NOTIFICATION

On the recommendations of Academic Council made in its 21st (2/2024) meeting held on 07.06.2024, the Syndicate in its 67th (3/2024) meeting held on 12.07.2024 approved the following for implementation w.e.f. Fall 2024 at Main Campus and Affiliated Colleges:

i.	Curriculum of Associate Degree in Computer Science	(Annex-'A')
ii.	Revised curriculum of BS in Computer Science	(Annex-'B')
iii.	Curriculum of BS in Computer Science (5th Semester Intake)	(Annex-'C')
iv.	Revised curriculum of Associate Degree in Information Technology	(Annex-'D')
v.	Revised curriculum of BS in Information Technology	(Annex-'E')
vi.	Revised curriculum of BS in Information Technology (5th Semester Intake)	(Annex-'F')
vii.	Curriculum of Associate Degree in Software Engineering	(Annex-'G')
viii.	Revised curriculum of BS in Software Engineering	(Annex-'H')
ix.	Curriculum of BS in Software Engineering (5th Semester Intake)	(Annex-'I')

(WAQAR AHMAD)
Additional Registrar (General)

No. SU/Acad/24/747

Dated: 26.09.2024

Distribution:

- Chairman, Department of Computer Science
- Chairman, Department of Information Technology
- Chairman, Department of Software Engineering
- Controller of Examinations
- Director Academics

C.C:

- Dean, Faculty of Computing & Information Technology
- Director, QEC
- Deputy Registrar (Affiliation)
- Deputy Registrar (Registration)
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

Curriculum

of

BS Software Engineering

for

Main Campus and Affiliated Colleges

Department of Software Engineering
University of Sargodha

(Applicable from Fall 2024)

Table of Contents

Vision Statement of University of Sargodha

Our vision is to contribute to society through the pursuit of quality education, creative learning and productive research

Mission Statement of University of Sargodha

- To provide students with a healthy learning experience based on critical thinking, innovation and leadership skills
- To ensure a collaborative work environment for faculty and staff to achieve professional excellence and institutional growth
- To contribute to knowledge economy and social transformation through advanced studies and research

Vision Statement of Department of Software Engineering

Our vision is to enable sustainable development of society by providing quality education, creative learning, and productive research in the field of software engineering.

Mission Statement of the Department of Software Engineering

Our mission is to:

- Prepare software engineering graduates to have strong knowledge, critical thinking, research, and leadership skills by providing a healthy learning environment.
- Bridge the gap and enhance the productive interaction with the national and international level academia and software industry for mutual benefits.
- Contribute to the knowledge economy, social transformation, and community services through advanced software studies andinterdisciplinary research.

Underlying Principles of SE Degree Programs

Curriculum plays an important role within education as it outline 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 Software Engineering (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 curriculum is based on following underlying principles:
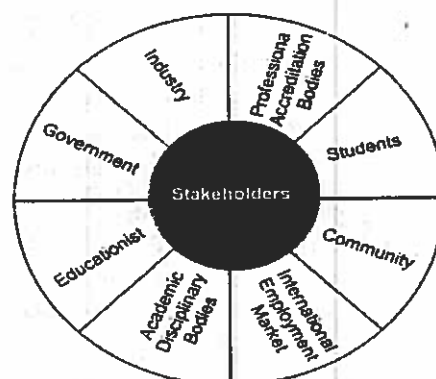
i.   The curriculum should be a broad based and provides students with the flexibility to work across many disciplines & professions.
ii.   The curriculum should prepare graduates to succeed in a rapidly changing field.
iii. The curriculum should provide guidance for the expected level of mastery of 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 curriculum has been developed using top-down curriculum development approach. It has adopted a balanced and multidisciplinary approach and presents a blend of study areas which spreads across the boundaries of fundamental knowledge of traditional disciplines to advanced knowledge of the emerging disciplines. Body of knowledge (BOK) of AI 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 Software Engineering Program

BSSE 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 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 mastery in the 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.

Curricula Consideration

During the revision of the Computing Curricula two major guidelines have been considered (ACM and Seoul Accord). However, in some cases the main focus of these guidelines is mostly traditional Software Engineering programs.

Association of Computing Machinery (ACM) - Guidelines

Association of Computing Machinery (ACM), USA is the largest body in the world for computer scientists (IT professionals). Its membership is spread over the entire globe. It has a pool of highly reputed professionals which meet after a few years to assess the directions being taken by the computing discipline. In view of its assessment, it identifies knowledge areas and also their relative importance in the years to come. Thus, ACM shows the path to follow to the computing academia and professionals all over the world. Computing curricula are designed keeping in view following identified knowledge areas of ACM [ref # ACM 2013 curriculum report]. It has been tried to reasonably cover all knowledge areas without compromising the flexibility needed for a national model curriculum. The mapping of these key knowledge areas with the courses are given in the table below.

- AL - Algorithms and Complexity
- AR - Architecture and Organization
- CN - Computational Science
- DS - Discrete Structures
- GV - Graphics and Visual Computing
- HCI - Human-Computer Interaction
- IAS - Information Assurance and Security
- IM - Information Management
- IS - Intelligent Systems
- NC - Networking and Communications
- OS - Operating Systems

- PBD - Platform-based Development
- PD - Parallel and Distributed Computing
- PL - Programming Languages
- SDF - Software Development Fundamentals
- SE - Software Engineering
- SF - Systems Fundamentals
- SP - Social Issues and Professional Issues

The following knowledge areas have been addressed with the major computing courses.

Knowledge Areas in ACM CS 2013 Curriculum

	Knowledge Area	CS 2013		ACM 2013 Subjects Taught in Various Universities	NCEAC Revised 2023 Subjects in Core
		Tier-1	Tier-2		
1	AL-Algorithms and Complexity	19	9	Algorithms; Algorithms and Data Structures; Algorithm Design and Analysis	Data structures, Analysis of Algorithms, Theory of Automata
2	AR-Architecture and Organization	0	16	Intro to Computer Architecture; DLD; Computer Engineering	DLD, Computer Org & Assembly Language, Computer Architecture
3	CN-Computational Science	1	0	eScience; Modeling and Simulation; Computer Graphics	HCI & Computer Graphics; (Elective: Numerical Analysis)
4	DS-Discrete Structures	37	4	Discrete Mathematics; Mathematical Foundations of CS; Probability for CS; Discrete Structures 1; Discrete Str 2	Discrete Structures, Probability & Statistics
5	GV-Graphics and Visualization	2	1	Computer Graphics; Computer Graphics	HCI & Computer Graphics; (Elective: Computer Graphics)
6	HC-Human-Computer Interaction	4	4	Human Computer Interaction	HCI & Computer Graphics
7	IAS-Information Assurance and Security	3	6	Computer Systems Security	Information Security; (Elective: Cyber Security)

8	IM-Information Management	1	9	Database Systems	Database Systems; Adv Database Management Sys
9	IS-Intelligent Systems	0	10	Artificial Intelligence Programming; Artificial Intelligence	Artificial Intelligence
10	NC-Networking and Communication	3	7	Introduction to Computer Networking; Computer Networks	Computer Networks

Outcome Based Education (OBE) System and Seoul Accord:

Keeping in view the latest transformation from knowledge-based education philosophy to Outcome based education (OBE) system, the OBE model based on Seoul Accord has also been considered. Computing programs prepare students to attain educational objectives by ensuring that students demonstrate achievement of the following outcomes (derived from Graduate Attributes define by Seoul Accordwww.seoulaccord.org).

S#	Program Learning Outcomes (PLOs)	Computing Professional Graduate
1	Academic Education	To prepare graduates as computing professionals
2	Knowledge for Solving Computing Problems	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.
3	Problem Analysis	Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.
4	Design/ Development of Solutions	Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

5	Modern Tool Usage	Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.
6	Individual and Team Work	Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.
7	Communication	Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.
8	Computing Professionalism and Society	Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice
9	Ethics	Understand and commit to professional ethics, responsibilities, and norms of professional computing practice
10	Life-long Learning	Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional

Bloom's Taxonomy

Revised Bloom's Taxonomy	Skill level with applicable verbs
Remember	**Explain:** define, describe, discuss, enumerate, express, identify, indicate, list, name, select, state, summarize, tabulate, translate
Understand	
Apply	**Apply:** backup, calculate, compute, configure, debug, deploy, experiment, install, iterate, interpret, manipulate, map, measure, patch, predict, provision, randomize, recover, restore, schedule, solve, test, trace, train, virtualize
Analyze	**Evaluate:** analyze, compare, classify, contrast, distinguish, categorize, differentiate, discriminate, order, prioritize, criticize, support, decide, recommend, assess, choose, defend, predict, rank
Evaluate	
Create	**Develop:** combine, compile, compose, construct, create, design, develop, generalize, integrate, modify, organize, plan, produce, rearrange, rewrite, refactor, write
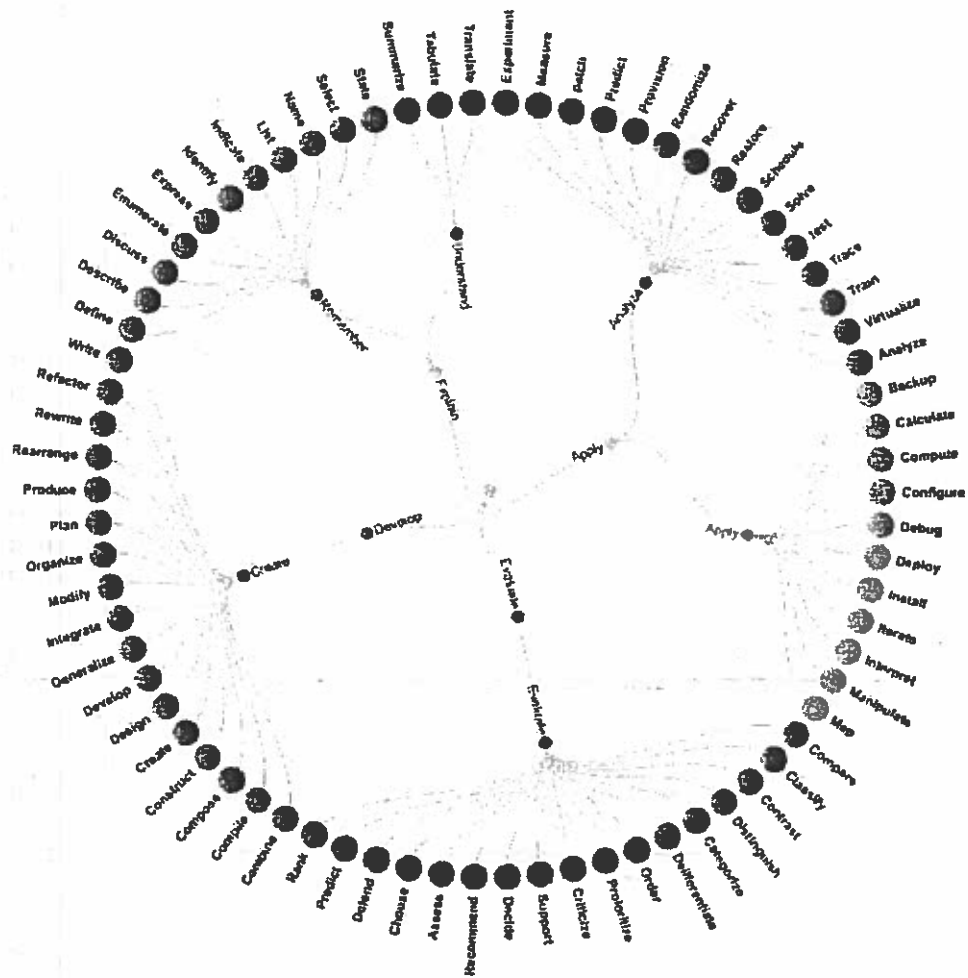
Program Educational Objectives (PEOs)

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:

PEO-1: Have the ability to effectively apply Software Engineering principles and best practices throughout different stages of Software Development Life Cycle (SDLC) to develop quality software applications.

PEO-2: Have an awareness of current industry standards and practices.

PEO-3: Are able to understand and apply software project management skills

PEO-4: Have strong communication, team management and interpersonal skills.

PEO-5: Understand professional responsibility and application of ethical principles.

PEO-6: Are able to translate their skills to knowledge economy and socio-economic growth of the country.

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 software engineering domain or proceed to further or higher education or training.

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 program shall comprise of minimum eight semesters/terms spread over four calendar years with two semesters/terms a year as per the rules of the University.

Eligibility Criteria

The minimum requirements for admission in a bachelor degree program in Software Engineering is at least 50% marks in Intermediate (HSSC) examination with one of the following combinations:
   1. Pre-Engineering
   2. Pre-Medical (Admitted candidates have to pass 6-credit hours courses of mathematics in first two semesters.)
   3. General Science

      a. Mathematics, Statistics, Physics
      b. Mathematics, Statistics, Economics
      c. Mathematics, Statistics, Computer
      d. Mathematics, Physics, Computer
      e. Mathematics, Economics, Computer
4. A-Levels (with equivalence of mentioned above by IBCC) with at-least 50% obtained marks

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:

C #	Taxonomy of Courses	Category/Areas	CreditHours	Courses
1	Major Courses	Computing Core	46	14
2		DomainCore	18	6
3		DomainElective	21	7
4	Interdisciplinary	Mathematics & SupportingCourses	12	4
5		ElectiveSupporting Courses	3	1
6	General Education	GeneralEducation Requirement	30	12
		Totals	130	45

Major Area Courses

Computing Core (46/130) 14 Courses

Sr. No	Sem. No	Code	Pre- Reqs	Course Title	Dom	Cr. Hr. (Cont Hr)
1	1	CMPC-5201		Programming Fundamentals	Core	4 (3-3)
2	2	CMPC-5202	CMPC-5201	Object Oriented Programming	Core	4 (3-3)
3	2	CMPC-5203		Database Systems	Core	4 (3-3)
4	2	CMPC-5204		Digital Logic Design	Core	3 (2-3)
5	3	CMPC-5205	CMPC-5202	Data Structures	Core	4 (3-3)
6	3	CMPC-5206		Information Security	Core	3 (2-3)
7	3	CMPC-5207		Artificial Intelligence	Core	3 (2-3)
8	3	CMPC-5208		Computer Networks	Core	3 (2-3)
9	3	CMPC-5101		Software Engineering	Core	3 (3-0)
10	4	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	Core	3 (2-3)
11	5	CMPC-6201		Operating Systems	Core	3 (2-3)
12	7	CMPC-6101	CMPC-5205	Analysis of Algorithms	Core	3 (3-0)
13	7	CMPC-6702		Final Year Project – I	Core	2 (0-6)
14	8	CMPC-6703	CMPC-6702	Final Year Project – II	Core	4 (0-12)

Domain Core (18/130) 6 Courses						
Sr. No	Sem. No.	Code	Pre-Reqs	Course Title	Domain	Cr Hr (Cont Hr)
15	4	SEDC-5101	-	Software Design & Architecture	Domain Core	3(3-0)
16	4	SEDC-5201	-	Software Construction & Development	Domain Core	3(2-3)
17	5	SEDC-6201	-	Software Quality Engineering	Domain Core	3(2-3)
18	5	SEDC-6202	-	Software Project Management	Domain Core	3(2-3)
19	6	SEDC-6203	-	Parallel and Distributed Computing	Domain Core	3(2-3)
20	6	SEDC-6204	-	Software Requirement Engineering	Domain Core	3(2-3)

Domain Elective (21/130) 7 Courses						
Sr. N.	Sem. No	Code	Pre-Reqs	Course Title	Domain	Cr Hr (Cont Hr)
21	5	SEDE-6201	-	Software Verification and Validation (Testing & QA)	Domain Elective	3(2-3)
22	5	SEDE-6202	-	Object Oriented Analysis & Design	Domain Elective	3(2-3)
23	6	CSDC-6201	-	HCI & Computer Graphics	Domain Elective	3(2-3)
24	6	ITDC-5201	-	Web Technologies	Domain Elective	3(2-3)
25	7	DSDE-6202	-	Advanced Database Management System	Domain Elective	3(3-0)

26	6	SEDE-6205	-	Data Science	Domain Elective	3(2-3)
27	6	SEDE-6206	-	Software Re-Engineering	Domain Elective	3(2-3)
.	6	SEDE-6207	-	Mobile Application Development 1	Domain Elective	3(2-3)
.	7	CSDC-5101	-	Theory of Automata	Domain Elective	3 (3-0)
.	7	DSDC-6201	-	Data Mining	Domain Elective	3(2-3)
	6	CSDC-6202	-	Computer Architecture	Domain Elective	3(2-3)
-	7	CSDE-6205	-	Web Engineering	Domain Elective	3(2-3)

Preliminary Courses – (For Pre-Medical Students Non-Credit Hour Courses) Students have to pass these courses in first and second semester.

Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
	1	URCM-5107	-	Mathematics I		Non-Crd hr
	2	URCM-5108	URCM-5107	Mathematics II		Non-Crd hr

Mathematics & Supporting Courses (12/130) 4 Courses

Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
28	2	MATH-5101	URCQ-5102	Multivariable Calculus	MATH	3 (3-0)
29	2	MATH-5102	URCQ-5102	Linear Algebra	MATH	3 (3-0)
30	3	MATH-5103	?	Probability & Statistics	MATH	3 (3-0)
31	7	ENGL-6101	URCE-5118	Technical & Business Writing	ENGL	3 (3-0)

Elective Supporting Courses (Social Science) (3/130) 1 Course

Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
32		BUSB-6101		Introduction to Marketing	Social Science	3 (3-0)
		BUSB-6103		Financial Accounting	Social Science	3 (3-0)

General Education Requirement as per HEC UG Education Policy (30/130) 12 Courses

Sr. N.	Sem. No	Code	Pre- Reqs	Course Title	Domain	Cr Hr (Cont Hr)
33	1	URCS-5123		Application of Information & Communication Technologies	GER	3 (2-3)
34	1	URCE-5118		Functional English	GER	3 (3-0)
35	2	URCE-5119	URCE-5118	Expository Writing	GER	3 (3-0)
36	1	URCQ-5102		Quantitative Reasoning – 1 (Discrete Structures)	GER	3 (3-0)
37	1	URCQ-5103		Quantitative Reasoning – 2 (Calculus and Analytic Geometry)	GER	3 (3-0)
38	4	URCI-5105		Islamic Studies / Ethics (for non-Muslims)	GER	2 (2-0)
39	8	URCI-5122		Ideology and Constitution of Pakistan	GER	2 (2-0)

40	4	URCA-5118		Introduction to Management	GER	2 (2-0)
41	4	URCW-5201		Natural Sciences (Applied Physics)	GER	3 (2-3)
42	8	URCS-6101		Arts & Humanities (Professional Practices)	GER	2 (2-0)
43	8	URCC-5125		Civics and Community Engagement	GER	2 (2-0)
44	7	URCE-5124		Entrepreneurship	GER	2 (2-0)
		URCQ-5111		Translation of Holy Quran-I	GER	0
		URCQ-5111		Translation of Holy Quran-II	GER	0
		URCQ-5111		Translation of Holy Quran-III	GER	0
		URCQ-5111		Translation of Holy Quran-IV	GER	0

Course Coding Scheme

Discipline Code	
CMPC	Computing Core
CSCC	Computer Science Core
SEDC	Software Engineering Core
SEDE	Software Engineering Elective
URCP	Pakistan Studies
URCI	
MATH	
ENGL	
URCC	
URCQ	
URCS	General Science
URCE	
URCA	
URCF	
URCW	
URCT	

Scheme of Studies for BS Software Engineering Program

Sr.#	Code	Pre-Reqs	Course Titl	Domain	Cr Hrs (Cont Hr)
			Semester 1		
1	CMPC-5201		Programming Fundamentals	Core	4 (3-3)
2	URCS-5123		Application of Information & Communication Technologies	GER	3 (2-3)
3	URCQ-5102		QR 1 (Discrete Structures)	GER	3 (3-0)
4	URCQ-5103		QR 2 (Calculus and Analytic Geometry)	GER	3 (3-0)
5	URCE-5118		Functional English	GER	3 (3-0)
6	BUSB-6101		Elective Supporting Course (Introduction to Marketing)	SS	3 (3-0)
				Total Cr Hrs	19 (17-6)
			Semester 2		
7	CMPC-5202	CMPC-5201	Object Oriented Programming	Core	4 (3-3)
8	CMPC-5203		Database Systems	Core	4 (3-3)
9	CMPC-5204		Digital Logic Design	Core	3 (2-3)
10	MATH-5101	URCQ-5122	Multivariable Calculus	MATH	3 (3-0)
11	MATH-5102	URCQ-5122	Linear Algebra	MATH	3 (3-0)
	URCQ-5111		Translation of Holy Quran-I ✓	GER	NC
				Total Cr Hrs	17 (14-9)
			Semester 3		

12	CMPC-5205	CMPC-5202	Data Structures	Core	4 (3-3)
13	CMPC-5206		Information Security	Core	3 (2-3)
14	CMPC-5207		Artificial Intelligence	Core	3 (2-3)
15	CMPC-5208		Computer Networks	Core	3 (2-3)
16	CMPC-5101		Software Engineering	Core	3 (3-0)
17	MATH-5103		Probability & Statistics	MATH	3 (3-0)
				Total Cr Hrs	19 (15-12)
Semester 4					
18	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	Core	3 (2-3)
19	SEDC-5101	-	Domain Core 1 (Software Design & Architecture)	Domain Core	3 (3-0)
20	SEDC-5201	-	Domain Core 2 (Software Construction & Development)	Domain Core	3 (2-3)
21	URCW-5201		Natural Science (Applied Physics)	GER	3 (2-3)
22	URCE-5119	URCE-5118	Expository Writing	GER	3 (3-0)
23	URCI-5105		Islamic Studies	GER	2 (2-0)
	URCQ-5111		Translation of Holy Quran-II	GER	NC
				Total Cr Hrs	17 (14-9)
Semester 5					
24	CMPC-6201		Operating Systems	Core	3 (2-3)
25	SEDC-6201	-	Domain Core 3 (Software Quality Engineering)	Domain Core	3 (2-3)
26	SEDC-6204	-	Domain Core 4 (Software Requirement Engineering)	Domain Core	3 (2-3)
27			Domain Elective 1	Domain Elective	3 (2-3)
28			Domain Elective 2	Domain Elective	3 (2-3)
29	URCA-5118		Social Science (Introduction to Management)	GER	2 (2-0)
				Total Cr Hrs	17 (12-15)
Semester 6					
30	SEDC-6202	-	Domain Core 5 (Software Project Management)	Domain Core	3 (2-3)
31	SEDC-6203	-	Domain Core 6 (Parallel and Distributed Computing)	Domain Core	3 (2-3)
32			Domain Elective 3	Domain Elective	3 (2-3)
33			Domain Elective 4	Domain Elective	3 (2-3)
34			Domain Elective 5	Domain Elective	3 (2-3)
35			Domain Elective 6	Domain Elective	3 (2-3)
	URCQ-5111		Translation of Holy Quran-III	GER	NC
				Total Cr Hrs	18 (12-18)
Semester 7					
36	CMPC-6702		Final Year Project – I	Core	2 (0-6)
37	CMPC-6101		Analysis of Algorithms	Core	3 (3-0)
38			Domain Elective 7	Domain Elective	3 (2-3)
39	ENGL-6101	URCE-5118	Technical & Business Writing	EN	3 (3-0)
40	URCE-5124		Entrepreneurship	GER	2 (2-0)
				Total Cr Hrs	13 (10-9)
Semester 8					
41	CMPC-6703	CMPC-6702	Final Year Project – II	Core	4 (0-12)
43	URCS-6101		Arts & Humanities (Professional Practices)	GER	2 (2-0)
44	URCC-5125		Civics and Community Engagement	GER	2 (2-0)

URCQ-5111		Translation of Holy Quran-IV	GER	NC
URCI-5122		Ideology and Constitution of Pakistan	GER	2 (2-0)
			Total Cr Hrs	10 (6-12)

Course Contents

Computing Core Courses

CMPC-5201 Programming Fundamentals	
Credit Hours: **Contact Hours:** **Pre-requisites:**	4 (3-3) 3-3 None

Course Introduction:

This course provides fundamental concepts of programming to freshmen. The courses is prerequisite
to many other courses, therefore, students are strongly advised to cover all contentsand try to achieve CLOs to the maximum possible level. The course may be taught aslanguage independent. Further, it is up to the university to choose any language for thepractical/Lab purpose but that must be latest and market oriented.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand basic problem solving steps and logicconstructs	C2 (Understand)
CLO-2	Apply basic programing concepts	C3 (Apply)
CLO-3	Design and implement algorithms to solve real worldproblems	C3 (Solve)

Course Outline:

Introduction to problem solving, a brief review of Von-Neumann architecture, Introductionto programming, role of compiler and linker, introduction to algorithms, basic data types andvariables, input/output constructs, arithmetic, comparison and logical operators, conditionalstatements and execution flow for conditional statements, repetitive statements andexecution flow for repetitive statements, lists and their memory organization, multidimensionallists, introduction to modular programming, function definition and calling,stack rolling and unrolling, string and string operations, pointers/references, static anddynamic memory allocation, File I/O operations.

Reference Materials (or use any other standard and latest books):

1. Starting out with Programming Logic & Degins, 4th Edition, Tony Gaddis,
2. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie
3. Object Oriented Programming in C++ by Robert Lafore
4. C How to Program, 7th Edition by Paul Deitel & Harvey Deitel
5. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B.Koffman

CMPC-5202 Object Oriented Programming

Credit Hours:	4 (3-3)
Contact Hours:	3-3
Pre-requisites:	Programming Fundamentals

Course Introduction:

The course aims to focus on object-oriented concepts, analysis and software development.The basic concept of OOP is covered in this course.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand principles of object-oriented paradigm.	C2 (Understand)
CLO-2	Identify the objects & their relationships to build object-oriented solution	C3 (Apply)
CLO-3	Model a solution for a given problem using object-oriented principles	C3 (Solve)
CLO-4	Examine an object-oriented solution	C4 (Examine)

Course Outline:

Introduction to object oriented design, history and advantages of object oriented design,introduction to object oriented programming concepts, classes, objects, data encapsulation,constructors, destructors, access modifiers, const vs non-const functions, static data members& functions, function overloading, operator overloading, identification of classes and theirrelationships, composition, aggregation, inheritance, multiple inheritance, polymorphism,abstract classes and interfaces, generic programming concepts, function & class templates,standard template library, object streams, data and object serialization using object streams,exception handling.
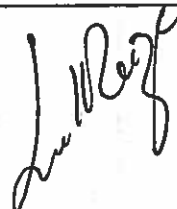
Reference Materials (or use any other standard and latest books):

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

CMPC-5203 Database Systems

Credit Hours:	4 (3-3)
Contact Hours:	3-3
Pre-requisites:	None

Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain fundamental database concepts.	C2 (Explain)
CLO-2	Design conceptual, logical and physical database schemas using different data models.	C5 (Design)
CLO-3	Identify functional dependencies and resolve database anomalies by normalizing database tables.	C2 (Identify)
CLO-4	Use Structured Query Language (SQL) for database definition and manipulation in any DBMS	C4 (Use)

Course Outline:

Basic database concepts, Database approach vs. file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and subqueries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

Reference Materials (or use any other standard and latest books):

1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom
3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke

CMPC-5204 Digital Logic Design

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:
The course introduces the concept of digital logic, gates and the digital circuits. Further, itfocuses on the design and analysis combinational and sequential circuits. It also serves tofamiliarize the student with the logic design of basic computer hardware components.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Acquire knowledge related to the concepts, tools andtechniques for the design of digital electronic circuits	-
CLO-2	Demonstrate the skills to design and analyze bothcombinational and sequential circuits using a variety oftechniques	-
CLO-3	Apply the acquired knowledge to simulate and implementsmall-scale digital circuits	-
CLO-4	Understand the relationship between abstract logiccharacterizations and practical electrical implementations.	-

Course Outline:
Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs,Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches,Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggereddevices & its types. Mealy machines and Moore machines. Binary Arithmetic and ArithmeticCircuits, Memory Elements, State Machines. Introduction Programmable Logic Devices(CPLD, FPGA) Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.

Reference Materials (or use any other standard and latest books):
1. Digital Fundamentals by Floyd, 11/e. 2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e

CMPC-5205 Data Structures

Credit Hours: Contact Hours: Pre-requisites:	4 (3-3) 3-3 Programming Fundamentals

Course Introduction:
The course is designed to teach students structures and schemes, which allow them to writeprogrammer to efficiently manipulate, store, and retrieve data. Students are exposed to theconcepts of time and space complexity of computer programs.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Implement various data structures and their algorithmsand apply them in implementing simple applications	C3 (Apply)

CLO-2	Analyze simple algorithms and determine theircomplexities.	C5 (Analyze)
CLO-3	Apply the knowledge of data structure to other applicationdomains.	C3 (Apply)
CLO-4	Design new data structures and algorithms to solve problems.	C6 (Design)

Course Outline:

Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and arrayimplementations), Recursion and analyzing recursive algorithms, divide and conqueralgorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix,bucket), queue, dequeuer, priority queues (linked and array implementations of queues),linked list & its various types, sorted linked list, searching an unsorted array, binary searchfor sorted arrays, hashing and indexing, open addressing and chaining, trees and treetraversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first anddepth-first traversal, topological order, shortest path, adjacency matrix and adjacency listimplementations, memory management and garbage collection.

Reference Materials (or use any other standard and latest books):

1. Data Structures and Algorithm Analysis in Java by Mark A. Weiss
2. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
3. Data Structures and Algorithms in C++ by Adam Drozdek
4. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

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CMPC-5206 Information Security

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:

This course provides a broad overview of the threats to the security of information systems,the responsibilities and basic tools for information security, and the levels of training andexpertise needed in organizations to reach and maintain a state of acceptable security. Itcovers concepts and applications of system and data security. Areas of particular focusinclude secure network design, implementation and transition issues, and techniques forresponding to security breaches.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain key concepts of information security such asdesign principles, cryptography, risk management, andethics	C2 (Explain)
CLO-2	Discuss legal, ethical, and professional issues ininformation security	A2 (Discuss)
CLO-3	Apply various security and risk management tools forachieving information security and privacy	C3 (Apply)

CLO-4	Identify appropriate techniques to tackle and solveproblems in the discipline of information security	C4 (Identify)

Course Outline:

Information security foundations, security design principles; security mechanisms,symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, keymanagement, authentication and access control; software security, vulnerabilities andprotections, malware, database security; network security, firewalls, intrusion detection;security policies, policy formation and enforcement, risk assessment, cybercrime, law andethics in information security, privacy and anonymity of data.

Reference Materials (or use any other standard and latest books):

1. Computer Security: Principles and Practice, 3rd edition by William Stallings
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-5207 Artificial Intelligence

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:

Artificial Intelligence has emerged as one of the most significant and promising areas ofcomputing. This course focuses on the foundations of AI and its basic techniques likeSymbolic manipulations, Pattern Matching, Knowledge Representation, Decision Makingand Appreciating the differences between Knowledge, Data and Code. AI programming
language Python has been proposed for the practical work of this course.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the fundamental constructs of Pythonprogramming language.	C2 (Understand)
CLO-2	Understand key concepts in the field of artificialintelligence	C2 (Understand)
CLO-3	Implement artificial intelligence techniques and casestudies	C3 (Apply)

Course Outline:

An Introduction to Artificial Intelligence and its applications towards Knowledge BasedSystems; Introduction to Reasoning and Knowledge Representation, Problem Solving bySearching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmaxalgorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver,Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing;Recent trends in AI and applications of AI algorithms. Python programming

language willbe used to explore and illustrate various issues and techniques in Artificial Intelligence.

Reference Materials (or use any other standard and latest books):

1. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 3rd ed, Prentice Hall, Inc., 2015.
2. Norvig, P., "Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp", Morgan Kaufman Publishers, Inc., 1992.
3. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2009.
4. Severance, C.R., 2016. "Python for everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform.
5. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. "Python programming in context." Jones & Bartlett Pub.
6. Joshi, P., 2017. "Artificial intelligence with python." Packt Publishing Ltd.

CMPC-5208 Computer Networks

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:

This course introduces the basic concept of computer network to the students. Networklayers, Network models (OSI, TCP/IP) and protocol standards are part of the course.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe the key terminologies and technologies ofcomputer networks	C2 (Describe)
CLO-2	Explain the services and functions provided by each layerin the Internet protocol stack.	C2 (Explain)
CLO-3	Identify various internetworking devices and protocolsand their functions in a networking	C4 (Identify)
CLO-4	Analyze working and performance of key technologies,algorithms and protocols	C4 (Analyze)
CLO-5	Build Computer Network on various Topologies	P3 (Build)

Course Outline:

Introduction and protocols architecture, basic concepts of networking, network topologies,layered architecture, physical layer functionality, data link layer functionality, multipleaccess techniques, circuit switching and packet switching, LAN technologies, wirelessnetworks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IPaddressing, sub netting, CIDR, routing protocols, transport layer protocols, ports andsockets, connection establishment, flow and congestion control, application layer protocols,latest trends in computer networks.

Reference Materials (or use any other standard and latest books):

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

CMPC-5101 Software Engineering

Credit Hours:	3 (3-0)
Contact Hours:	3-0
Pre-requisites:	None

Course Introduction:

This course provides students with a foundational understanding of the principles, methodologies, and practices essential for designing, developing, and maintaining software systems. Emphasis is placed on the entire software development life cycle, covering requirements analysis, system design, quality assurance and testing.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Describe various software engineering processes andactivates	C1 (Describe)
CLO-2	Apply the system modeling techniques to model amedium size software systems	C3 (Apply)
CLO-3	Apply software quality assurance and testing principles tomedium size software systems	C4 (Apply)
CLO-4	Discuss key principles and common methods for softwareproject management such as scheduling, size estimation,cost estimation and risk analysis	C2 (Discuss)

Course Outline:

Nature of Software, Overview of Software Engineering, Professional software development,Software engineering practice, Software process structure, Software process models, Agilesoftware Development, Agile process models, Agile development techniques, Requirementsengineering process, Functional and non-functional requirements, Context models,Interaction models, Structural models, behavioral models, model driven engineering,Architectural design, Design and implementation, UML diagrams, Design patterns, Softwaretesting and quality assurance, Software evolution, Project management and project planning,configuration management, Software Process improvement

Reference Materials (or use any other standard and latest books):

1. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014
2. Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., 8th Edition, McGraw-Hill, 2015.

CMPC-5209 Computer Organization & Assembly Language

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	Digital Logic Design

Course Introduction:

The main objective of this course is to introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis should be given to expose the low-level logic employed for problem solving while using assembly language as a tool. At the end of the course the students should be capable of writing moderately complex assembly language subroutines and interfacing them to any high level language.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Acquire the basic knowledge of computer organization computer architecture and assembly language	C2 (Understand)
CLO-2	Understand the concepts of basic computer organization, architecture, and assembly language techniques	C2 (Understand)
CLO-3	Solve the problems related to computer organization and assembly language	C3 (Apply)

Course Outline:

Introduction to computer systems: Information is bits + context, programs are translated byother programs into different forms, it pays to understand how compilation systems work,processors read and interpret instructions stored in memory, caches matter, storage devicesform a hierarchy, the operating system manages the hardware, systems communicate withother systems using networks; Representing and manipulating information: informationstorage, integer representations, integer arithmetic, floating point; Machine-levelrepresentation of programs: a historical perspective, program encodings, data formats,accessing information, arithmetic and logical operations, control, procedures, arrayallocation and access, heterogeneous data structures, putting it together: understandingpointers, life in the real world: using the gdb debugger, out of-bounds memory referencesand buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations offloating-point programs; Processor architecture: the Y86 instruction set architecture, logicdesign and the Hardware Control Language (HCL), sequential Y86 implementations, generalprinciples of pipelining, pipelined Y86 implementations

Reference Materials (or use any other standard and latest books):

1. Computer System Architecture, M. Morris Mano, Latest Edition,
2. Assembly Language Programming for Intel- Computer, Latest Edition
3. Computer Systems: A Programmer's Perspective, 3/E (CS:APP3e), Randal E. Bryant and
4. David R.O' Hallaron, Carnegie Mellon University
5. Robert Britton, MIPS Assembly Language Programming, Latest Edition,

CMPC-6201 Operating Systems

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	Data Structures

Course Introduction:

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.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems	C2 (Understand)
CLO-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	C5 (Evaluate)
CLO-3	Demonstrate the knowledge in applying system software and tools available in modern operating systems.	C3 (Demonstrate)

Course Outline:

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and
disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security

Reference Materials (or use any other standard and latest books):

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

CMPC-6101 Analysis of Algorithms

Credit Hours:	3 (3-0)
Contact Hours:	3-0
Pre-requisites:	Data Structures

Course Introduction:

Detailed study of the basic notions of the design of algorithms and the underlying datastructures. Several measures of complexity are introduced. Emphasis on the structure,complexity, and efficiency of algorithms.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain what is meant by "best", "expected", and "worst"case behavior of an algorithm	
CLO-2	Identify the characteristics of data and/or other conditionsor assumptions that lead to different behaviors.	
CLO-3	Determine informally the time and space complexity ofsimple algorithms	
CLO-4	List and contrast standard complexity classes	
CLO-5	Use big O, Omega, Theta notation formally to giveasymptotic upper bounds on time and space complexity ofalgorithms	
CLO-6	Use of the strategies(brute-force, greedy, divide-andconquer,and dynamic programming) to solve anappropriate problem	
CLO-7	Solve problems using graph algorithms, including singlesource and all-pairs shortest paths, and at least oneminimum spanning tree algorithm	
CLO-8	Trace and/or implement a string-matching algorithm	

Course Outline:

Introduction; role of algorithms in computing, Analysis on nature of input and size of inputAsymptotic notations; Big-O, Big Ω, Big Θ, little-o, little-ω, Sorting Algorithm analysis,loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, BruteForce Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach;Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing;Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexityclasses.

Reference Materials (or use any other standard and latest books):

1. Introduction to Algorithms (3rd edition) by Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein
2. Algorithm Design, (1st edition, 2013/2014), Jon Kleinberg, Eva Tardos,
3. Algorithms, (4th edition, 2011), Robert Sedgewick, Kevin Wayne

CMPC-6702 Final Year Project-I				
Credit Hours:	2(0-6)	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-6703 Final Year Project-II

Credit Hours:	4(0-12)	Prerequisites:	CMPC-6702

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:

Domain Core Courses

SEDC-5101 Software Design & Architecture			
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 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]
    Reconstructing Software Architectures: Introduction, Information Extraction, Database Construction, View Fusion, Reconstruction [TB 2: Ch. 10]

Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, 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.

SEDC-5201 Software Construction & Development

Credit Hours:	3(2-3)	Prerequisites:	

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	C	2

	of software.		
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

URCW-5201 Applied Physics

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:

The course introduces students with the basic concept of Physics and electronics. Students are also taught Physics laws and other associate topics to prepare them for the advanced level courses in this area. The focus of the course on electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force and many other useful topics.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	

Course Outline:

Electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss' Law, Application of Gauss' Law, Spherically symmetric charge distribution, A charge isolated conductor, Electric potential energy, Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential, Electric current, Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, The Hall effect, The magnetic force on a current, The Biot-Savart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroids, Faraday's experiments, Faraday's Law of Induction, Lenz's law, Motional emf, Induced electric field, Induced electric fields, The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems.

Reference Materials (or use any other standard and latest books):	
1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker	
2. Narciso Garcia, Arthur Damask, Steven Schwarz., "Physics for Computer Science Students", Springer Verlag, 1998.	

SEDC-6201 Software Quality Engineering

Credit Hours:	3(2-3)	Prerequisites:	-

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	Domain	BT Level*
1. Outline software testing and software quality assurance principles.	C	1
2. Prepare test case and test suites for completely testing all aspects of a system under test (SUT)	C	3
3. Analyze which of the software testing techniques are relevant for a particular case and know software reliability analysis tools and techniques.	C	4
4. 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, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, 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.

SEDC-6202 Software Project Management			
Credit Hours:	3(2-3)	Prerequisites:	-

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, Semester Project, Presentations

Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, 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

SEDC-6203 Parallel and Distributed Computing

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	Object Oriented Programming, Operating Systems

Course Introduction:

The Parallel and Distributed Computing course explores advanced computing paradigms, covering parallel processing and distributed systems. Participants gain expertise in designing and optimizing algorithms for parallel execution, addressing challenges in distributed computing environments.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Learn about parallel and distributed computers.	C2 (Understand)
CLO-2	Write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library	C3 (Apply)
CLO-3	Analyze complex problems with shared memory programming with openMP.	C4 (Analyze)

Course Outline:

Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Reference Materials (or use any other standard and latest books):

1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 2ndEdition, 2007
2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet, K Hwang, J

Dongarra and GC. C. Fox, Elsevier, 1st Ed.

SEDC-6204 Software Requirement Engineering			
Credit Hours:	3(2-3)	Prerequisites:	-

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

Software Engineering Domain Elective Courses

SEDE-6201 Software Verification and Validation (Testing & QA)				
Credit Hours:	3(2-3)	Prerequisites:	-	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	Domain	BT Level*
1. Understand the fundamental concepts and principles of software verification and validation.	C	2
2. Apply effective software testing techniques to identify and mitigate defects.	C	2
3. Develop comprehensive test plans and execute them to validate software functionality.	C	2
4. Utilize automated testing tools to improve efficiency and accuracy in software verification.	C	2
5. Evaluate the effectiveness of software verification and validation activities and suggest improvements	C	2
6. Understand the fundamental concepts and principles of software verification and validation.	C	3

Course Content:

Fault-Based Testing, Validation and Verification of Software Systems using Virtual Reality and Coloured Petri Nets, Integrating Usability, Semiotic, and Software Engineering into a Method for Evaluating User Interfaces, Automated Software Testing, A Formal Verification and Validation Approach for Real-Time Databases, Requirements for the Testable Specifications and Test Case Derivation in Conformance Testing, Test-Case Mutation, Discrete Event Simulation Process Validation, Verification, and Testing, The STECC Framework: An Architecture for Self-Testable Components, Certifying Properties of Programs using theorem Provers, Static Type Systems: From Specification to Implementation Generic Model of the Business Model and Its Formalization in Object-Z

Teaching Methodology:

Lectures, Semester Project, Assignments, Presentations, Interactive sessions

Course Assessment:

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

Reference Materials:

1. Verification, Validation and Testing in Software Engineering, Author(s): Aristides Dasso, Aristides Dasso; Ana Funes Publisher: IGI Global, Year: 2006 ISBN: 1591408512,9781591408512,9781591408536
2. Software Verification and Validation_ An Engineering and Scientific Approach-Springer US (2007), Marcus S. Fisher (auth.)

SEDE-6202 Object Oriented Analysis & Design

Credit Hours:	3(2-3)	Prerequisites:	-

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.	C	2
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	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:
Lectures, Semester Project, Assignments, Presentations, Interactive sessions

Course Assessment:
Sessional Marks(Assignments, Quizzes, Project, Presentations), Mid Exam, 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

CSDC-6201 HCI & Computer Graphics

Credit Hours:	3(2-3)	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	DE	2
2. Apply the principles of good design for people from the	DE	3
3. Perspective of age and disabilities	DE	4
4. Analyze techniques for user centered design for a medium sized software.	DE	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
2. 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.
3. Interaction design basics: What is design? The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping
4. HCI in the software process
5. Using toolkits, User interface management systems, Evaluation techniques
6. Universal design, User support, Task analysis
7. Modeling rich interaction, Groupware
8. Ubiquitous computing and augmented realities: Ubiquitous computing applications research, Virtual and augmented reality, Information and data visualization. Hypertext, multimedia and the World Wide Web: Understanding hypertext, Finding things, Web technology and issues, Static web content, Dynamic web content.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

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

Reference Material:

1. Human-Computer Interaction by Alan Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, Prentice Hall; 3rd Edition (December 20, 2003). ISBN-10: 013046109

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

ITDC-5201 Web Technologies

Credit Hours:	3 (2-3)	Prerequisites:	-		
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 Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10: 047051860X

Credit Hours:	3 (2-3)	Prerequisites:	Database Systems

Course Introduction:

Advanced Database Management Systems is an extension to "Database Systems" course. The aim of the course is to enhance the previous knowledge of database systems by deepening the understanding of the theoretical and practical aspects of the database technologies, and showing the need for distributed database technology to tackle deficiencies of the centralized database systems. Moreover, it focuses to introduce the basic principles and implementation techniques of distributed database systems, and expose emerging research issues in database systems and application development.

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	Domain	BT Level*
1. Understanding advance data models, technologies and approaches for building distributed database systems	C	2
2. Applying the models and approaches in order to become enabled to select and apply appropriate methods for a particular case	C	3
3. To develop a database solution for a given scenario/challenging problem in the domain of distributed database systems.	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

Introduction to advance data models such as object relational, object oriented. File organizations concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing and optimization, Database Programming (PL/SQL, T-SQL or similar technology), Integrity and security, Database Administration (Role management, managing database access, views), Physical database design and tuning, Distributed database systems, Emerging research trends in database systems, MONGO DB, NO SQL (or similar technologies)

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

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

Reference Materials:

1. **Database Systems: A Practical Approach to Design, Implementation, and Management,6th Edition by Thomas Connolly and Carolyn Begg**
2. **Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke**
3. **Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.**
4. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom

SEDE-6205 Data Science

Credit Hours:	3 (2-3)	Prerequisites:	None

Data Science is the study of the generalizable extraction of knowledge from data. Being adata scientist requires an integrated skill set spanning mathematics, statistics, machinelearning, databases and other branches of computer science along with a good understandingof the craft of problem formulation to engineer effective solutions. The aim of this course isto: Introduce students to this rapidly growing field and equip them with some of its basicprinciples and tools as well as its general mindset. Explain the significance of exploratorydata analysis in data science. Identify common approaches used for Feature Generation aswell as Feature Selection, and finally discuss the Ethical and Privacy issues. Programminglanguage Python has been proposed for the practical work of this course

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	Domain	BT Level*
1. Data Science is and the skill sets needed to be a data scientist.	C	1
2. Apply EDA and the Data Science process in a case study.	C	2
3. Comprehend the fundamental constructs of Python programming language	C	3
4. Apply basic machine learning algorithms to solve real world problems of moderate complexity.		
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

Introduction: What is Data Science? Big Data and Data Science hype, Datafication, Currentlandscape of perspectives, Skill sets needed; Statistical Inference: Populations and samples,Statistical modeling, probability distributions, fitting a model, Intro to Python; ExploratoryData Analysis and the Data Science Process; Basic Machine Learning Algorithms: LinearRegression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes; Feature Generation andFeature Selection; Dimensionality Reduction: Singular Value Decomposition, PrincipalComponent Analysis; Mining Social-Network Graphs: Social networks as graphs,Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs,Neighborhood properties in graphs; Data Visualization: Basic principles, ideas and tools fordata visualization; Data Science and Ethical Issues: Discussions on privacy, security, ethics,Next-generation data scientists.

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

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

Reference Materials:

1. Foundations of data science, Blum, A., Hopcroft, J., & Kannan, R., Vorabversion eines Lehrbuchs, 2016.
2. An Introduction to Data Science, Jeffrey S. Saltz, Jeffrey M. Stanton, SAGE Publications, 2017.
3. Python for everybody: Exploring data using Python 3, Severance, C.R., CreateSpace Independent Pub Platform. 2016.
4. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil and Rachel Schutt, O'Reilly. 2014.
5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, John Wiley & Sons, 2015.

SEDE-6206 Software Re-Engineering

Credit Hours:	3(2-3)	Prerequisites:	-

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, Semester Project, Assignments, Presentations, Interactive sessions

Course Assessment:

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

CSDE-6202 Mobile Application Development I

Credit Hours:	3(2-3)	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	DE	1
2. Develop mobile applications using current software development environments.	DE	3
3. Compare the different performance tradeoffs in mobile application development.	DE	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, Semester 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.

CSDC-5101 Theory of Automata

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. 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]

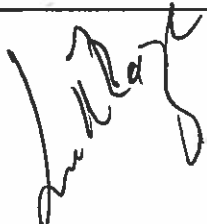| Teaching Methodology: |
|---|
| Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations |
| Course Assessment: |
| Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam |
| Reference Materials: |

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; 4th Edition (2006). ISBN-10: 0763737984
3. Automata and Formal Languages: An Introduction by Dean Kelley, Prentice Hall (1995). ISBN-10: 0134977777

DSDC-6201 Data Mining

Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	Probability and Statistics, Data Science

Course Introduction:

The Data Mining has emerged at the confluence of artificial intelligence, statistics, and

databases as a technique for automatically discovering hidden patterns in large datasets. The main purpose of this course is the ability to analyze and construct knowledge from data.

The aims of this course are to:

- Expand on the student's understanding and awareness of the concepts of datamining basics, techniques, and application.
- Introduce the concepts of *Data Pre-processing and Summary Statistics*.
- Introduce the concepts of *Frequent Item Set Generation, Associations andCorrelations measures*.
- Introduce the concepts of *Classification, Prediction, and Clustering algorithms*.

Build on the programming and problem-solving skills developed in previous subjects studied by the student, to achieve an understanding of the development of Classification, Prediction, and Clustering applications..

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Apply preprocessing techniques on any given raw data.	C3 (Apply)
CLO-2	Select and apply proper data mining algorithm to discover interesting patterns	C3 (Apply)
CLO-3	Analyze and extract patterns to solve problems and point out how to deploy solution	C4 (Analyze)
CLO-4	Evaluate systematically supervised, semi supervised and unsupervised models and algorithms with respect to their accuracy	C4 (Analyze)

Course Outline:

Introduction to data mining and basic concepts, Pre-Processing Techniques & Summary Statistics, Association Rule mining using Apriori Algorithm and Frequent Pattern Trees, Introduction to Classification Types, Supervised Classification (Decision trees, Naïve Bae Classification, K-Nearest Neighbors, Support Vector Machines etc.), Unsupervised Classification (K Means, K Median, Hieratical and Divisive Clustering, Kohonan Self Organizing maps), outlier & anomaly detection, Web and Social Network Mining, Data Mining Trends and Research Frontiers. Implementing concepts using Python

Reference Materials (or use any other standard and latest books):

1. Jiawei Han & Micheline Kamber, Jian Pei (2011). Data Mining: Concepts and Techniques, 3rd Edition.
2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar (2005). Introduction to Data Mining.
3. Charu C. Aggarwal (2015). Data Mining: The Textbook
4. D. Hand, H. Mannila, P. Smyth (2001). Principles of Data Mining. MIT Press.

CSDC-6202 Computer Architecture					
Credit Hours:	3	**Prerequisites:**	Digital Logic & Design		
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				C	2

modules of the computer.		
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

CSDE-6205 Web Engineering			
Credit Hours:	3 (2-3)	**Prerequisites:**	Web Technologies

Course Introduction:

In this course students will dive into the world of "Web Engineering," where creativity meets technology in crafting dynamic and responsive web solutions. This course will guide them through the intricacies of designing, developing, and deploying websites, covering essential technologies, frameworks, and best practices. They will learn the art of building robust and user-friendly web applications for the modern digital landscape.

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 standard.	C	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

Web programming languages (e.g., HTML5, CSS 3, Java Script, PHP/JSP/ASP.Net), Design principles of Web based applications, Web platform constraints, Software as a Service (SaaS), Web standards, Responsive Web Design, Web Applications, Browser/Server Communication, Storage Tier, Cookies and Sessions, Input Validation, Full stack state management, Web App Security - Browser Isolation, Network Attacks, Session Attacks, Large scale applications, Performance of Web Applications, Data Centers, Web Testing and Web Maintenance.

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

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

Reference Materials:

1. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016
2. Web Engineering, Emilia Mendes and Nile Mosley, Springer Verlag, 2010.
3. Web Engineering: A Practitioners' Approach, Roger S. Pressman, McGraw Hill, 2008.
4. Dynamic HTML: The Definitive Reference: A Comprehensive Resource for XHTML, CSS, DOM, JavaScript 3rd Edition, O'Reilly Media 2007.
5. JavaScript: The Definitive Guide, 8th Edition, David Flanagan. O'Reilly Media. 2014.

Preliminary Courses for Pre-Medical Students

URCM – 5107 Mathematics I			
Credit Hours:	**Non-Credit Hour**	**Prerequisites:**	

Course Content:
The goal of Mathematics I is to prepare students for first-year Calculus. Helping students gain proficiency in their understanding and ability to utilize real-valued functions, the primary tool in Calculus, accomplishes this goal. Students are presented a broad set of 'function tools', including a general understanding of function properties together with a 'library' of commonly used functions. It is intended that students become skilled at recognizing the different families of functions and the primary properties that set each apart, are able to apply the general function properties to each type of function, and are able to use the special set of algebraic skills associated with each. Students are also expected to become adept in utilizing and interpreting the results from graphing calculators, as an important investigative tool. *Contents* 1. Preliminaries 2. Real-number system, complex numbers 3. Introduction to sets, set operations, functions, types of functions. 4. Matrices Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule. 5. Quadratic Equations 6. Solution of quadratic equations, qualitative analysis of roots of a quadratice 7. Equations reducible to quadratic equations 8. Cube roots of unity, relation between roots and coefficients of quadratic 9. Sequences and Series 10. Arithmetic progression 11. Geometric progression 12. Harmonic progression 13. Binomial Theorem 14. Introduction to mathematical induction 15. Binomial theorem with rational and irrational indices. 16. Trigonometry, Fundamentals of trigonometry, Trigonometric identities.

Teaching Methodology:
Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials:
1. Thomas, G. B., & Finney, A. R. *(2005). Calculus.* Reading: Addison-Wesley. 2. Anton, H., Bevens. I., & Davis, S. (2005). *Calculus: A new horizon* (8th ed.). New York: John Wiley. 3. Stewart, J. (1995). *Calculus* (3rd ed.).Pacific Grove, California: Brooks/Cole. 4. Swokowski, E. W. (1983). *Calculus and analytic geometry.* Boston: PWS-Kent Company. 5. Thomas, G. B., & Finney, A. R. (2005). *Calculus* (11th ed.). Reading: Addison-Wesley.

URCM – 5108 Mathematics II

Credit Hours:	Non-Credit Hour	Prerequisites:	

Course Content:

Calculus is the mathematical study of continuous change. It has two major branches, differential calculus and integral calculus. Both branches make use of the fundamental notions of convergence of infinite sequences and infinite series to a well-defined limit. Modern calculus is considered to have been developed in 17th century .A course in calculus is a gateway to other, more advanced courses in mathematics devoted to the study of functions and limits, broadly called mathematical analysis. Calculus is used in every branch of the physical sciences, actuarial science, computer science, medicine, demography, and in other fields. It allows one to go from rates of change to the total change or vice versa, and many times in studying a problem we know one and are trying to find the other. This course aims to provide students with the essential concepts of mathematics and how these can be employed for analyzing real data.

1. Preliminaries
2. Real-number line
3. Functions and their graphs
4. Solution of equations involving absolute values, inequalities.
5. Limits and Continuity
6. Limit of a function
7. Left-hand and right-hand limits
8. Continuity
9. Continuous functions.
10. Derivatives and their Applications
11. Differentiable functions
12. Differentiation of polynomial
13. Rational and transcendental functions, derivatives.
14. Integration and Definite Integrals
15. Techniques of evaluating indefinite integrals
16. Integration by substitution, integration by parts
17. Change of variables in indefinite integrals.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Thomas, G. B., & Finney, A. R. *(2005). Calculus.* Reading: Addison-Wesley.
2. Anton, H., Bevens. I., & Davis, S. (2005). *Calculus: A new horizon* (8th ed.). New York: John Wiley.
3. Stewart, J. (1995). *Calculus* (3rd ed.).Pacific Grove, California: Brooks/Cole.
4. Swokowski, E. W. (1983). *Calculus and analytic geometry.* Boston: PWS-Kent Company.

5. Thomas, G. B., & Finney, A. R. (2005). *Calculus* (11th ed.), Reading: Addison-Wesley.

Mathematics & Supporting Courses

MATH-5101 Multivariable Calculus

Credit Hours:	3(3-0)	Prerequisites:	URCM-5108	
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.			MATH & SC	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
2. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley; 10th Edition (August 16, 2011). ISBN-10: 0470458364
3. Multivariable Calculus by James Stewart, Brooks Cole; 7th Edition (January 1, 2011). ISBN-10: 0538497874
4. Multivariable Calculus by James Stewart 6th Edition, 2007, Cengage Learning 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

MATH-5102 Linear Algebra

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	Calculus and Analytical Geometry

Course Introduction:

To provide fundamentals of solution for system of linear equations, operations on system of equations, matrix properties, solutions and study of their properties.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Develops students fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems	C2(Understand)

Course Outline:

Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms.

Reference Materials (or use any other standard and latest books):

1. Introduction to Linear Algebra by Gilbert Strang, Wellesley Cambridge Press; latest Edition
2. Elementary Linear Algebra with Applications by Bernard Kolman, David Hill, latest Edition, Prentice Hall.

MATH-5103 Probability and Statistics

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	None

Course Introduction:

To introduce the concepts of data analysis, presentation, counting techniques, probability and decision making.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Develops students fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems	C2(Understand)

Course Outline:

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. 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. Discrete Probability Distributions. Continuous Probability Distributions. 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, FQuantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of PValues for Decision Making in Testing Hypotheses (Single Sample & One- and TwoSample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear

Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.

Reference Materials (or use any other standard and latest books):

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

TechnicalandBusinessWriting	
CreditHours:	3(3-0)
ContactHours:	**3-0**
Pre-requisites:	functional English

CourseIntroduction:

Students in the senior level needs good technical writing skills not only for writing project report but also useful for them to communicate their resume and get place in the market. This is a high level course which provide useful knowledge to the students for writing proposals etc. Further, the course aims at augmenting students' proficiency in technical writing in order to sensitize them to the dynamics, challenges, and needs of the modern world characterized by technologically advanced social, cultural, and corporate settings. It will focus on students' ability to effectively convey and exchange information in cross-cultural, international, and multinational milieu necessitated by the emergence of global society.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	-

Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information; Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy, Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, crossreferencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

Reference Material:
1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition.
2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill

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URCE-5119Expository Writing

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	Functional English

Course Introduction:

The course introduces students to the communications so they can effectively communicate their message. The course also covers how to make an effective presentation both written and verbal. Various modern techniques of communication and presentation skills are covered in this course. Further the course aims to enhance students' linguistic command, so they could communicate effectively in diversified socio-cultural situations; create larger stretches of interactive text in speech and writing; and identify and repair any instances of potential

communication break-up.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	-	-

Course Outline:

Principles of writing good English, understanding the composition process: writing clearly; words, sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation. Process of writing, observing, audience collecting, composing, drafting and revising, persuasive writing, reading skills, listening skills and comprehension, skills for taking notes in class, skills for exams; Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation.

Reference Materials (or use any other standard and latest books):

1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740
2. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748
3. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
4. A Textbook Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

Elective Supporting Courses

BUSB-6101 Introduction to Marketing			
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.	C	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

Defining Marketing and the Marketing Process, Marketing: Creating and Capturing, Customer Value, Company and Marketing Strategy: Partnering to Build Customer Relationships, Analyzing the Marketing Environment, Managing Marketing Information to Gain Customer Insights, Consumer Markets and Consumer Buyer Behavior, Customer-Driven Marketing Strategy: Creating Value for Target Customers, New Product Development and Product Life-Cycle Strategies, New Product Development and Product Life-Cycle Strategies, Pricing: Understanding and Capturing Customer

Value, Pricing Strategies, Marketing Channels: Delivering Customer Value, Retailing and Wholesaling, Advertising and Public Relations
Teaching Methodology:
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Principles of Marketing by Philip Kotler 17th   2. Principles of Marketing 17th Edition by Gary Armstrong (Author)

BUSB-6103 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-6102 Human Resource 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		ESC	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

General Education Courses

URCS-5123 Application of Information & Communication Technologies

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	None

Course Introduction:

This is an introductory course in Computer Science designed for beginners. Apart from leading the participants through a whirlwind history of computing, the course also develops a feel for web programming through a series of lectures that help the students develop their own web page. Main objective of the course is to build an appreciation for the fundamental concepts in computing and to become familiar with popular PC productivity software.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand basics of computing technology	C1 (Knowledge)
CLO-2	Do number systems conversions and arithmetic	C2 (Understand)
CLO-3	Have knowledge of types of software	C2 (Understand)
CLO-4	Have knowledge of computing related technologies	C3 (Apply)

Course Outline:

Brief history of Computer, Four Stages of History, Computer Elements, Processor, Memory, Hardware, Software, Application Software its uses and Limitations, System Software its Importance and its Types, Types of Computer (Super, Mainframe, Mini and Micro Computer), Introduction to CBIS (Computer Based Information System), Methods of Input and Processing, Class2. Organizing Computer Facility, Centralized Computing Facility, Distributed Computing Facility, Decentralized Computing Facility, Input Devices. Keyboard and its Types, Terminal (Dump, Smart, Intelligent), Dedicated Data Entry, SDA (Source Data Automation), Pointing Devices, Voice Input, Output Devices. Soft- Hard Copies, Monitors and its Types, Printers and its Types, Plotters, Computer Virus and its Forms, Storage Units, Primary and Secondary Memories, RAM and its Types, Cache, Hard Disks, Working of Hard Disk, Diskettes, RAID, Optical Disk Storages (DVD, CD ROM), Magnetic Types, Backup System, Data Communications, Data Communication Model, Data Transmission, Digital and Analog Transmission, Modems, Asynchronous and Synchronous Transmission, Simplex. Half Duplex, Full Duplex Transmission, Communications, Medias (Cables, Wireless), Protocols, Network Topologies (Star, Bus, Ring), LAN, LAN, Internet, A Brief History, Birthplace of ARPA Net, Web Link, Browser, Internet Services provider and Online Services Providers, Function and Features of Browser, Search Engines, Some Common Services available on Internet.

Reference Materials (or use any other standard and latest books):

1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017.
3. Zawacki-Richter, Olaf, and Colin Latchem. "Exploring four decades of research in Computers & Education." Computers & Education 122 (2018): 136-152.
4. Sinha, Pradeep K., and Priti Sinha. Computer fundamentals. BPB publications, 2010.
5. Goel, Anita. Computer fundamentals. Pearson Education India, 2010.

URCE-5118 Functional English

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	None

Course Introduction:

Course Introduction:
This is first course in English to the Bachelor of Science students and covers all the fundamental concept of English composition and comprehension. The course is designed in such a way that students can use this knowledge to further enhance their language skills in English. The course aims at enhancing students' skill and competence in communicating their ideas in writing and speaking in English language. It will primarily focus on four areas of language to help the students achieve proficiency in language use, develop skills in listening comprehension, improve reading efficiency, use the conventions of standard written English with skill and assertion, build-up vocabulary, and clearly and accurately reproduce specific data. It will illustrate the force and effectiveness of simple and direct English.

CLO	Course Learning Outcomes	Bloom

No.		Taxonomy
CLO-1	-	-

Course Outline:

Paragraph and Essay Writing, Descriptive Essays; Sentence Errors, Persuasive Writing; How to give presentations, Sentence Errors; Oral Presentations, Comparison and Contrast Essays, Dialogue Writing, Short Story Writing, Review Writing, Narrative Essays, Letter Writing

Reference Materials (or use any other standard and latest books):

1. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
2. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

URCS-5210 Digital Skills

Credit Hours:	3 (3-0)
Contact Hours:	3-0
Pre-requisites:	None

Course Introduction:

This course introduces Digital skills which is basically the use of websites, apps, mobile devices, social media and its diverse platforms, search engines, and other digital means to promote and sell products and services

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand of digital skills, its principles, and best practices.	C2(Understand)
CLO-2	Apply theoretical concepts to real-world scenarios, demonstrating proficiency in executing effective digital skills and strategies.	C3(Apply)
CLO-3	Develop analytical skills to measure and optimize the performance of digital skill based initiatives, utilizing relevant metrics.	C4(Analyze)

Course Outline:

Introduction to fundamental concepts of digital skills, digital strategy and planning, emphasizing the use of websites, apps, mobile devices, social media and its diverse platforms, search engines, and other digital means. Ethical use of social media. Search engine optimization (SEO), social media marketing, email campaigns, and pay-per-click (PPC) advertising. Analytics and measurement techniques, legal and ethical considerations, and exploration of emerging trends. The use of latest online tools for better learning as IT student.

Reference Materials (or use any other standard and latest books):

1. "Basic Digital Skills: Your Guide to Basic Digital Skills" . A Training Manual by British Council. Second Edition, 2022.
2. "Digital Skills: Unlocking the Information Society" by Kennith A Leparo, Publisher: Palgrave Macmillan 2014.

URCQ-5102 Discrete Structures

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	-

Course Introduction:

Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. Further, this course aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. In this course more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs and Trees etc.	C2 (understand)
CLO-2	Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles.	C3 (Apply)
CLO-3	Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.	C3 (Apply)
CLO-4	Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular	C4 (Differentiate)

Course Outline:

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations. Algorithms, Searching and Sorting Algorithms, elements of graph theory, planar graphs, graph coloring, Graph Algorithms, euler graph, Hamiltonian path, rooted trees, traversals.

Reference Materials (or use any other standard and latest books):

1. Discrete Mathematics and Its Applications, 7th edition by Kenneth H. Rosen
2. Discrete Mathematics with Applications, 4th Edition by Susanna S. Epp
3. Discrete Mathematics, 7th edition by Richard Johnson Baugh
4. Discrete Mathematical Structures, 4th edition by Kolman, Busby & Ross
5. Discrete and Combinatorial Mathematics: An Applied Introduction by Ralph P. Grimaldi
6. Logic and Discrete Mathematics: A Computer Science Perspective by Winifred Grassman

URCQ-5103 Calculus and Analytic Geometry

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	-

Course Introduction:

To provide foundation and basic ground for calculus and analytical geometry background.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	

Course Outline:

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normals lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

Reference Materials (or use any other standard and latest books):

1. Calculus and Analytic Geometry by Kenneth W. Thomas.
2. Calculus by Stewart, James.
3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole

URCI-5105 Islamic Studies

Credit Hours:	2 (2-0)
Contact Hours:	2
Pre-requisites:	-

Course Introduction:

To provide Basic information about Islamic Studies. To enhance understanding of the students regarding Islamic Civilization. History of Islam, understanding of the worship and its usefulness. The basic concept of Quran Pak: wisdom, patience, loyalty. The comparative analysis of Islam with other religions. The Concept and Value of *Haqooq ul Ibad* (Bandon Kay Haqooq) in Islam. What is The rights of people in Islamic Point of View. Islamic point of view about other religions.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To further enhance the knowledge of Islam.	
CLO-2	To understand the basic concept of Islam and Quran Pak.	
CLO-3	To understand the concept of Haqooq ul ibad in the light of Quran.	
CLO-4	To know the importance of Islamic concept about other religions.	

Course Outline:

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam. Definition of Akhlaq.The Most Important Characters mentioned in the Holy Qur'an and Sunnah, SIDQ (Truthfulness)Generosity Tawakkaul(trust on Allah)Patience Taqua (piety). Haqooq ul ibad in the light of Quran & Hadith - the important characteristic of Islamic Society.

Reference Materials (or use any other standard and latest books):

1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

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URCI-5122 Ideology and Constitution of Pakistan

Credit Hours:	2 (2-0)
Contact Hours:	2
Pre-requisites:	-

Course Introduction:

Pakistan studies is an important course at this university in which students study about their motherland. The following are the specific objective of the course.
- to develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
- To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To educate students about the history of Pakistan.	
CLO-2	To understand the basic concept of Islam and Quran Pak.	
CLO-3	To educate student Government and politics	

Course Outline:

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Pakistan and its geopoliticaldimension, Pakistan and International Affairs, Pakistan and the challenges ahead.

Reference Materials (or use any other standard and latest books):

1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976
3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988

URCA-5118 Introduction to Management

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. Fundamentals and principles of management.	GER	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, Behavioural 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: Labour 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

URCS-6101Professional Practices		
Credit Hours:	2 (2-0)	
Contact Hours:	2	
Pre-requisites:	None	

Course Introduction:		
A Computing graduate as professional has some responsibilities with respect to the society. This course develops student understanding about historical, social, economic, ethical, and professional issues related to the discipline of Computing. It identifies key sources for information and opinion about professionalism and ethics. Students analyze, evaluate, and assess ethical and professional computing case studies.		
CLO No.	**Course Learning Outcomes**	**Bloom Taxonomy**
-	-	-

Course Outline:

Historical, social, and economic context of Computing (software engineering, Computer Science, Information Technology); Definitions of Computing (software engineering, Computer Science, Information Technology) subject areas and professional activities; professional societies; professional ethics; professional competency and life-long learning; uses, misuses, and risks of software; information security and privacy; business practices and the economics of software; intellectual property and software law (cyber law); social responsibilities, software related contracts, Software house organization. Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics.

Reference Materials (or use any other standard and latest books):

1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eatonand Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
2. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN-10: 0131112414
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.

URCC-5125: Civics and Community Engagement

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. Understand theimportanceofcivicparticipation,cultureandculturaldiversity, basicfoundationsofcitizenship,groupidentitiesandtheroleofindividualsincrea tingpositivechangewithintheircommunities.	GER	2
2. Developstudents'knowledge,skillsandattitudesnecessaryforactiveandrespon siblecitizenship	GER	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

1. IntroductiontoCivics&CommunityEngagement
  • Overviewofthecourse: Civics&CommunityEngagement
  • Definitionandimportanceofcivics
  • Keyconcepts incivics:citizenship,democracy, governance,andtherule oflaw
  • Rightsandresponsibilitiesofcitizens
2. CitizenshipandCommunityEngagement

- IntroductiontoActiveCitizenship:OverviewoftheIdeas,Concepts,PhilosophyandSkills
- ApproachesandMethodologyforActiveCitizenship

3. Identity,Culture,andSocialHarmony
   - ConceptandDevelopmentofIdentity,Groupidentities
   - Components of Culture, Cultural pluralism, Multiculturalism, Cultural Ethnocentrism, Culturalrelativism,Understandingculturaldiversity,GlobalizationandCulture,Social Harmony,
   - ReligiousDiversity(Understandingandaffirmationofsimilarities&differences)
   - UnderstandingSocio-PoliticalPolarization
   - Minorities,SocialInclusion,Affirmativeactions

4. Multi-culturalsocietyandinter-culturaldialogue
   - Inter-culturaldialogue(bridgingthedifferences,promotingharmony)
   - Promotingintergroupcontact/Dialogue
   - Significanceofdiversityanditsimpact
   - Importanceanddomains ofInter-cultural dialogue

5. ActiveCitizen:LocallyActive,GloballyConnected
   - Importanceofactivecitizenshipatnational andgloballevel
   - Understandingcommunity
   - Identificationofresources(human,naturalandothers)
   - Utilizationofresourcesfordevelopment(communityparticipation)
   - Strategicplanning,fordevelopment(communitylinkagesandmobilization)

6. Humanrights,constitutionalismandcitizens'responsibilities
   - IntroductiontoHumanRights
   - HumanrightsinconstitutionofPakistan
   - Publicdutiesandresponsibilities
   - Constitutionalismanddemocraticprocess

7. Social Institutions,SocialGroups,FormalOrganizations andBureaucracy
   - Types of groups, Group identities, Organizations
   - Bureaucracy, Weber's model of Bureaucracy
   - Role of political parties, interest groups and non-government organizations

8. CivicEngagementStrategies
   - Grassroots organizing and community mobilization
   - Advocacy and lobbying for policy change
   - Volunteerism and service-learning opportunity

9. Social issues/Problems of Pakistan

Teaching Methodology:
Lectures, Written Assignments, Sem, Report Writing

Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Material:

1. Kennedy. J. K., & Brunold, A. (2016). Regional context and Citizenship education in Asia andEurope.New Yourk:Routledge, Falmer.
2. Henslin, James M. (2018). Essentials of Sociology: A Down to Earth Approach (13th ed.). New York:Pearson Education
3. Macionis,J.J., &Gerber,M.L. (2020).Sociology. NewYork: Pearson Education
4. GlencoeMcGraw-Hill.(n.d.).CivicsToday:Citizenship,Economics,andYouth.
5. Magleby, D. B., Light, P. C., & Nemacheck, C. L. (2020). Government by the People (16th ed.).Pearson.
6. Sirianni, C., & Friedland, L. (2005). The Civic Renewal Movement: Community-Building
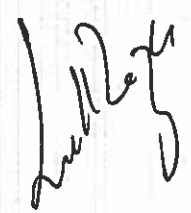
andDemocracyin the United States. KetteringFoundationPress.

7. Bloemraad, I. (2006). Becoming a Citizen: Incorporating Immigrants and Refugees in the UnitedStatesand Canada. Universityof California Press.
8. Kuyek,J.(2007).CommunityOrganizing:TheoryandPractice.FernwoodPublishing.
9. DeKieffer,D.E.(2010).TheCitizen'sGuidetoLobbyingCongress.TheCapitol.Net.
10. Rybacki, K. C., & Rybacki, D. J. (2021). Advocacy and Opposition: An Introduction toArgumentation(8thed.). Routledge.
11. Kretzmann,J.   P.,&McKnight,J.L.(1993).   BuildingCommunitiesfromthe InsideOut:APathTowardsFindingandMobilizinga Community'sAssets. ACTAPublications.
12. Patterson,T.E.(2005).EngagingthePublic:HowGovernment andtheMediaCanReinvigorateAmericanDemocracy. Oxford UniversityPress.
13. Love, N. S., & Mattern, M. (2005). Doing Democracy: Activist Art and Cultural Politics. SUNYPress

URCE-5124: Entrepreneurship			
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. 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 GER	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
1. Entrepreneurship by Robert Hisrich, Michael Peters and Dean Shepherd, McGrawHill/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)

URCQ-5111: Translation of the Holy Quran - I

Credit Hours:	NC	Prerequisites:	None

Semester / Level	Insome discipline1ˢᵗsemesterandinsomediscipline2ⁿᵈSemester/ ADP Program1ˢᵗYear
Course Learning Outcomes (CLOs):	• Tofamiliarizethestudentstokeysandfundamentalsofrecitationofthe holyQuran. • Todeveloptheskillofthestudentsofrecitationthelastrevelation. • StudentswilllearnthebasicArabicgrammarinapracticalway. • TodevelopaneagernessamongthestudentstoexplorethelastdivineBook.
Course Contents:	• تیلسواں پارہ - ناظرہ مع تجوید • بنیادی عربی گرامر اسم اور اسکے متعلقات : اسم فاعل سفعول شتضیل سبالغہ فعل اور اسکی اقسام : ماضی ،مضارع ،امر ، نہی حرف اور اسکی اقسام : حرف علت ،حرف جارہ ،مشبہ بالفعل
Memorization:	تیسرں پارے کی لخری بیس سورتیں (حفظ مع ترجمہ)

URCQ-5111: Translation of the Holy Quran - II

Credit Hours:	NC	Prerequisites:	None

Semester/Level	Insome discipline3ʳᵈsemesterandinsomediscipline4ᵗʰSemester/ ADP Program2ⁿᵈYear

Course Learning Outcome (CLO):	- Students will come to know about the real nature, significance and relevance of the Islamic beliefs in light of the text of the Holy Quran. - Students will seek knowledge of translation and transliteration of the Holy Book Quran. - To familiarize the students with the concept of Ibādah (Its significance, scope and relevance) and its types in Islam. - Students will learn literal and idiomatic way of translation of the Holy Book. - Students will learn about the polytheism and its incompatibility in Islam highlighted by the Holy Quran. - To highlight the significance of learning through using all human faculties provided by the almighty Allah and familiarize the students about condemnation of ignorance mentioned in the Quranic text. - To develop Awareness among the students about rights and duties of different circles of society in the light of Holy Quran. - To introduce the students to Quranic Arabic grammar in practical manner.
CourseCo ntents:	ایمانیات اور عبادات0 اللا پر ایمان ،فرشتوں پر ایمان ،رسولوں پر ایمان ،آسمانی کتابوں پر ایمان یوم آخرت پر ایمان ، تقدیر پر ایمان نماز ،روزہ ،زکوۃ،حج ،جہاد - معاشرے کے حقوق - خاندان کی تکوین - حق مہر - رضاعت و حمل - اولاد کو قتل کرنے کے ممانعت - شوہر کی نافرمانی - طلاق - بیوہ کی عدت کے احکام - نکاح کا پیغام بھیجنا - عورت کی وراثت)اس کے شوہر کی طرف سے(- والدین کے حقوق - بیویوں اور اولاد کے بیچ عداوت - خاندان کے حقوق - مہمان کی عزت - اجازت طلب کرنے کے اصول - مجلس کے آداب - تعاون اور بھائی چارہ - گروہ بندی - محبت - لوگوں کے درمیان صلح - عفو ودرگزر، غصہ پر قابو اور معاف کرنا - شعوب و قبائل - لوگوں کے بیچ اختلافات - حمایت و نگہبانی
Grammar:	قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)
Details of Chapters and verse Numbers:	- منتخب آیات مع ترجمہ وتجوید - البقرہ ((۱۱۷ ، ۲۳۸ ، ۴۵ ، ۱۱۸ ، ۲۷۸ ، ۱۷۷ ، ۴۵ ، ۳۴۷ ، ۱۱۸، ۷۱۸ ، ۴۲۸ ،۵۳، ۴۲۸، ۴۷ ، ۲۸۷ ، ۳۴۸ ، ۲۲ ، ۸۲ ، ۲۸۷ ، ۴۲۸ ، ۲۴۸ ، ۱۱۷ ، ۲۳۷

URCQ-5111: Translation of the Holy Quran - III			
Credit Hours:	0	Prerequisites:	None

Semester/Level	Insome discipline5ᵗʰsemesterandinsomediscipline6ᵗʰSemester/BS(5ᵗʰ Semesterintake) 1ˢᵗ/2ⁿᵈ
Objectives	- To introduce ethics and highlight its importance, need and relevanceforindividualandcollectivelife. - To illuminate the students with the Quranic norms of Morality i.e.truthfulness,patience,gratitude,modesty,forgiving,hospitali tyetc. - Tofamiliarizethestudentswithimmoralvalueslikefalsify,arrogance ,immodesty,extravagance, backbitingetc. - Toinculcateethicalandmoral valuesin ouryouth. - Todevelopabalanceddynamicandwholesomepersonality. - To introduce the students to Quranic Arabic grammar in practicalmanner.

CourseCo ntents:	اخلاق (تعارف،ضرورت واہمیت ،اقسام،معنویت) • اخلاق حسنہ: • ۔برائی کو نیکی سے مٹانا • ۔نیکی کے کاموں میں مسابقت • ۔لوگوں کے درمیان صلح • ۔عدل وانصاف • سچائی • ۔ایثار • ۔سلیم قلب • ۔مہمان نوازی • ۔لغویات سے اعراض • ۔عاجزی و انکساری • ۔نگاہ اور آوازکو پست رکھنا • ۔چال میں میانہ روی • ۔شرمگاہوں کی حفاظت • صبر • شکر • ۔امور میں میانہ روی • اخلاق سیئہ : • ظلم اور زیادتی • غرور و تکبر • نفسانی خواہشات کی پیروی • بدگمانی • جھوٹ • چغلی اور تہمت • تمسخر اور شیخی خوری • لہو و لعب • برے ناموں سے پکارنا • احسان جتانا اور تکلیف دینا • فضول خرچی اور حد سے بڑھنا • حسد اور تنگ دل • بے پردگی •
Grammar:	قرآنی عربی گرامر کے اصول اور انکے اطلاقات)متن قرآنی پر اطلاق سے • توضیحات (
Detailsof	منتخب آیات مع ترجمہ وتجوید
Chapters andverseNumbers:	البقره)۸۷۷، ۴۵۸، ۳۲، ۸۲۷، ۸۱۷، ۸۴۷، ۸۱۷، ۸۴، ۳۴۷، ۱۱۷، • ۱۴۸، ۴۸۷، ۸۸۸، ۱۸، ۱۱، ۸۲۷، ۲۵۷، ۱۲۷، ۲۱۷، ۵۲۸، ۳۲۸، ۸۲۸، ۸۷۸، ۱۲، • ۷۳۸، ۱۷، ۵۳، ۵۸۷، ۲۴۸، ۱۸، ۷۱، ۳۲، ۲۸۸، ۴۲۷، ۲۱، • آل عمران)۵۴۷، ۵۷، ۵۸، ۴۲۷، ۸۳۷، ۲۵۷، ۵۳۷، ۴۵۷، ۱۷، • ۱۱۸، ۴۸۷، ۳۳۷، ۵۷۷، ۵۱۷، ۵۱۷، ۲۸، ۲۱، ۷۵۷، ۱۵۷، ۲۴۷(النساء)۴۳۷، ۳۸، ۸۸، ۲۱۷، ۱۱۷، ۴۱۷، ۵۴، ۱۸، ۱۸، ۳۱۷، ۲۳، • ۴۸، ۵۸، ۱۵، ۱۴، ۵۸(• المائدۃ)۲۴، ۱۴، ۳۲، ۳۷، ۲، ۷۵، ۲۷(• النحل)۱۲، ۲۸۷، ۴۱۷، ۳۷۷، ۱۳، ۲۸۷، ۴۸۷(□ الرعد)۴۸، ۱۸، ۵۸، ۸۸، ۲(□ العراف)۷۳، ۲۲، ۷۴، ۲۵۷، ۱۵، ۵، ۱۸، ۵۵۷، ۲۲۷، ۴۲، ۷۲(□ القصص)۵۴، ۵۲(□ فصلت)۵۳(□ النعام)۸۳، ۱۱، ۱۱، ۱۳۷، ۴۴۷، ۱۲۷(• النمل)۱۲، ۲۵(• الحج)۱۳، ۲۴، ۱۲، ۲۲، ۱۱(•

	• □ الحجرات)٢، ٧٧، ٢، ٧٧، ٣، ٨٧، ٤٧، ١٧(
	• □ الحزاب)٣٨، ١٤، ٢٤، ٢٤، ٤٤، ٨٤، ٣٤، ٣٤، ٨٥، ٣٤(
	• □ الحشر)٢(
	• □ طه)٨١(
	• □ النعام)٥٢٧، ٧٥٧، ٢٧٧، ٧٤٧، ٣٢، ٧٨١(
	• □ ق)٣٥(
	• □ النفال)١٨، ٢٥، ٧٢(
	• □ الفتح)٧٤(
	• □ يونس)١٧، ٢٧، ٧٨، ٢٢، ٨٨، ٨٨(
	• □ الفرقان)٢٣، ٧٨، ١٢، ٢٣(
	• □ النور)٣٨، ٢، ٥، ١٣، ٣٧، ٣٣، ٣٧، ٢٧، ٣٧، ٨٨(
	• □ لقمان)٢، ٣٣، ٢٧، ٣٨، ٢٧(
	• □ السراء)١٣، ٧٧١، ٤، ١٣(
	• □ المزمل)٢٧(
	• □ المدثر)٢، ٥(
	• □ المدثر)١٥(
	• □ فاطر)٣٨(
	• □ الفتح)٨٢(
	• □ البلد)١٧(
	• □ الزمر)٣، ١٧(
	• □ الحجر)٢٤(
	• □ النجم)٣٧(
	• □ الرحمن)١٢(
	• □ هود)٢، ٧١٨، ٣(
	• □ الكهف)٨، ٢٤(
	• □ الشورى)١٣(
	• □ غافر)٨٢، ١٨(
	• □ الحديد)٨١، ١٨(
	• □ مريم)٢٤(
	• □ النازعات)٧٥(
	• □ التوبه)٢٤، ٢٥، ١١(
	• □ الهمزه)٧(

URCQ-5111: Translation of the Holy Quran - IV			
Credit Hours:	0	Prerequisites:	None

Semester/Level	In some discipline7thsemesterandinsomediscipline8thSemester/BS(5th Semesterintake)3rd/ 4th
Objectives	• To familiarize the students with commandments of trade and inheritance mentioned in the Quranic text (with the help of Urdu translation). • Students • To introduce the students to scientific facts and miracles of the Holy Quran and Quranic stress on deep study of Allah's explored universe. • To motivate the students for reading and exploring the last Holy Book revealed by Almighty Allah. • Through memorization students will develop their relation with last revelation.
CourseCo ntents:	• تجارت اور وراثت: • مال کی تقسیم • نادان کا مال • عوام الناس کا مال • عورتوں کا مال • یتیموں کا مال • کفار کا مال • جائز مال • معاہدے • رہن • قرض • سائنسی حقائق: • تخلیقِ کائنات • اجرامِ فلکی • شجر و حجر • زمین و آسمان کے اسرار • ہوائیں اور طوفان • بہائم اور مویشی • حشرات الارض • پہاڑ اور سمندر
Grammar:	• قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)

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Detailsof	منتخب آيات مع ترجمه وتجويد

- البقره)٧٢٨، ٤٧٨٨، ٤٢٨، ٢٧٨، ٥٢٨، ٤١٨، ٢٧، ٤٢٨، ١١٧، ٤٢٨، ٢٧، ٤١٨،
- ٨٢٨، ٨٢٨، ٥١٨، ٧١٨، ٣٢، ١١٧، ٤٧٨، ٢١٨، ٢١٨، ٢٧، ١٨، ٣٨٨، ٢٨، ٤٤٨،
- ٥٢٧، ٢٢٨، ٥٢٧، ٥٢٧، ١٤، ١٢، ٥٢٧، ١٤، ١٧٨، ٢٧، ٢٨، ٧١، ٨٢، ٣٢)
- آل عمران)١٧٧، ٥٣٧، ١٣٧، ١٢٧، ١٨، ٢٤)
- النساء)٢٨، ٨، ٢٨، ٧٢٧)
- المانده)٢٢، ٤٢، ٤١، ٢٢، ١٢)
- التوبه)٢٢، ٥٨، ٥٨، ٢٢، ١٢، ٥)
- العراف)٨١٧، ٤٢٧، ١٤، ٢٤، ٣٢٧، ٣٢٧، ١٢٧، ١٥، ٣٣٧، ٢١٧، ٢٢٧)
- الرعد)١٧، ٥)
- الطور)٥٥)
- النعام)٢٤، ٣٢، ٧٥٧، ٢٣، ٢٥٧)
- النفال)٢٨، ٢٣، ٧٥)
- الكهف)٧٤، ٢١٧، ١٥، ٨٣، ٤٥، ١٧، ٤٥)
- الجاثيم)٤)
- فاطر)١٨، ٨٧، ٣٧)
- العنكبوت)١٨، ٣٢، ٧٥)
- الروم)١٤)
- السراء)١١، ٢٢)
- الرعد)٨)
- السبا)١٧، ٣، ٨٨)
- يونس)٢٢، ٧١٧، ٥٨، ٥٨، ٤، ٨٨)
- يوسف)٥٢، ٥٧)
- الفرقان)٨٢، ٣٤)
- لقمان)٢٨، ٢٧)
- طه)٥٧٧، ٣٤)
- النحل)٤١، ٧٧، ٧٢، ٢٥، ٢١، ٢٢، ٢٢، ٤٧٧، ٢، ٢)
- النمل)٥٢، ٥٢، ٢٢، ١٢، ٨٢، ٢٧، ١٧، ٢٧)
- السجده)١٨)
- الحديد)٢)
- هود)٣٥، ٢)
- يسين)١٣، ٧٥)
- الروم)٢٣، ٢٣، ١٤، ٢٧، ٥٨، ٢٥)
- فصلت)٢٣، ٢٣)
- الحج)٧٢، ٤٢، ٨٨، ٣١)
- الحجر)٢٧، ٨٨)
- النبياء)٧٣، ١٣، ١٥)
- الزاريات)١٥)
- الزلزله)٧)
- القصص)٢١، ٢١، ١٢، ٧٢، ٨٢)
- النور)١٣، ٨٨، ٨٨، ١٥، ٤٥، ٣٥)
- الجمعه)٧٧، ٨٢، ١٧، ٧٧، ٤)

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	• القمر)١(
	• الواقعه)٢٢(
	• الفاطر)١٨، ٣٧(
	• الملك)٢٧(
	• الصف)١٧(
	• الجن)٣٧(
	• الشور ٰى)٢٨(
	• الزخرف)٧٧(
	• الفيل)٧(