Evolution of Software Systems by Yang & Ward, Artech House Publishers, ISBN 1580533493, 2003.
5. Software Evolution and Feedback: Theory and Practice by Nazim H. Madhavji, M.M. Lehmann, J. Ramil, Dewayne Perry, John Wiley & Sons, ISBN 0470871806, 2005.
6. The latest research articles on the topics will be presented.

Course Title: Program Comprehension and Reverse Engineering

Course Code: CSEC-817

Course Structure: Lecture: 3/ Lab: 0

Credit Hour: 3

Prerequisite:

Course Objectives:
The objective of this course is to introduce students with reverse engineering techniques and algorithms.

Course Syllabus:

Static Analysis: Parsing, lexical analysis, issues in parsing languages; Program analysis: Control flow analysis, Data flow analysis, flow graphs, program dependence graphs, call graphs; Dynamic analysis: Profiling, dynamic testing; Reverse engineering: Design recovery and re-documentation, challenges in reverse engineering, reverse engineering approaches; Reverse engineering techniques: Techniques for reverse engineering at the program level, Techniques for reverse engineering at the architectural level Reverse Engineering tools.

Reference Material:

1. Wills, Linda M., and Philip Newcomb, eds. Reverse engineering. Springer Science & Business Media, 2007.
2. Reversing: Secrets of Reverse Engineering by Eldad Eilam 2011.
3. Reverse Engineering of Object Oriented Code By Paolo Tonella, Alessandra Potrich, 2005.

Course Title: Software Refactoring

Course Code: CSEC-818

Course Structure: Lecture: 3/ Lab: 0

Credit Hour: 3

Prerequisite:

Course Objectives:
The objective of this course is to learn the techniques for: Use refactoring to facilitate adding new functionality to system; Use refactoring to improve design; Refactor existing applications to make them more maintainable; Use tests during refactoring; Recognize when and when not to refactor; Identify and choose the appropriate type of refactoring technique to solve specific problems.

Course Syllabus:

Refactoring principles: Reasons for refactoring, what to refactor, Challenges in refactoring ; Refactoring categories: Refactoring in the small and large; Refactoring techniques: Recognizing bad

smells in code, refactoring for organizing code, higher abstraction, improvement and others; Refactoring of UML models, Tool support for refactoring: Strengths and limitations

Reference Material:

1. Refactoring: Improving the Design of Existing Code By Martin Fowler, Kent Beck, John Brant, William Opdyke, Don Roberts
2. AntiPatterns: Refactoring Software, Architectures, and Projects in Crisis. William J. Brown. 1998.
3. Refactoring in Large Software Projects: Performing Complex Restructurings By Martin Lippert, Stephen Roock. 2006.

Course Title: Advance Software Architecture

Course Code: CSEC-819

Course Structure: Lecture: 3/ Lab: 0

Credit Hour: 3

Prerequisite:

Course Objectives:

This course enables the students to understand the challenges of advanced software design and the issues associated with large-scale software architectures, frameworks, patterns and components. To develop the students' understanding of the tools and techniques that may be used for the automatic analysis and evaluation of software.

Course Syllabus:

Re-use in architectures: Software product lines, evaluation and validation of product lines, product line testing, re-use in product lines; Service oriented architectures (SOAs): SOA concepts, risks and challenges, quality attributes and SOAs, evaluating and testing SOAs; Architectural evaluation: Methods for architectural analysis, Comparison of methods; Architectural evolution and reconstruction: Models of software evolution, analysis and metrics for evolution, Techniques and tools for architecture reconstruction; Architectures in dynamic environments: Modeling and analyzing dynamic software architectures; Self healing architectures: The need for self-healing, approaches for self healing and state of art topics in software architecture.

Reference Material:

1. Software Product Lines: Practices and Patterns by Clements and L. Northrup, Addison-Wesley, 2002.
2. Software Architecture : Foundations, Theory, and Practice by R. Taylor, N. Medvidović and E.M. Dashofy, John Wiley, 2010.

Course Title: Special Topics Natural Language Engineering

Course Code: CSEC-801
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
This course covers a broad range of topics in computational linguistics/natural language processing, including word and sentence tokenization, text classification and sentiment analysis, spelling correction, information extraction, parsing, meaning extraction, and question answering, We will also introduce the underlying theory from probability, statistics, and machine learning that are crucial for the field, and cover fundamental algorithms like n-gram language modeling, naive bayes and maxent classifiers, sequence models like Hidden Markov Models, probabilistic dependency and constituent parsing, and vector-space models of meaning.

Course Syllabus:
Introduction, Chomsky hierarchy, Language models, Probability concepts, Bayes' Theorem, Smoothing n-grams, Improving CFG with attributes, Context-free parsing, Earley's algorithm, Extending CFG, Probabilistic parsing, Parsing tricks, Human sentence processing, Semantics, Forward-backward algorithm, Expectation Maximization, Finite-state algebra, Finite-state implementation, Finite-state tagging, Noisy channels and FSTs, More FST examples, Programming with regexps, Morphology and phonology, Optimal paths in graphs, Structured prediction, Current NLP tasks and competitions, Applied NLP, Topic models, Machine translation.

Course Outline:

1. Introduction, Why is NLP hard? Levels of language, NLP applications ,Random language via n-grams. [J&M Ch. 1]
2. Chomsky hierarchy, What's wrong with n-grams? Regular expressions, CFGs, & more, Lists, trees, and vectors. [J&M Ch. 16]
3. Language models, Language ID, Text categorization, Spelling correction, Segmentation, Speech recognition, Machine translation. [M&S 6]
4. Probability concepts, Joint & conditional prob, Chain rule and backoff, Modeling sequences, Cross-entropy and perplexity. [M&S 2]
5. Bayes' Theorem, Smoothing n-grams, Maximum likelihood estimation, Bias and variance, Add-one or add-lambda smoothing, Good-Turing discounting, Smoothing with backoff, Deleted interpolation, Conditional log-linear models (interactive visualization), Regularization. [M&S2, 6; J&M 4;]
6. Improving CFG with attributes, Morphology, Lexicalization, Tenses, Gaps (slashes). [J&M 15]
7. Context-free parsing, What is parsing? Why is it useful? Brute-force algorithm, CKY and Earley algorithms, From recognition to parsing, Incremental strategy, Dotted rules, Sparse matrices. [J&M 13]
8. Earley's algorithm, Top-down parsing, Earley's algorithm; Extending CFG, CCG, TSG, TAG [J & M 14]

9. Probabilistic parsing, Dependency grammar, Lexicalized PCFGs; Parsing tricks, Pruning; best-first, Rules as regexps, Left-corner strategy, Smoothing, Evaluation, A song about parsing; Human sentence processing, Methodology, Frequency sensitivity, Incremental interpretation, Unscrambling text; [M&S 12; J&M 14; TT]
10. Semantics, What is understanding? Lambda terms, Semantic phenomena and representations, More semantic phenomena and representations, Adding semantics to CFG rules, Compositional semantics. [J&M 17-18;]
11. Forward-backward algorithm, Ice cream, weather, words and tags, Forward and backward probabilities, Inferring hidden states, Controlling the smoothing effect, Reestimation, Likelihood convergence, Symmetry breaking, Local maxima, Uses of states. [J&M 6]
12. Expectation Maximization, Generalizing the forward-backward strategy, Inside-outside algorithm, Posterior decoding; Finite-state algebra, Regexp review, Properties, Functions, relations, composition, Simple applications; [M&S11; R&S 1]
13. Finite-state implementation, Acceptors, Expressive power, Weights and semirings, Lattice parsing, Transducers; Finite-state tagging, The task, Hidden Markov Models, Transformation-based, Constraint-based; Noisy channels and FSTs, Regexps and segmentation, The noisy channel generalization, Applications of the noisy channel, Implementation using FSTs More FST examples, Baby talk, Edit distance, Back-transliteration, Machine translation; [J&M 5 or M&S 10]
14. Programming with regexps, Analogy to programming, Extended finite-state operators, Date parsing, FASTUS; Morphology and phonology, English, Urdu, Arabic, Stemming, Compounds, segmentation, Two-level morphology, Punctuation, Rewrite rules, OT; Optimal paths in graphs, The Dyna perspective; [R&S 2]
15. Structured prediction, Perceptrons, CRFs, Feature engineering, Generative vs. discriminative; Current NLP tasks and competitions, The NLP research community, Text annotation tasks, Other types of tasks; Applied NLP, Topic models (Guest lecture); Machine translation (Guest lecture). [J&M 25, M&S 13]

Reference Material:

1. Daniel Jurafsky and James H. Martin. 2008. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Second Edition. Prentice Hall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural Language Processing. MIT Press.
3. Steven Bird. 2009. Natural Language Processing with Python. O'Reilly. (Free on SearchWorks)
4. Philipp Koehn. 2010. Statistical Machine Translation. Cambridge.
5. Yoshua Bengio. 2009. Learning Deep Architectures for AI. Technical Report. (Free from Stanford network)
6. Frederick Jelinek. 1998. Statistical Methods for Speech Recognition. MIT Press.
7. James Allen. 1995. Natural Language Understanding. Benjamin/Cummings, 2ed.
8. Psycholinguistics: Tanenhaus & Trueswell (2006), Human Sentence Processing website

Course Title: Category Theory

Course Code: CSEC-820
Course Structure: Lectures: /Labs: 3+0
Credit Hours: 03
Prerequisites: Linear Algebra

Course Objectives:
To develop students' basic understanding in category theory so that they may be able to develop scientific models using category theory, especially in the field of computer science.

Course Syllabus:
Basic concepts of category theory, mappings, natural transformations and the algebras.

Course Outline:

1. Introduction to category theory [Ch. 1]
2. Category of sets: Sets and functions, Commutative diagrams, Ologs, Products and coproducts, Finite limits in Set, Finite colimits in Set, Other notions in Set [Ch. 2]
3. Categories and functors: Monoids, Groups, Graphs, Orders, Databases: schemas and instances [Ch. 3]
4. Basic category theory: Categories and functors commonly arising in mathematics, Natural transformations, Categories and schemas equivalence, Limits and colimits, Other notions in Cat [Ch. 4]
5. Categories at work: Adjoint functors, Categories of functors, Monads, Operads [Ch. 5]

Reference Material:

1. Spivak, David I. Category Theory for Scientists, 2013
2. 1.Awodey, Steve. Category Theory. Oxford University Press, 2010. ISBN: 9780199237180

Course Title: Concrete Mathematics

Course Code: CSEC-821
Course Structure: Lectures: /Labs: 3+0
Credit Hours: 03
Prerequisites: Discrete Mathematics

Course Objectives:
To develop sound theoretical foundations for computer science problems.

Course Syllabus:
Recurrent problems, sums, integer functions, binomial coefficients, special numbers and generating functions.

Course Outline:
1. Recurrent Problems: The Tower of Hanoi, Lines in the Plane, The Josephus Problem [Ch. 1]
2. Sums: Notation, Sums and Recurrences, Manipulation of Sums, Multiple Sums, General Methods, Finite and Infinite Calculus, Infinite Sums [Ch. 2]
3. Integer Functions: Floors and Ceilings, Floor/Ceiling Applications, Floor/Ceiling Recurrences, 'mod': The Binary Operation, Floor/Ceiling Sums [Ch. 3]
4. Binomial Coefficients: Basic Identities, Basic Practice, Tricks of the Trade, Generating Functions, Hypergeometric Functions, Hypergeometric Transformations, Partial Hypergeometric Sums, Mechanical Summation [Ch. 5]
5. Special Numbers: Stirling Numbers, Eulerian Numbers, Harmonic Numbers, Harmonic Summation, Bernoulli Numbers, Fibonacci Numbers, Continuants [Ch. 6]
6. Generating Functions: Domino Theory and Change, Basic Maneuvers, Solving Recurrences, Special Generating Functions, Convolutions, Exponential Generating Functions, Dirichlet Generating Functions [Ch. 7]

Reference Material:
1. Donald L. Graham, Donald E. Knuth, Oren Patashnik, Concrete Mathematics: A Foundation for Computer Science (2nd Edition), Addison-Wesley Professional, ISBN-10: 0201558025, ISBN-13: 978-0201558029

Course Title: Number Theory and Cryptography

Course Code: CSEC-822
Course Structure: Lectures: /Labs: 3+0
Credit Hours: 03
Prerequisites: Linear Algebra, Analysis of Algorithms, Probability and Statistics

Course Objectives:
In this course the focus will be on the mathematical background that makes modern cryptography work as well as the mathematics behind cryptanalysis.

Course Syllabus:
The concept of public key cryptography, and more advanced mathematical concepts are introduced.

Course Outline:

1. Basics of Number Theory: Time estimates for doing arithmetic, Divisibility and the Euclidean algorithm, Congruences, Some applications to factoring [Ch. I]
2. Finite Fields and Quadratic Residues: Finite fields, Quadratic residues and reciprocity [Ch. II]
3. Cryptography: Some simple cryptosystems, Enciphering matrices [Ch. III]
4. Public Key: The idea of public key cryptography, RSA, Discrete log, Knapsack, Zero-knowledge protocols and oblivious transfer [Ch. IV]
5. Primality and Factoring: Pseudoprimes, The rho method, Fermat factorization and factor bases, The continued fraction method, The quadratic sieve method [Ch. V]
6. Elliptic Curves: Basics, Elliptic curve cryptosystems, Elliptic curve primality test, Elliptic curve factorization [Ch. VI]

Reference Material:

1. Neal Koblitz, A Course in Number Theory and Cryptography, 2nd Edition, 1994.
2. Alfred Menezes, Paul C. van Oorschot, Scott A Vanstone, A Handbook of Cryptography, 1st edition, 1997.
3. IEEE P1363 Standard Specifications for Public Key Cryptography, Aug 2000.

Course Title: Harmonic Analysis

Course Code: CSEC-823
Course Structure: Lectures: /Labs: 3+0
Credit Hours: 03
Prerequisites: Linear Algebra, Calculus-I

Course Objectives:
To introduce central concepts of harmonic analysis useful in the field of computer science.

Course Syllabus:
Fourier analysis leading up to the Poisson summation formula, generalization of the concepts of Fourier analysis in the context of locally compact abelian groups and non-commutative harmonic analysis.

Course Outline:
Fourier Analysis: Fourier Series [Ch. 1], Hilbert Spaces [Ch. 2], The Fourier Transform [Ch. 3], Distributions [Ch. 4]
LCA Groups: Finite Abelian Groups [Ch. 5], LCA Groups [Ch. 6], The Dual Group [Ch. 7], Plancherel Theorem [Ch. 8]
Noncommutative Groups: Matrix Groups [Ch. 9], The Representations of SU(2) [Ch. 10], The Peter-Weyl Theorem [Ch. 11], The Heisenberg Group [Ch. 12]

Reference Material:
1. Anton Deitmar, A First Course in Harmonic Analysis (2nd Ed.), 2005, Springer, ISBN-10: 0387228373, ISBN-13: 978-0387228372
2. Carl L. DeVito, Harmonic Analysis: A Gentle Introduction, 2006, Jones & Bartlett Learning, ISBN-10: 076373893X, ISBN-13: 978-0763738938

Course Title: Randomized Algorithms

Course Code: CSEC-824
Course Structure: Lectures: /Labs: 3+0
Credit Hours: 03
Prerequisites: Analysis and Design of Algorithms

Course Objectives:
The course is aimed to develop students' basic understanding in design and analysis of randomized algorithms

Course Syllabus:
Concepts of a probability theory required for the course and usage of these concepts for design of algorithms.

Course Outline:

1. Introduction: A Min-Cut Algorithm, Las Vegas and Monte Carlo, Binary Planar Partitions, A Probabilistic Recurrence [Ch. 1]
2. Game-Theoretic Techniques: Game Tree Evaluation, The Minimax Principle, Randomness and Non-uniformity [Ch. 2]
3. Moments and Deviations: Occupancy Problems, The Markov and Chebyshev Inequalities, Randomized Selection, Two-Point [Ch. 3]
4. Tail Inequalities: The Chernoff Bound, Routing in a Parallel Computer, A Wiring Problem, Martingales [Ch. 4]
5. The Probabilistic: Maximum Satisfiability, Expanding, Oblivious, The Lovasz Local Lemma, The Method of Conditional [Ch. 5]
6. Markov Chains and Random Walks: A 2-SAT Example, Markov Chains, Random Walks on Graphs, Cover Times, Graph Connectivity, Expanders and Rapidly Mixing Random Walks, Probability Amplification by Random Walks on Expanders [Ch. 6]
7. Algebraic Techniques: Fingerprinting and Freivalds' Technique, Verifying Polynomial Identities, Perfect Matchings in Graphs, Verifying Equality of Strings, A Comparison of Fingerprinting Techniques, Pattern Matching, Interactive Proof Systems [Ch. 7]
8. Graph Algorithms: All-pairs Shortest Paths, The Min-Cut Problem, Minimum Spanning Trees [Ch. 10]
9. Approximate Counting: Randomized Approximation Schemes, The DNF Counting Problem [Ch. 11]
10. Parallel and Distributed Algorithms: The PRAM Model, Sorting on a PRAM, Maximal Independent Sets, Perfect Matchings [Ch. 12]
11. Online Algorithms: The Online Paging Problem, Adversary Models, Paging against an Oblivious Adversary, Relating the Adversaries, The Adaptive Online Adversary, The k-Server Problem [Ch. 13]

Reference Material:

1. Motwani, and Raghavan. Randomized Algorithms. Cambridge, UK: Cambridge University Press, 1995. ISBN: 0521474655.
2. Feller, William. An Introduction to Probability Theory and Its Applications.Vol. 1. New York, NY: John Wiley, 1968. ISBN: 0471257087

Course Title: Spectral Graph Theory

Course Code: CSEC-825
Course Structure: Lectures: /Labs:
Credit Hours:
Prerequisites: Analysis and Design of Algorithms

Course Objectives:
The course is aimed to develop students' understanding of spectral properties of graphs to deduce theorems

Course Syllabus:
Concepts of a graph spectrum, coloring concepts of linear algebra with emphasis on eigenvalues, spectra of trees, relationships between groups and graphs, Euclidean representations, Strongly regular graphs, Regular two-graphs, Association schemes, Distance regular graphs, *p*-ranks, Spectral characterizations, Graphs with few eigenvalues

Course Outline:

1. Graph spectrum: Matrices associated to a graph, The spectrum of a graph, The spectrum of an undirected graph, Spectrum of some graphs, Decompositions, Automorphisms, Algebraic connectivity, Cospectral graphs (4 hours)
2. Linear algebra: Simultaneous diagonalization, Perron-Frobenius Theory, Equitable partitions, The Rayleigh quotient, Interlacing, Schur's inequality, Schur complements, The Courant-Weyl inequalities, Gram matrices, Diagonally dominant matrices (2 hours)
3. Eigenvalues and eigenvectors: The largest eigenvalue, Interlacing, Regular graphs, Bipartite graphs, Cliques and cocliques, Chromatic number, Shannon capacity, Classification of integral cubic graphs, The largest Laplace eigenvalue, Laplace eigenvalues and degrees, The Grone-Merris Conjecture, The Laplacian for hypergraphs, Applications of eigenvectors (7 hours)
4. The second largest eigenvalue: Bounds for the second largest eigenvalue, Large regular subgraphs are connected, Randomness, Expansion, Toughness and Hamiltonicity, Diameter bound, Separation, Block designs, Polarities (3 hours)
5. Trees: Characteristic polynomials of trees, Eigenvectors and multiplicities, Sign patterns of eigenvectors of graphs, Sign patterns of eigenvectors of trees, The spectral center of a tree, Integral trees (2 hours)
6. Groups and graphs: □(*G*,*H*,*S*), Spectrum, Nonabelian Cayley graphs, Covers, Cayley sum graphs (2 hours)
7. Topology: Embeddings, Minors, The Colin de Verdi`ere invariant, The Van der Holst-Laurent-Schrijver invariant (2 hours)
8. Euclidean representations: Examples, Euclidean representation, Root lattices, Cameron-Goethals-Seidel-Shult (2 hours)
9. Strongly regular graphs: Strongly regular graphs, Strongly regular graphs with eigenvalue – 2, Connectivity, Cocliques and colorings, Automorphisms, Generalized quadrangles, The (81,20,1,6) strongly regular graph, Strongly regular graphs and -weight codes (8 hours)
10. Regular two-graphs: Strong graphs, Two-graphs, Regular two-graphs, Conference matrices,

Hadamard matrices, Equiangular lines (3 hours)

11. Association schemes: Definition, The Bose-Mesner algebra, The Linear Programming Bound, The Krein parameters, Automorphisms, *P*- and *Q*-polynomial association schemes (2 hours)
12. Distance regular graphs: Parameters, Spectrum, Examples, Bannai-Ito conjecture, Connectedness, Degree of eigenvalues, Moore graphs and generalized polygons, Primitivity, Euclidean representations, Extremality (2 hours)
13. *p*-ranks: Reduction mod *p*, The minimal polynomial, Bounds for the *p*-rank, Interesting primes *p*, Adding a multiple of *J*, Paley graphs, Strongly regular graphs, Smith Normal Form (2 hours)

Spectral characterizations: Generalized adjacency matrices, Constructing cospectral graphs, Enumeration, DS graphs, Distance-regular graphs, The method of Wang & Xu (5 hours)

Graphs with few eigenvalues: Regular graphs with four eigenvalues, Three Laplace eigenvalues, Other matrices with at most three eigenvalues (2 hours)

Reference Material:

1. Spectra of Graphs by A.E. Brouwer and W.H. Haemers, Springer-Verlag New York; 1st edition (2012) ISBN: 978-1-4614-1938-9 and 978-1-4899-9433-2

Course Title: Wavelets

Course Code: CSEC-826
Course Structure: Lectures: /Labs: 3+0
Credit Hours: 03
Prerequisites: Linear Algebra

Course Objectives:
To develop students' understanding in the design of wavelets so that they are able to design their own wavelets.

Course Syllabus:
Basics of complex numbers and linear algebra, Discrete Fourier transform, Wavelets construction in $\mathbb{Z}$.

Course Outline:
Introduction to Complex Numbers and Linear Algebra

The Discrete Fourier Transform: Basic Properties of the Discrete Fourier Transform, Translation-Invariant Linear Transformations, Fast Fourier Transform
Wavelets on $\mathbb{Z}$ *N*: Construction of Wavelets on $\mathbb{Z}$ *N* - First Stage and The Iteration Step, Examples and Applications
Wavelets on $\mathbb{Z}$: $l^2(\mathbb{Z})$, Complete Orthonormal Sets in Hilbert Spaces, $l^2([-\pi, \pi))$ and Fourier Series, The Fourier Transform and Convolution on $l^2(\mathbb{Z})$, First-Stage Wavelets on $\mathbb{Z}$, The Iteration Step for Wavelets on $\mathbb{Z}$, Implementation and Examples
Wavelets on R: $l^2(R)$ and Approximate Identities, The Fourier Transform on R, Multiresolution Analysis and Wavelets, Construction of Multiresolution Analyses, Wavelets with Compact Support and Their Computation

Reference Material:
1. Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra, Springer, 2001, ISBN-10: 0387986391, ISBN-13: 978-0387986395
2. Gerald Kaiser, A Friendly Guide to Wavelets, 1st Ed., Birkhäuser Boston, 1994, ISBN-10: 0817637117, ISBN-13: 978-0817637118

Course Title: Information Theory I

Course Code: CSEC-827
Course Structure: Lectures: 3/Labs: 0
Credit Hours: 3
Prerequisites: None

Course Objectives:
The course will introduce students with key concepts of Information Theory.

Course Syllabus:
Information Sources. Pair Processes. Block Independent Channels. Entropy. The Entropy Ergodic Theorem. Distortion and Approximation. Approximating Random Vectors and Processes. Distortion and Entropy. Relative Entropy. Information Rates. Distortion and Information. Ergodic Theorems for Densities. Source Coding Theorems. Asynchronous Block Codes, Sliding-Block Source Codes, Geometric Interpretation, Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Course Outline:
1. Information Sources: Probability Spaces and Random Variables, Random Processes and Dynamical Systems, Distributions, Standard Alphabets, Expectation, Asymptotic Mean Stationary, Ergodic Properties.
2. Pair Processes: Channels, Codes, and Couplings, Pair Processes, Channels, Stationary Properties of Channels, Extremes: Noiseless and Completely Random Channels, Deterministic Channels and Sequence Coders, Stationary and Sliding-Block Codes, Block Codes, Random Punctuation Sequences, Memoryless Channels, Finite-Memory Channels, Output Mixing Channels.
3. Block Independent Channels, Conditionally Block Independent Channels, Stationarizing Block Independent Channels, Primitive Channels, Additive Noise Channels, Markov Channels, Finite-State Channels and Codes, Cascade Channels, Communication Systems, Couplings, Block to Sliding-Block: The Rohlin-Kakutani Theorem.
4. Entropy: Entropy and Entropy Rate, Divergence Inequality and Relative Entropy, Basic Properties of Entropy, Entropy Rate, Relative Entropy Rate, Conditional Entropy and Mutual Information, Markov Approximations, Relative Entropy Densities.
5. The Entropy Ergodic Theorem: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, The Asymptotic Equi partition Property.
6. Distortion and Approximation: Distortion Measures, Fidelity Criteria, Average Limiting Distortion, Communications Systems Performance, Optimal Performance, Code Approximation.
7. Approximating Random Vectors and Processes, The Monge/Kantorovich/Vasershtein Distance. Variation and Distribution Distance, Coupling Discrete Spaces with the Hamming Distance, Process Distance and Approximation, Source Approximation and Codes, d-bar Continuous Channels.
8. Distortion and Entropy: The Fano Inequality, Code Approximation and Entropy Rate, Pinsker's and Marton's Inequalities, Entropy and Isomorphism, Almost Lossless Source Coding, Asymptotically Optimal Almost Lossless Codes, Contents xv, Modelling and Simulation.

9. Relative Entropy: Divergence, Conditional Relative Entropy, Limiting Entropy Densities, Information for General Alphabets, Convergence Results.
10. Information Rates: Information Rates for Finite Alphabets, Information Rates for General Alphabets, A Mean Ergodic Theorem for Densities, Information Rates of Stationary Processes, The Data Processing Theorem, Memoryless Channels and Sources,
11. Distortion and Information: The Shannon Distortion-Rate Function, Basic Properties, Process Definitions of the Distortion-Rate Function, The Distortion-Rate Function as a Lower Bound, Evaluating the Rate-Distortion Function.
12. Ergodic Theorems for Densities: Stationary Ergodic Sources, Stationary Nonergodic Sources, AMS Sources, Ergodic Theorems for Information Densities.
13. Source Coding Theorems: Source Coding and Channel Coding, Block Source Codes for AMS Sources, Block Source Code Mismatch, Block Coding Stationary Sources, Block Coding AMS Ergodic Sources Subadditive Fidelity Criteria.
14. Asynchronous Block Codes, Sliding-Block Source Codes, Geometric Interpretation, Properties of Good Source Codes, Optimal and Asymptotically Optimal Codes, Block Codes Sliding-Block Codes.

Reference Material:

1. Entropy and Information Theory by Robert M. Gray, Springer; 2nd Edition. Edition (February 3, 2011). ISBN-10: 1441979697
2. Information and Coding Theory by Gareth A. Jones, J.Mary Jones, Springer; 2000 Edition (July 31, 2000). ISBN-10: 1852336226
3. Information Theory And Evolution by John Scales Avery, World Scientific Publishing Company; 2nd Edition (July 16, 2012). ISBN-10: 9814401234
4. Elements of Information Theory by Thomas M. Cover, Joy A. Thomas, Wiley-Interscience; 2nd Edition (July 18, 2006). ISBN: 0-471-24195-4

Course Title: Special Topics in Grammar Engineering

Course Code: CSEC-802
Course Structure: Lectures: 3/Labs: 1
Credit Hours: 4
Prerequisites: None

Course Objectives:

Natural language processing (NLP) enables computers to make use of data represented in human language (including the vast quantities of data available on the web) and to interact with computers on human terms. Applications from machine translation to speech recognition and web-based information retrieval demand both precision and robustness from NLP technology. Meetings these demands will require better hand-built grammars of human languages combined with sophisticated statistical processing methods. This course focuses on the implementation of linguistic grammars, drawing on a combination of sound grammatical theory and engineering skills.

Course Syllabus:

Introduction, LFG, Templates, C & F description, Agreement, Determiners, Rules & alternations,

Adjuncts, Obliques, Prepositions, Pronouns, Punctuation, Generation & Optimality, Complements, Uncertainty, Imperatives, Finite-State Morpholog, Free Word Order and the Shuffle Operator, Coordination

Course Outline:

1. Introduction and Overview, LFG Basics [TB1, Ch. 1,2]
2. LFG Basics II, Templates I, MacOSX, Unix. [TB1 Ch 3, 5]
3. Templates II, f-descriptions, Subject-Verb Agreement, Determiners, xlerc file [TB2, Ch 6]
4. Lexical Rules, Passive and Argument alternations. [TB2 Ch. 7]
5. Adjuncts (Adjectives and Adverbs) and Obliques: PPs, Semantic and Non-Semantic Prepositions. [TB2 Ch. 8 & TB3]
6. Pronouns, Lexical Entries, Punctuation, Note on Adjuncts: Sets and Scope. [TB2 Ch 10]
7. Generation & Optimality Projection, Restricting Over-generation [TB2 Ch. 11]
8. Complements, xcomp and comp. [TB2 Ch. 13]
9. Functional Uncertainty, Imperatives and empty categories. [TB2 Ch. 14]
10. Finite-State Morphology (FSM) I. [TB2 Ch. 15]
11. FSM II (-unknown), Free Word Order and the Shuffle Operator. [TB2 Ch. 16]
12. Meta-cateogries, Metarulemacros and Coordination. [TB2 Ch. 18-20]
13. Project

Reference Material:

1. Butt, Miriam, Tracy Holloway King, Maria-Eugenia Nino and Fred-erique Segond. 1999. A Grammar Writer's Cookbook. CSLI Publications.
2. Crouch, Dick, Mary Dalrymple, Ronald M. Kaplan, Tracy Holloway King, John T. Maxwell III, und Paula Newman (2008). XLE Documentation. Palo Alto: Palo Alto Research Center.
3. Dalrymple, Mary. 2001. Lexical-Functional Grammar. Academic Press.
4. Kaplan, Ronald M. und John T. Maxwell III (1995). Constituent Coordination in Lexical-Functional Grammar. In Dalrymple, Mary, Ronald M. Kaplan, John T. Maxwell III, und Annie Zaenen (eds.)(1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications. First published in Proceedings of COLING-88, vol. 1 (1988). Budapest.
5. Kaplan, Ronald M. und Annie Zaenen (1989). Long-distance Dependencies, Constituent Structure, and Functional Uncertainty. In Baltin, Mark und Anthony Kroch (eds.), Alternative Conceptions of Phrase Structure, pp. 17-42. Chicago University Press. Republished in Dalrymple et al. (eds.) (1995). Formal Issues in Lexical-Functional Grammar. Stanford: CSLI Publications.
6. Kaplan, Ronald M., John T. Maxwell III, Tracy Holloway King, und Dick Crouch (2004). Integrating Finite-state Technology with Deep LFG Grammars. Proceedings of the Workshop on Combining Shallow and Deep Processing for NLP. Proceedings of ESSLLI 2004.

Course Title: Special Topics in Big Data Analysis

Course Code: CSEC-828
Course Structure: Lectures: 3/Labs:0
Credit Hours: 3
Prerequisites: None

Course Objectives:
At the end of this course, the student will become familiar with the fundamental concepts of Big Data management and analytics; will become competent in recognizing challenges faced by applications dealing with very large volumes of data as well as in proposing scalable solutions for them; and will be able to understand how Big Data impacts business intelligence, scientific discovery, and our day-to-day life.

Course Syllabus:
Introduction to Big Data, Defining Big Data, Delivering Business benefit from Big Data, Storing Big Data, Analyzing your data characteristics, Overview of Big Data stores, Selecting Big Data Stores, Processing Big Data, Integrating disparate data stores, Employing Hadoop MapReduce, The building blocks of Hadoop MapReduce, Handling streaming data, Tools and Techniques to Analyze Big Data, Abstracting Hadoop MapReduce jobs with Pig, Performing ad hoc Big Data querying with Hive, Creating business value from extracted data, Developing a Big Data Strategy, Employing Hadoop MapReduce, Defining a Big Data strategy for your organization, Enabling analytic innovation, Implementing a Big Data solution.

Reference Material:
1. Big Data: A Revolution that Will Transform how We Live, Work, and Think, Kenneth Cukier and Viktor Mayer-Schönberger, Latest Edition
2. Data-Intensive Text Processing with MapReduce, Morgan & Claypool Publishers, Latest Edition.
3. Learning Spark: Lightning-Fast Big Data Analysis, Andy Konwinski, Holden Karau, Matei Zaharia, and Patrick Wendell, Latest Edition
4. Anand Rajaraman and Jeff Ullman, Mining of Massive Datasets, Cambridge Press, Latest Edition
5. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques. Latest Edition

Course Title: Advance topics in Fog Computing

Course Code: CSEC-829
Course Structure:
Credit Hours: 3
Prerequisites:

Course objectives:

Primary purpose of this course is to realize the full potential of Fog Computing and similar paradigms. In this course, this, researchers and practitioners will identify and address various challenges in Fog Computing and develop suitable conceptual and technological solutions for tackling them. These include development of scalable architectures, moving from closed systems to open systems, dealing with privacy and ethical issues involved in data sensing, storage, processing, and actions, designing interaction protocols, and autonomic management.

Course Syllabus:

The current list of topics include, but is not limited, to Fog and Edge Computing Principals, Architectures, Internet of Everything, Fog Orchestration, Nodal Collaboration, Research challenges in Federating Edge Resources: Resource-constrained devices management and optimization, Resource sharing and management, Load balancing, Offloading, Scheduling, Capacity planning, Mobility, Security, Resilience, Parallel Processing of Machine learning Algorithms for Decision making at the Fog Nodes, Application Scenarios: Automation, Health care, Smart Cities, and Infotainment, streaming.

This course is based on collection of latest journal and research papers related to address various challenges of Fog Computing. Reading list will be provided to students in class.

Reference Material:

1. Fog and Edge Computing: Principles and Paradigms, edited by Rajkumar Buyya, Satish Srirama, Wiley Press
2. The Rise of Fog Computing in the Digital Era, edited by K. G. Srinivasa, Pankaj Lathar, G. M. Siddesh, ISBN 152256070X, 9781522560708
3. OpenFog Consortium(https://www.openfogconsortium.org/resources/#use-cases
4. Fog of everything: energy-efficient networked computing architectures, research challenges, and a case study (https://ieeexplore.ieee.org/document/7921687/)
5. FOCAN: A Fog-supported Smart City Network Architecture for Management of Applications in the Internet of Everything Environments (https://arxiv.org/abs/1710.01801)
6. iFogSim: A Toolkit for Modeling and Simulation of Resource Management Techniques in Internet of Things, Edge and Fog Computing Environments (*https://arxiv.org/abs/1606.02007*)

7. Modeling and Simulation of Fog and Edge Computing Environments using iFogSim Toolkit
8. Data Storage and management in fog/edge Computing - webcourse
9. FogStore: Toward a Distributed Data Store for Fog Computing (*https://arxiv.org/pdf/1709.07558*)
10. An architecture for Load Balancing Techniques for Fog Computing *https://pdfs.semanticscholar.org/24e5/022d0b6775f460159dd1a96d63ec4fbb4f68.pdf*
11. Multiobjective optimization for computation offloading in Fog Computing https://ieeexplore.ieee.org/document/8168252/
12. An overview of Fog Computing and its security issues, *Security and privacy issues of fog*
13. Architecture for Management of Applications in the Internet of Everything Environments (https://arxiv.org/abs/1710.01801)

Course Title: Advance Topics in Cloud Computing

Course Code: CSEC-834

Credit Hours: 3

Prerequisite: Computer Networks

Course Objectives:

Primary purpose of this course is to realize the full potential of Cloud Computing. In this course, researchers and practitioners will identify, address various challenges in Cloud Computing and develop suitable conceptual and technological solutions for tackling them. These include development of scalable architectures, Resource management and optimization, Virtualization, Containerization, KVM, Docker, VM Allocation, Migration of VM, Resource management in Cloud.

Course Syllabus:

The current list of topics include, but is not limited to, Cloud Computing Principals, Architectures and Applications, Virtualization, Containerization, KVM, Allocation of VM to hosts, Migration of VM, Resource-constrained Devices Management and Optimization, Load balancing, Static and dynamic Scheduling in Cloud. Reliability, Security, Privacy, Robustness and Reliability challenges and

solutions, Identity and Trust management, Cloud Data Management, Storage, Data analytics, Real-time Streaming data processing, Modeling and Simulation of Cloud Computing Environments using CloudSim Toolkit.

There is no Textbook is for this course. This course is based on collection of recent conference and journal papers on various topics in Cloud Computing.

Reference Material:

1. https://ieeexplore.ieee.org/document/7036275
2. https://www.sciencedirect.com/science/article/pii/S1877705812022503
3. https://ieeexplore.ieee.org/document/7570950/
4. http://www.cloudbus.org/cloudsim/
5. https://arxiv.org/abs/1703.00374
6. https://www.researchgate.net/publication/313647411_A_Survey_Paper_on_Data_security_in_Cloud_Computing
7. https://ieeexplore.ieee.org/document/7396341/
8. https://www.sciencedirect.com/science/article/pii/S1877050915005104
9. https://ieeexplore.ieee.org/document/6472470
10. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6779012