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)

Dated: 26.09.2024

No. SU/Acad/24/747

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

Revised
Curriculum
of
ADP Information Technology
for
Main Campus, and Affiliated Colleges

Department of Information Technology

University of Sargodha

(Applicable from Fall 2024)

Table of Contents

Guidelines for Affiliated Colleges

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

The Discipline of Information Technology

The evolution of information technology (IT) has been marked by rapid and transformative changes, starting from the mechanical calculators of the 19th century to the sophisticated digital systems of the 21st century. Initially, IT was primarily focused on data processing and number crunching, but over time, it has expanded to include a wide range of functionalities, such as communication, data storage, and security. The advent of personal computing in the 1980s and the internet in the 1990s revolutionized the field, making technology more accessible and integral to daily life. This evolution continued with the development of mobile computing, cloud computing, and artificial intelligence, significantly impacting how individuals and organizations interact with technology and process information.

Information technology (IT) refers to the use of computers, networking devices, and software to process, store, retrieve, and send information. It encompasses a variety of activities, including computer programming, data management, networking, system administration, and hardware development. IT is fundamental to the operations of modern organizations, enabling them to manage their information resources efficiently, enhance communication, implement automation, and improve decision-making processes. Through IT, businesses and other entities can leverage technological advancements to optimize their operations, innovate services and products, and maintain competitiveness in the digital age.

The motivation to offer a Associate Degree Program in Information Technology ADP-(IT) stems from the critical role that IT plays in the contemporary world. As businesses and societies become increasingly reliant on technology, there is a growing demand for skilled professionals who can develop, implement, and manage IT systems. A ADP in Information Technology equips students with the necessary knowledge and skills to address complex technological challenges, meet the evolving needs of the digital economy, and contribute to the advancement of various sectors. This degree program is designed to provide a comprehensive understanding of fundamental and advanced IT concepts, preparing graduates for a range of careers in the tech industry, from systems analysis and network administration to cybersecurity and software development.

Information Technology Programs' Rationale

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

expand, disseminate and teach the information technology body of knowledge through academics, applications and research which positively impact society (locally, nationally, and internationally). It will also provide an integration of all components that allow accessing all of the new knowledge and technologies for meeting the above discussed challenges.

Underlying Principles of Information Technology Programs

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

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

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

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

following six (6) key areas:

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

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

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 Information Technology

Department of Information Technology aspires to societal betterment through a commitment to quality education, technical skills, fostering creativity via analytical learning, and conducting impactful research in the ever-dynamic field of Information Technology.

Mission Statement of Department of Information Technology

Our mission includes:

- Imparting students with an enriching learning experience in the field of Information Technology centered on in-depth knowledge, critical thinking, innovation, and technical proficiency.
- Cultivating a professional and collaborative work environment for faculty and staff of the department, fostering the attainment of professional excellence

Contributing to knowledge economy, drive social transformation and deliver community services through advanced studies and research in the field of Information Technology.

Curriculum
for
ADP-Information Technology Program

Details of ADP-Information Technology

Program Educational Objectives

The aim of the ADP-(IT) program is to produce entrepreneurs of great character, competence, vision and drive equip with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in information technology domain or proceed to further or higher education or training. One of the key objectives of the program is to equip students with skills and knowledge that enable them to take on appropriate professional positions in IT and grow into leading roles. The following are the PEOs for all BS degree programs being offered in the Department of Information Technology:

PEO-1: Provide in-depth knowledge, analytical skills, and creativity in the domain of Information Technology.

PEO-2: Attain the ability to adapt in an evolving technological environments, assimilate new information with a strong focus on application to solve real-world problems.

PEO-3: Instill moral and ethical values, along with the ability to communicate effectively.

PEO-4: Train graduates to contribute towards knowledge economy and socio-economic growth of the country.

Program's Outcome

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

Program's Structure

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

Specialization Tracks
Following specialization tracks are being offered:
1. Regular Track [Public-Private campuses and affiliated colleges will follow track]
2. General Track [Main and public sub campuses]

Degree Requirement

To become eligible for award of ADP-(IT) degree, a student must satisfy the following requirements:

a) Must have studied and passed the prescribed courses, totaling at least 72 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 a minimum of four semesters/terms spread over two calendar years with two semesters/terms a year as per the rules of the University.

Eligibility Criteria

HSSC (Part-I) with least 50% Marks with one of the following combinations:

I. Pre-Engineering
II. Pre-Medical (Admitted candidates has to pass 6-credit hours courses of mathematics in first two semester.)

Merit: Basic criteria+20 marks of Hafiz-e-Quran (if applicable)

1) General Science

a) Math, Stat, Phy

b) Math, Stat, Eco

c) Math, Stat, Comp

d) Math, Phy, Comp

e) Math, Eco, Comp

2) A-Level (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

ADP-(IT)			
Taxonomy of Courses	**Major Areas**	**Credit Hours**	**Courses**
Major Courses	Computing Core	34	10
	Domain Core	06	02
Interdisciplinary	Mathematics & Supporting	09	03
	Elective Supporting	03	01
General Education	General Education	20	09
	Total	72	25

Major Area Courses

Computing Core Courses – 34 Credit Hours - 10 Courses

#	Code	Pre-Req	Course Title	Cr. Hrs. (Contact Hrs)
1	CMPC-5201	-	Programming Fundamentals	4 (3-3)
2	CMPC-5202	CMPC-5201	Object Oriented Programming	4 (3-3)
3	CMPC-5203	-	Database Systems	4 (3-3)
4	CMPC-5204	-	Digital Logic Design	3 (2-3)
5	CMPC-5205	CMPC-5202	Data Structures	4 (3-3)
6	CMPC-5206	-	Information Security	3 (2-3)
7	CMPC-5207	-	Artificial Intelligence	3 (2-3)
8	CMPC-5208	-	Computer Networks	3 (2-3)
9	CMPC-5101	-	Software Engineering	3 (3-0)
10	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	3 (2-3)

Domain Core – 6 Credit Hours - 02 Courses

#	Code	Pre-Req	Course Title	Cr. Hrs. (Contact Hrs)
1	ITDC-5201	-	Web Technologies	3 (2-3)
2	ITDC-5202	-	Cyber Security	3 (2-3)

Mathematics & Supporting Courses – 09 Credit Hours - 03 Courses

#	Code	Pre-Req	Course Title	Cr. Hrs. (Contact Hrs)
1	MATH-5101	URCQ-5102	Multivariable Calculus	3 (3-0)
2	MATH-5102	URCQ-5102	Linear Algebra	3 (3-0)
3	MATH-5103	-	Probability & Statistics	3 (3-0)

Elective Supporting Courses – 03 Credit Hours - 01 Courses

#	Code	Pre-Req	Course Title	Cr. Hrs. (Contact Hrs)
1	URCS-5210		Digital skills	3 (3-0)

General Education – 20 Credit Hours - 9 Courses

#	Code	Pre-Req	Course Title	Cr. Hrs. (Contact Hrs)
1	URCF-5118	-	Functional English	3 (3-0)
2	URCE-5119	URCF-5118	Expository Writing	3 (3-0)
3	URCQ-5101	-	Quantitative Reasoning I (Discrete Structures)	3 (3-0)
4	URCI-5105	-	Islamic Studies	2 (2-0)

5	URCE-5126		Ethics (for non-Muslims)	2 (2-0)
6	URCS-5123	-	Applications of Information & Communication Technologies	3 (2-3)
7	URCQ-5102	-	Calculus & Analytical Geometry*	3 (3-0)
8	URCW-5201	-	Applied Physics	3 (2-3)
9	URCQ-5111	-	Translation of Holy Quran-I	NC
10	URCQ-5111	-	Translation of Holy Quran-II	NC

*A pre-medical student can only study Calculus & Analytical Geometry after passing 6-credit hours courses of mathematics.

Course Coding Scheme

Discipline Code	Course Level	Course Type	Course Number
4 Letters	1 Digit	1 Digit	2 Digits
Xxxx	5-6	1-2	01-99

Discipline Code

Code	Discipline
CMPC	Computing Core
ITDC	Information Technology Domain Core
ITDE	Information Technology Domain Elective
CSDC	Computer Science Domain Core
CSDE	Computer Science Domain Elective
SEDC	Software Engineering Domain Core
SEDE	Software Engineering Domain Elective
AIDC	Artificial Intelligence Domain Core
AIDE	Artificial Intelligence Domain Elective
DSDC	Data Science Domain Core
DSDE	Data Science Domain Elective
MATH	Mathematics
ENGL	English
URCI	General Science
URCC	
URCQ	
URCS	
URCE	
URCA	
URCF	
URCW	
URCT	

Course Level

Level	Course Type
5	Semester 1-4
6	Semester 5-8

Course Type

Level	Course Type
1	Non-lab Course
2	Lab Course

Scheme of Studies for ADP-(IT)

For Main Campus

2-Year Program (4 Regular Semesters)

Semester – I

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5201	-	Programming Fundamentals	Core	4 (3-3)
2	URCS-5123	-	Application of Information & Communication Technologies	GER	3 (2-3)
3	URCQ-5101	-	Discrete Structures	GER	3 (3-0)
4	URCQ-5102	-	Calculus and Analytic Geometry	GER	3 (3-0)
5	URCF-5118	-	Functional English	GER	3 (3-0)
6	BUSB-61xx	-	Elective Supporting Course	SS	3 (3-0)
			Total Credit Hours		19 (17-6)

Semester - II

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5202	CMPC-5201	Object Oriented Programming	Core	4 (3-3)
2	CMPC-5203	-	Database Systems	Core	4 (3-3)
3	CMPC-5204	-	Digital Logic Design	Core	3 (2-3)
4	MATH-5101	URCQ-5102	Multivariable Calculus	MATH	3 (3-0)
5	MATH-5102	URCQ-5102	Linear Algebra	MATH	3 (3-0)
6	URCQ-5111	-	Translation of Holy Quran-I	GER	0 (0-0)
			Total Credit Hours		17 (14-9)

Semester – III

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5205	CMPC-5202	Data Structures	Core	4 (3-3)
2	CMPC-5206	-	Information Security	Core	3 (2-3)
3	CMPC-5207	-	Artificial Intelligence	Core	3 (2-3)
4	CMPC-5208	-	Computer Networks	Core	3 (2-3)
5	CMPC-5101	-	Software Engineering	Core	3 (3-0)

6	MATH-5103	-	Probability & Statistics	MATH	3 (3-0)
			Total Credit Hours		**19 (15-12)**

Semester – IV

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	Core	3 (2-3)
2	ITDC-5201	-	Web Technologies	Domain Core	3 (2-3)
3	ITDC-5202	-	Cyber Security	Domain Core	3 (2-3)
4	URCI-5105	-	Islamic Studies/ Ethics	GER	2 (2-0)
5	URCW-5201	-	Applied Physics	GER	3 (2-3)
6	URCE-5119	URCF-5118	Expository Writing	GER	3 (3-0)
7	URCQ-5111	-	Translation of Holy Quran-II	GER	0 (0-0)
			Total Credit Hours		**17 (13-12)**

Scheme of Studies for ADP-(IT)

For Affiliated Colleges

2-Year Program (4 Regular Semesters)

Semester – I

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5201	-	Programming Fundamentals	Core	4 (3-3)
2	URCS-5123	-	Application of Information & Communication Technologies	GER	3 (2-3)
3	URCQ-5101	-	Discrete Structures	GER	3 (3-0)
4	URCQ-5102	-	Calculus and Analytic Geometry	GER	3 (3-0)
5	URCF-5118	-	Functional English	GER	3 (3-0)
6	URCS-5210		Digital Skills	SS	3 (3-0)
			Total Credit Hours		**19 (17-6)**

Semester - II

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5202	CMPC-5201	Object Oriented Programming	Core	4 (3-3)
2	CMPC-5203	-	Database Systems	Core	4 (3-3)
3	CMPC-5204	-	Digital Logic Design	Core	3 (2-3)
4	MATH-5101	URCQ-5102	Multivariable Calculus	MATH	3 (3-0)
5	MATH-5102	URCQ-5102	Linear Algebra	MATH	3 (3-0)
6	URCQ-5111	-	Translation of Holy Quran-I	GER	0 (0-0)
			Total Credit Hours		**17 (14-9)**

Semester – III

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5205	CMPC-5202	Data Structures	Core	4 (3-3)
2	CMPC-5206	-	Information Security	Core	3 (2-3)
3	CMPC-5207	-	Artificial Intelligence	Core	3 (2-3)
4	CMPC-5208	-	Computer Networks	Core	3 (2-3)
5	CMPC-5101	-	Software Engineering	Core	3 (3-0)
6	MATH-5103	-	Probability & Statistics	MATH	3 (3-0)
				Total Credit Hours	**19 (15-12)**

Semester – IV

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5209	CMPC-5204	Computer Organization & Assembly Language	Core	3 (2-3)
2	ITDC-5201	-	Web Technologies	Domain Core	3 (2-3)
3	ITDC-5202	-	Cyber Security	Domain Core	3 (2-3)
4	URCI-5105	-	Islamic Studies/ Ethics	GER	2 (2-0)
5	URCW-5201	-	Applied Physics	GER	3 (2-3)
6	URCE-5119	URCF-5118	Expository Writing	GER	3 (3-0)
7	URCQ-5111	-	Translation of Holy Quran-II	GER	0 (0-0)
				Total Credit Hours	**17 (13-12)**

Contents of Computing Core Courses

CMPC-5201 Programming Fundamentals	
Credit Hours:	4 (3-3)
Contact Hours:	3-3
Pre-requisites:	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 contents and try to achieve CLOs to the maximum possible level. The course may be taught as language independent. Further, it is up to the university to choose any language for the practical/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 logic constructs	C2 (Understand)
CLO-2	Apply basic programing concepts	C3 (Apply)
CLO-3	Design and implement algorithms to solve real world problems	C3 (Solve)

Course Outline:

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multidimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic 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	Course Learning Outcomes	Bloom

No.		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 their relationships, 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. Thomas Wu
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, it focuses on the design and analysis combinational and sequential circuits. It also serves to familiarize 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 and techniques for the design of digital electronic circuits	-
CLO-2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	-
CLO-3	Apply the acquired knowledge to simulate and implement small-scale digital circuits	-
CLO-4	Understand the relationship between abstract logic characterizations 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, Triggered devices & its types. Mealy machines and Moore machines. Binary Arithmetic and Arithmetic Circuits, 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 write programmer to efficiently manipulate, store, and retrieve data. Students are exposed to the concepts of time and space complexity of computer programs.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)
CLO-2	Analyze simple algorithms and determine their complexities.	C5 (Analyze)
CLO-3	Apply the knowledge of data structure to other application domains.	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 array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms, 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 search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, 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

CMPC-5206 Information Security

Credit Hours: Contact Hours: Pre-requisites:	3 (2-3) 2-3 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 and expertise needed in organizations to reach and maintain a state of acceptable security. It covers concepts

and applications of system and data security. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain key concepts of information security such as design principles, cryptography, risk management, and ethics	C2 (Explain)
CLO-2	Discuss legal, ethical, and professional issues in information security	A2 (Discuss)
CLO-3	Apply various security and risk management tools for achieving information security and privacy	C3 (Apply)
CLO-4	Identify appropriate techniques to tackle and solve problems 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, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics 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:	Object Oriented Programming

Course Introduction:

Artificial Intelligence has emerged as one of the most significant and promising areas of computing. This course focuses on the foundations of AI and its basic techniques like Symbolic manipulations, Pattern Matching, Knowledge Representation, Decision Making and 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 Python programming language.	C2 (Understand)
CLO-2	Understand key concepts in the field of artificial intelligence	C2 (Understand)
CLO-3	Implement artificial intelligence techniques and case studies	C3 (Apply)

Course Outline:

An Introduction to Artificial Intelligence and its applications towards Knowledge Based

Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, 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 will be 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. Network layers, 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 of computer networks	C2 (Describe)
CLO-2	Explain the services and functions provided by each layer in the Internet protocol stack.	C2 (Explain)
CLO-3	Identify various internetworking devices and protocols and 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, multiple access techniques, circuit switching and packet switching, LAN technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, sub netting, CIDR, routing protocols, transport layer protocols, ports and sockets, 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 and activates	C1 (Describe)
CLO-2	Apply the system modeling techniques to model a medium size software systems	C3 (Apply)
CLO-3	Apply software quality assurance and testing principles to medium size software systems	C4 (Apply)
CLO-4	Discuss key principles and common methods for software project 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, Agile software Development, Agile process models, Agile development techniques, Requirements engineering 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, Software testing 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:

This course helps students understanding the architecture and design principles of modern computing systems. They will explore the essentials of assembly language programming, understanding how low-level instructions contribute to the functioning of CPUs. They will also gain a profound understanding of hardware-software interactions, setting the foundation for advanced studies in computer science and programming.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Understanding the basics of computer organization with emphasis on the lower level abstraction of a computer system	C1 (Memorize)
CLO-2	Understand the digital logic, instruction set	C2 (Understand)
CLO-3	Familiarity with assembly language programming.	C2 (Understand)

Course Outline:

Introduction to Microprocessor Architecture: Microprocessor Bus Structure -Addressing, Data and Control, Registers and Flags. Addressing Modes. Introduction to Assembly Language, 80x86 families; program layout. Data Definitions, Basic Instructions. Unsigned Arithmetic; Logic and Bit Operations. Modules; Separate Assembly; Argument Passing Libraries; Combining Assembly and C Code. String Instructions; Arrays. Macros; Structures. Floating Point Instruction. Bit MS-DOS. BIOS Disk Accessing. BIOS Keyboard/Video/Graphics. Interrupts; TSR Programs. Accessing I/O Ports; 8253 Timer

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

1. Assembly Language for x86 Processors by Kip R. Irvine, Prentice Hall; 6thEdition (March 7, 2010). ISBN-10: 013602212X
2. The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications by Walter A. Triebel & Avtar Singh, Prentice Hall; 4thEdition (September 8, 2002). ISBN-10: 0130930814.
3. Lab Manual to Accompany - The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications by Walter A. Triebel & Avtar Singh, Pearson; 4thEdition (2003). ASIN: B000Q652KQ
4. Principles of Computer Organization and Assembly Language by Patrick Juola, Prentice Hall; 1stEdition (January 11, 2011). ASIN: B009TGBI1Q
5. The Art of Assembly Language by Randall Hyde, No Starch Press; 2ndEdition (March 22, 2010). ISBN-10: 1593272073.

Contents of Domain Core Courses

ITDC-5201 Web Technologies	
Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:

The Web Technologies course provides a comprehensive understanding of internet-based technologies, covering web development, protocols, and design principles. Participants acquire skills in creating dynamic and interactive web applications.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Learn basic WWW, its structure and working.	C1 (Remember)
CLO-2	Describe the constraints that the web puts on developers.	C2 (Understand)
CLO-3	Implement basic client side and server-side languages.	C4 (Apply)
CLO-4	Design and implement a simple web application.	C4 (Apply)
CLO-5	Review an existing web application against a current web standard.	C4 (Apply)

Course Outline:

Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Big Θ, little-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion and recurrence relations; Algorithm Design Techniques, Brute Force 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 complexity classes.

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

1. Learning PHP, MySQL, JavaScript, and CSS, A Step-by-Step Guide to Creating Dy-namic Websites By Robin Nixon, O'Reilly Media; latest edition
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

ITDC-5202 Cyber Security	
Credit Hours:	3 (2-3)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:

The Cyber Security course focuses on safeguarding digital systems and data, covering threat detection, encryption, and risk management strategies, preparing participants to defend against cyber threats and secure information assets.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To be able to identify computer system threats	C2 (Understand)
CLO-2	To be able to identify Malware attacks, and understand the stages of attack and payloads.	C2 (Understand)

| CLO-3 | Implement various cryptographic techniques and simulate attack scenarios | C3 (Apply) |

Course Outline:

Introduction to Cyber security; Networks and the Internet; cyber threat landscape; understanding security; information security Principles (Confidentiality, Integrity, Availability); Information Security Terminology; Who are the attackers; Advanced Persistent Threat (APT); Malware, types of malware; Attacks using malware; Malware Attack Lifecycle: Stages of Attack; Social engineering attacks; types of payload; Industrial Espionage in Cyberspace; Basic cryptography; Web application attacks; Database security; Cyber kill chain; Privacy and anonymity; Network security; Software security; Mobile device security; Mobile app security; Cyber Terrorism and Information Warfare; Introduction to Digital Forensics; Digital Forensics Categories.

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

1. Computer Security Fundamentals by Chuck Easttom, 4th edition or latest
2. Security+ Guide to Network Security Fundamentals, by Mark Ciampa, 5th Edition
3. Security in Computing by C.P. Pfleeger, Prentice-Hall, 4th Edition or Latest

Preliminary Courses for Pre-Medical Students

URCM-5107 Mathematics I	
Credit Hours:	Non-Credit Hour
Contact Hours:	3
Pre-requisites:	None

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.

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
Contact Hours:	3
Pre-requisites:	None

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.

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

Course Introduction:

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Develop the skills to have ground knowledge of multivariate calculus and appreciation for their further computer science courses.	C2 (Understand)

Course Outline:

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. 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. 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. 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. Power Series, Taylor Series: Sequences, Series, Convergence Tests. Power Series. Functions Given by Power Series. Taylor and Maclaurin Series. Laurent Series. Residue Integration: Laurent Series. Singularities and Zeros. Infinity. Residue Integration Method. Residue Integration of Real Integrals.

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

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

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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 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:

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

Content of Supporting Elective Courses

URCS-5210 Digital Skills	
Credit Hours:	3 (2-3)
Contact Hours:	2-3
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.

Content of General Education Courses

URCE-5118 Functional English	
Credit Hours: **Contact Hours:** **Pre-requisites:**	3 (3-0) 3 None

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 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 of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

URCE-5119 Expository 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

URCQ-5101 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

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

URCA-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.

URCQ-5102 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

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.

URCQ-5111: Translation of the Holy Quran - I

Credit Hours:	Non-Credit
Contact Hours:	-
Pre-requisites:	None

Course Introduction:

This course is designed to develop the recitation skills in students.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	To familiarize the students to keys and fundamentals of recitation of the holy Quran.	-
CLO-2	To develop the skill of the students of recitation the last revelation.	-
CLO-3	Students will learn the basic Arabic grammar in a practical way.	-
CLO-4	To develop an eagerness among the students to explore the lastdivine Book.	-

Course Outline:

تیسواں پارہ – ناظرہ مع تجوید
بنیادی عربی گرامر
اسم اور اسکے متعلقات : اسم فاعل ،مفعول ،تفضیل ،مبالغہ
فعل اور اسکی اقسام : ماضی ،مضارع ،امر ، نہی
حرف اور اسکی اقسام : حروف علت ،حروف جارہ ،مشبہ بالفعل

URCQ-5111: Translation of the Holy Quran – II	
Credit Hours:	Non-Credit
Contact Hours:	-
Pre-requisites:	None

Course Introduction:

This course is designed to develop the recitation skills in students.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	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.	-
CLO-2	Students will seek knowledge of translation and transliteration of the Holy Book Quran.	-
CLO-3	To familiarize the students with the concept of Ibādah (Its significance, scope and relevance) and its types in Islam.	
CLO-4	Students will learn literal and idiomatic way of translation of the Holy Book.	-
CLO-5	Students will learn about the polytheism and its incompatibility in Islam highlighted by the Holy Quran.	-
CLO-6	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.	-
CLO-7	To develop Awareness among the students about rights and duties of different circles of society in the light of Holy Quran.	-
CLO-8	To introduce the students to Quranic Arabic grammar in practical manner.	-

Course Outline:

ایمانیات اور عبادات

اللہ 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 و درگزر، غصہ پر قابو اور معاف کرنا،

شعوب و قبائل، لوگوں کے بیچ اختلافات، حمایت و نگہبانی۔

قرآنی عربی گرامر کے اصول اور اسکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)

منتخب آیات مع ترجمہ و تجوید

- البقرہ(۱۱۲،۲۳۸،۳۵،۲۲۸،۱۱۸،۲۲۸،۷۷،۲۲۸،۳۲۲،۱۵۸،۳۲۸،۲۱۸،۳۲۸،۵۳،۳۲۸،۲۸۲،۲۸۲،۳۲۸،۲۲،۸۲،۲۸۲،

  ۳۲۸،۲۲۸،۱۱۲،۲۳۲،۲۲۲،۱۱۸،۵۷۲،۳۲۲،۲۲۸،۲۲۲،۲۷۲،۲۲۲،۷۵۸،۱۸۸،۲۸۸،۱۳۸،۲۸۸،۲۸۸،

  ۲۳۸،۱۳۸،۱۳۸،۳۲۸،۸۲،۵۷۲،۳۲۸،۸۲،۱۲۲،۳۲)

- النساء(۳۲،۸۲،۲۳۲،۲۲،۲۳۲،۲۲،۲۲،۲۲،۱۲،۳۲،۲۳،۲۱۲،۸۲،۳۲،۲۸۲،۵۳،۷۷،۵،۲۱۲،۵۸،۳۸،

  ۲۲،۲۸۲،۲۲۲،۳۲،۱۸،۳۲،۲۷۲،۲۷۲،۲،۷،۱۸،۷،۲۷،۲۲،۲۵۲،۵۳،۲۸۲،۷۲)

- الانعام(۸۸،۸۲،۵۲،۱۳۲،۲۷۲،۲۵،۵۲)

- آل عمران(۱۲،۲۳،۳۲،۲۸۲،۵۲،۵۵۲،۷،۲۷)

- المائدہ(۵۴،۸،۸۲،۲۲،۳۲،۸۲،۸،۲)

- الاعراف(۳۲،۲۲۷،۲۲۷)

- التوبہ(۱۸،۲۷،۷۱)

- ہود(۸۷)

- الزمر(۲)

- النور(۵۴،۸۲،۲۸،۱۸،۱۲،۲۸)

- محمد(۳۳)

- انفال(۱۸،۸۲)

- الرعد(۳)

- الطلاق(۵)

- الحج(۳)

- ابراہیم(۳۸،۵۵)

- الاسراء(۵۸،۳۸)

- الاحقاف(۳۲)

- المومنون(۱۸)

- العنکبوت(۲،۳۸،۲۵)

- النحل(۸۸)

- لقمان(۵،۳۲،۵۲)

- الاحزاب(۳۳،۲۳،۱۲،۲۵)

- الشعراء(۱)

- الروم(٤٨)
- مريم(٢٨،٥٤)
- المجادله(٨٤،٢٢)