UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

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

Annex – 'A'

Curriculum
of
Associate Degree in Computer Science
for
Main Campus and Affiliated Colleges

Department of Computer Science

University of Sargodha

(Applicable from Fall 2024)

Chairman
Department of Computer Science
University of Sargodha

Table of Contents

Underlying Principles of Computer Science Degree Programs

Computing (a nucleus of all activities including technical, academic, professional and development practices relating to computers) provides a wide range of choices on how an individual might focus his or her professional life. This document provides an overview of the different kinds of degree programs in Computing that are currently available and for which curriculum standards are now available. It is believed that this report may be an essential source for university faculty, administrators, students, parents and professionals who need to be aware of Computing as a broad based discipline that crosses the boundaries between science, engineering, and professional practice. In reality, computing consists of several disciplines. Various questions are naturally critical including: what are the different kinds of Computing degree programs or how are they similar and how are they different? The variety of degree programs in Computing presents prospective students, educators, and administrators with important choices where they may focus their efforts.

The following sections of the report also provide a complete detail of the proposed curricula pertaining to the Computer Science BS program. All details regarding the scheme of study, course content with CLOs, and overall structure of the degree programs are presented in this document. Computing is a dynamic field and accordingly a good care has been taken to design a flexible structure that will maintain currency with the latest scientific and technological advancements in the field. Moreover, it seems that Computing is a discipline that incorporates scientific, engineering, and creative features. A reasonable emphasis has been given to formal scientific and engineering areas to enhance the level of formalization in the degree programs. Technology can play an important role in the implementation of Computing programs. As a result, all programs are structured on essential dimensions including scientific knowledge, technology, and design skills.

Curriculum for Associate Degree in Computer Science Program

ASSOCIATE DEGREE IN COMPUTER SCIENCE Program's Rationale

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

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

computer science offers a comprehensive foundation for research and innovation.

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

Objectives

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

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

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

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 Computer Science programs.

Association of Computing Machinery (ACM) - Guidelines

Association of Computing Machinery (ACM), USA is the largest body in the world for computer scientists. 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	HCI-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

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1.2 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 Accord www.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

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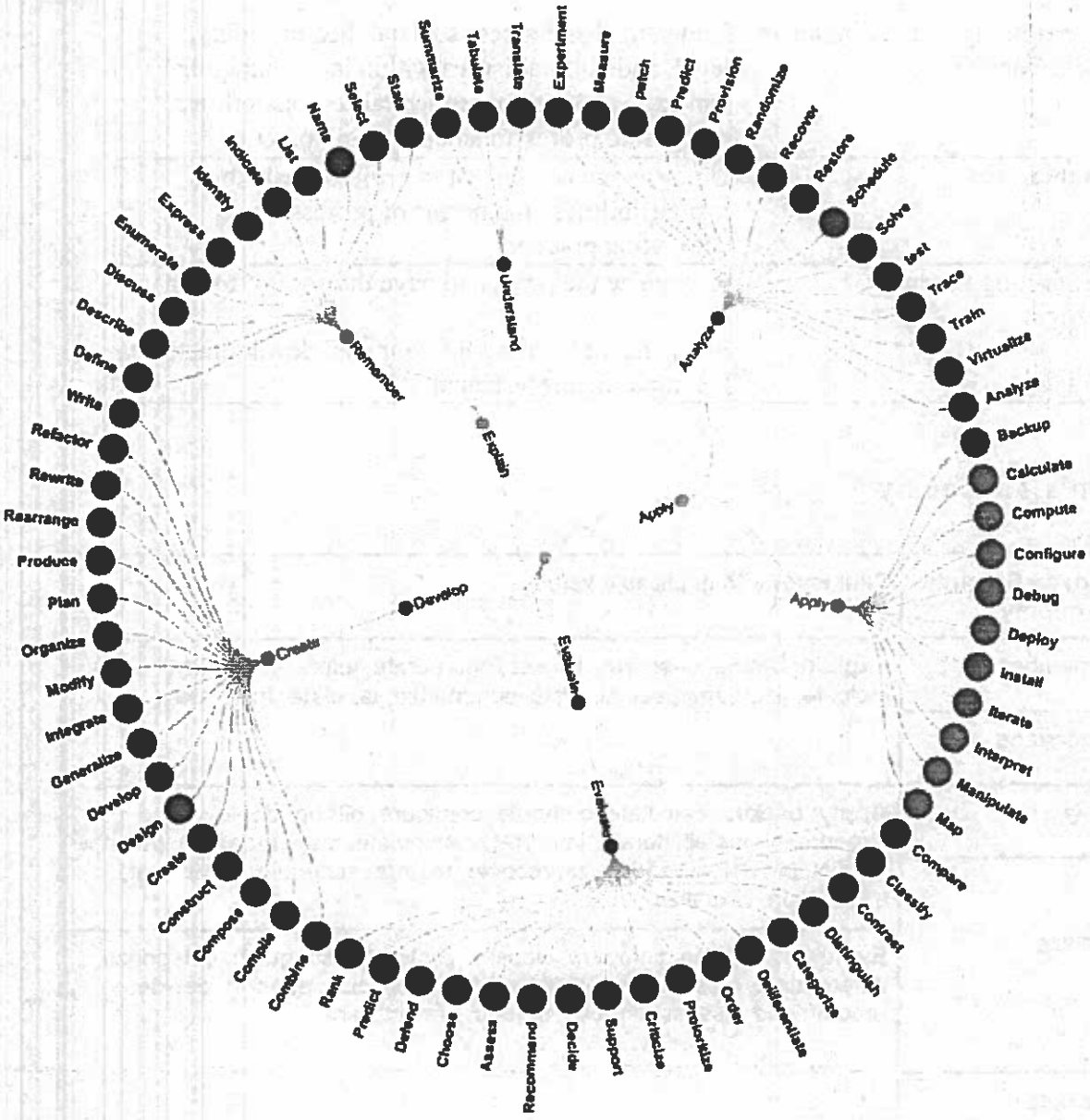


Program's Outcome

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

Program's Structure

- The structure of Associate Degree in Computer Science program meets the needs of students with formal computing experience and relevant skills. The students are expected to learn theoretical and practical understanding of the entire field of Computer Science. The program structure is dynamic and provides basis for various options

including Breadth-Based, Depth-Based, and Integrated Breadth & Depth-Based specializations. Student may choose a particular option, which is the most appropriate to their planned future career. Followings are the program's details:

Degree Requirement

Minimum credit hours shall be 72 for the Associate Degree in Computer Science program.

Duration

The program shall comprise of minimum four semesters/terms spread over two 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 Computer Science is at least 50% marks in Intermediate (HSSC) examination with one of the following combinations:

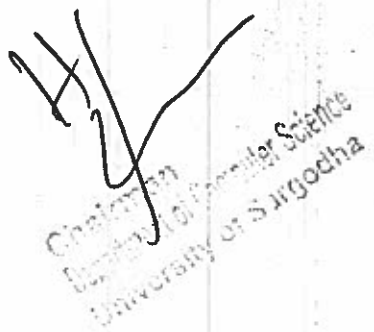
i. Pre-Engineering
ii. Pre-Medical (Admitted candidates have to pass 6-credit hours courses of mathematics in first two semesters.)
iii. General Science
    a. Mathematics, Statistics, Physics
    b. Mathematics, Statistics, Economics
    c. Mathematics, Statistics, Computer
    d. Mathematics, Physics, Computer
    e. Mathematics, Economics, Computer
iv. 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

The distribution of total credit hours for ASSOCIATE DEGREE IN COMPUTER SCIENCE is given as follows:



BS Computer Science			
Category	**Major Areas**	**Credit Hours**	**Courses**
General education	General Education Requirement	21	08
Major courses	Computing core	34	10
	Mathematics & Supporting	03	01
	Elective	14	05
		72	**24**

Mapping of ADA Computer Science Program on the Generic Structure

Computing Core Courses – 34 Credit Hours (10 Courses)				
Sr #	**Code**	**Pre-Req**	**Course Title**	**CH (Cont Hr)**
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 and Design	3 (3-3)
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-5209	CMPC-5204	Computer Organization & Assembly Language	3 (2-3)
10	CMPC-5101		Software Engineering	3 (3-0)

Elective – 14 Credit Hours (5 Courses)				
Sr #	Code	Pre-Req	Course Title	CH (Cont Hr)
1	CSDE-5201		Advanced Database Lab	2 (0-6)
2	CSDE-5202		Web Technologies Lab	3 (1-6)
3	CSDE-5203		Mobile Application Development Lab	3 (1-6)
4	CSDE-5203		Advanced Programming Lab	3 (1-6)
5	CSDE-5205		Cyber Security Lab	3 (1-6)

Preliminary Courses for Pre-Medical Students – Non-Credit Hour (2 Courses)				
Sr #	Code	Pre-Req	Course Title	CH (Cont Hr)
1	URCM-5107		Mathematics I	0 (3-0)
2	URCM-5108	URCM-5107	Mathematics II	0 (3-0)

Mathematics & Supporting Courses – 03 Credit Hours (1 Courses)				
Sr #	Code	Pre-Req	Course Title	CH (Cont Hr)
1	MATH-5102	URCQ-5102	Linear Algebra	3 (3-0)

General Education Requirement – 21 Credit Hours (8 Courses)				
Sr #	Code	Pre-Req	Course Title	CH (Cont Hr)
1	URCA-5123		Application of Information & Communication Technologies	3 (2-3)
2	URCE-5118		Functional English	3 (3-0)
3	URCE-5119		Expository Writing	3 (3-0)

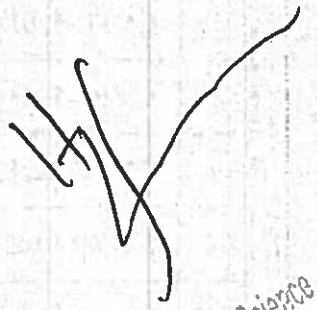
4	URCQ-5101		Quantitative Reasoning – 1 Discrete Structures	3 (3-0)
5	URCQ-5102		Quantitative Reasoning – 2 Calculus and Analytic Geometry	3 (3-0)
6	URCI-5105		Islamic Studies	2 (2-0)
7	URCI-5122		Ideology and Constitution of Pakistan	2 (2-0)
8	URCE-5124		Entrepreneurship	2 (2-0)
9	URCQ-5111		Translation of Holy Quran-I	0 (1-0)
10	URCQ-5111		Translation of Holy Quran-II	0 (1-0)

Course Coding Scheme

Level	Course Type
5	Foundation, Core Level 1 Courses
5	Foundation, Core Level 1 Courses
6	Core Level 2 + Specialization Level 1
6	Specialization Level 2

Code	Discipline
CMPC	Computing Core
CSDC	Computer Science Domain Core
CSDE	Computer Science Domain Elective
ITDC	Information Technology Domain Core
ITDE	Information Technology 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
URCP	Pakistan Studies
URCI	General Science
MATH	
ENGL	
URCC	
URCQ	
URCS	
URCE	
URCA	
URCF	
URCW	
URCT	



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Scheme of Studies for Associate Degree in Computer Science Program

(72 Credit Hours)

Semester I

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5201		Programming Fundamentals	Core	4 (3-3)
2	URCA-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	URCE-5118		Functional English	GER	3 (3-0)
6	URCM-5107	New	*Mathematics I	PREL	0 (3-0)
				Total Credit Hours	**16 (17-6)**

Semester II

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
7	CMPC-5202	CMPC-5201	Object Oriented Programming	Core	4 (3-3)
8	CMPC-5203		Database Systems	Core	4 (3-3)
9	CMPC-5208	New	Computer Networks	Core	3 (2-3)
10	MATH-5102		Linear Algebra	Maths	3 (3-0)
11	URCE-5119	New	Expository Writing	GER	3 (3-0)
12	URCM-5108	New	*Mathematics II	PREL	0 (3-0)
				Total Credit Hours	**17 (17-9)**

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	New	Information Security	Core	3 (2-3)
3	CSDE-5201	New	Advanced Database Lab	Elective	2 (0-6)
4	CSDE-5202	New	Web Technologies Lab	Elective	3 (1-6)
5	CMPC-5204	New	Digital Logic Design	Core	3 (2-3)
6	CMPC-5209	New	Computer Organization & Assembly Language	Core	3 (2-3)
7	URCQ-5111		Translation of Holy Quran-I	GER	0 (1-0)
				Total Credit Hours	**18 (12-24)**

Semester IV

S#	Code	Pre-requisite	Course Title	Domain	CH (Cont Hrs)
1	CMPC-5207	New	Artificial Intelligence	Core	3 (2-3)
2	CMPC-5101	N	Software Engineering	Core	3 (3-0)
3	CSDE-5203	N	Mobile Application Development Lab	Elective	3 (1-6)
4	CSDE-5204	N	Advanced Programming Lab	Elective	3 (1-6)
5	CSDE-5205	CMPC-5206	Cyber Security Lab	Elective	3 (1-6)
6	URCI-5105	Free	Islamic Studies	GER	2 (2-0)
7	URCI-5122		Ideology and Constitution of Pakistan	GER	2 (2-0)
8	URCE-5124		Entrepreneurship	GER	2 (2-0)
9	URCQ-5111	—	Translation of Holy Quran-II	GER	0 (1-0)
				Total Credit Hours	**21 (15-21)**

Computing Core Courses

CMPC-5201 Programming Fundamentals	
Credit Hours:	4 (3-1)
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 and Design: latest edition by Tony Gaddis.
2. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie.
3. Object Oriented Programming in C++ latest edition by Robert Lafore.
4. C++ How to Program latest Edition by Paul Deitel and Harvey Deitel
5. Problem Solving and Program Design in C++, latest Edition by Jeri R. Hanly & Elliot B. Koffman.

CMPC-5202 Object Oriented Programming

Credit Hours:	4 (3-1)
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 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, Early Objects: 11th Edition by by Paul Deitel, Harvey Deitel
2. Beginning Java 2, latest Edition by Ivor Horton
3. An Introduction to Object Oriented Programming with Java, latest Edition by C. Thomas Wu
4. Starting Out with C++ from Control Structures to Objects, latest Edition, Tony Gaddis
5. C++ How to Program, latest Edition, Deitel & Deitel.
6. Object Oriented Programming in C++, latest Edition by Robert Lafore

CMPC-5203 Database Systems

Credit Hours:	4 (3-1)
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. Fundamentals of Database Management Systems,Mark L. Gillenson, 3rd Edition, 2023
2. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg, 2019
3. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, 2013
4. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.2019
5. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke,2002

CMPC-5204 Digital Logic Design

Credit Hours:	3 (2-1)
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	C2 (Understand)
CLO-2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	C3 (Apply)
CLO-3	Apply the acquired knowledge to simulate and implement small-scale digital circuits	C3 (Solve)
CLO-4	Understand the relationship between abstract logic characterizations and practical electrical implementations.	C4 (Examine)

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, Global Edition.
2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e
3. DIGITAL DESIGN, GLOBAL EDITION, 6th/e by M. Morris Mano and Michael Ciletti

CMPC-5205 Data Structures

Credit Hours:	4 (3-1)
Contact Hours:	3-3
Pre-requisites:	Object Oriented Programming

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

CMPC-5207 Artificial Intelligence

Credit Hours:	3 (2-1)
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., 2020.
2. Norvig, P., "Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp", Morgan Kaufman Publishers, Inc., latest edition.
3. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2019.
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., 2022. "Artificial intelligence with python." Packt Publishing Ltd.

CMPC-5208 Computer Networks

Credit Hours:	3 (2-1)
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. Modern Software Engineering: Doing What Works to Build Better Software Faster,David Farley,1st Edition, 2022
2. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014
3. Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., 8th Edition, McGraw-Hill, 2015.

CMPC-6201 Operating Systems

Credit Hours:	3 (2-1)
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. Modern Operating Systems, 5th edition by Andrew S. Tanenbaum, 2022
2. Operating Systems: Three Easy Pieces,by Remzi H Arpaci-Dusseau and Andrea C Arpaci-Dusseau,1st Edition, 2018
3. Operating Systems Concepts, 9th edition by Abraham Silberschatz,2012
4. Operating Systems, Internals and Design Principles, 9th edition by William Stallings, 2017

Domain Core Courses

CSDC-5101 Theory of Automata	
Credit Hours:	3 (2-1)
Contact Hours:	2-3
Pre-requisites:	-

Course Introduction:

This course helps the students delving into the theoretical foundations of computation and automata theory. It uncovers the principles behind formal languages, regular expressions, finite automata, and Turing machines, gaining insights into the theoretical underpinnings of computer science.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-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.	C1 (Knowledge)

Course Outline:

Introduction to Automata: The Methods and the Madness, Introduction to Formal Proof, Inductive Proofs, the Central Concepts of Automata Theory. Finite Automata: Introduction of Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, Finite Automata with Epsilon Transitions. Regular Expressions and Languages, Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions. 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. Context-Free Grammars and Languages: Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages. Pushdown Automata: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDAs and CFGs, Deterministic Pushdown Automata. 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. 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. 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. Intractable Problems: The Classes P and NP, an NP-Complete Problem, A Restricted Satisfiability Problem.

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

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. 3. Automata and Formal Languages: An Introduction by Dean Kelley, Prentice Hall (1995). ISBN-10: 0134977777

Domain Elective Courses

ITDC-5201 Web Technologies

Credit Hours:	3 (2-1)
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:

Overview of WWW, Web Pages, Web Sites, Web Applications, TCP/IP, TCP/IP Application. Services, Web Servers, WAMP, LAMP,WAMP Configuration. Introduction to HTTP, HTML & HTML5 Tags, and Dynamic Web Content. CSS and CSS3. Client Side Programming: Programing in JavaScript: Basics, Expressions and Control Flow. Javascript Functions, Objects, and Arrays, Accessing CSS from JavaScript. Form Handling. Server Side Programing: Programing in PHP. PHP functions and objects, PHP arrays. Introduction MySQL, MySQL Functions, Normalization, Relationships. Accessing MySQL via PHP. Cookies, Sessions, and Authentication. Introduction to Ajax. Introduction to JQuery. Browsers and the DOM [W3 Schools Tutorial]. Designing a Social Networking Site

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; 6th Edition
2. WEB TECHNOLOGIES A Computer Science Perspective Kindle Edition by Jeffrey C. Jackson, Prentice Hall; (September 06, 2022).
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

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. Introduction to Computer Organization: An Under the Hood Look at Hardware and x86-64 Assembly,1st Edition, 2022
2. Assembly Language for x86 Processors by Kip R. Irvine, Prentice Hall; 6thEdition (March 7, 2010). ISBN-10: 013602212X
3. 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.
4. 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
5. Principles of Computer Organization and Assembly Language by Patrick Juola, Prentice Hall; 1stEdition (January 11, 2011). ASIN: B009TGBI1Q
6. The Art of Assembly Language by Randall Hyde, No Starch Press; 2ndEdition (March 22, 2010). ISBN-10: 1593272073.

CSDE-6202 Mobile Application Development

Credit Hours:	3 (2-1)
Contact Hours:	2-3
Pre-requisites:	None

Course Introduction:

Mobile Application Development equips learners with fundamental skills to create responsive and feature-rich mobile applications. Explore key concepts in UI/UX design, programming, and mobile platforms, fostering proficiency in app development. Gain hands-on experience to launch their journey into the dynamic realm of mobile application creation.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Discuss different architectures & framework for Mobile Application development.	C1 (Knowledge)
CLO-2	Develop mobile applications using current software development environments.	C3 (Apply)
CLO-3	Compare the different performance tradeoffs in mobile application development.	C3 (Apply)

Course Outline:

What is Android? Obtaining the Required Tools, Installing and Configuring the Android SDK Manager, Creating Your First Android Application, Anatomy of an Android Application. The Big Picture, How to Get Started, Your First Android Project, A bit About Eclipse, Enhancing Your First Project. Understanding Activities, Linking Activities Using Intents, Fragments, Calling Built-In Applications Using Intents, Displaying Notifications. 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. Using Basic Views, Using Picker Views, Using List View to Display Long Lists, Understanding Specialized Fragments. Using Image Views to Display Pictures, Using Menus with Views, Analog Clock and Digital Clock Views. Saving and Loading User Preferences, Persisting Data to Files, Creating and Using Databases. Sharing Data in Android, using a Content Provider, Creating Your Own Content Providers, Using the Content Provider. Sending SMS Messages Programmatically, Getting Feedback after Sending a Message, Sending SMS Messages Using Intent, Receiving SMS Messages, Sending E-mail. Displaying Maps, Getting Location Data, Monitoring a Location, Building a Location Tracker. Consuming Web Services Using HTTP, Accessing Web Services Using the Get Method, Consuming JSON Services, Sockets Programming. Creating Your Own Services, Establishing Communication between a Service and an Activity, Binding Activities to Services, Understanding Threading. Android games Development, Publishing Android Applications. Handling Telephone Calls, Fonts.

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

1. "Android Programming: The Big Nerd Ranch Guide" by Bill Phillips and Chris Stewart - A comprehensive guide for Android app development with hands-on examples and practical insights 2022, 5th Edition ISBN-10: 0137645546
2. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2012, 3rd Edition, ISBN-10: 1118102274.
3. React Native in Action: Developing iOS and Android apps with JavaScript 1st Edition, Kindle Edition, 2019, ISBN-13 978-1617294051
4. Flutter in Action by Eric Windmill, 2019, .ISBN-10: 1617296147

CSDE-5201 Advanced Database Lab	
Credit Hours:	2 (0-6)
Contact Hours:	06
Pre-requisites:	CMPC-5203 Database Systems

Course Introduction:

The Advanced Database Systems lab course aims to deepen understanding of advanced database concepts, including sophisticated data models, efficient data storage and retrieval techniques, and advanced database design strategies.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Explain advanced database concepts, including object-relational and object-oriented data models, transaction processing, concurrency control, recovery techniques, and query optimization.	C2 (Explain)
CLO-2	Design, implement, and optimize complex database schemas using advanced data models and programming languages such as PL/SQL or T-SQL, ensuring efficient data storage, retrieval, and application development	C5 (Design)
CLO-3	Implement and manage database integrity and security measures, including user authentication, authorization, data encryption, and perform database administration tasks like role management, access control, and performance tuning	C4 (Use)
CLO-4	Set up and manage distributed database systems, ensuring data consistency, replication, synchronization, and explore and utilize emerging database technologies, including NoSQL databases and cloud-based database service	C4 (Use)

Course Outline:

The Advanced Database Systems lab course begins with an introduction to the lab environment and tools, where students install essential software and receive a basic SQL review. The course covers advanced data models, focusing on object-relational and object-oriented models, and delves into file organization concepts and various indexing strategies. Transaction processing is examined through simulations and isolation level tests, followed by concurrency control techniques such as two-phase locking and deadlock resolution. Recovery techniques are taught, including backup management and crash recovery. Query processing and optimization are explored through execution plan analysis and indexing. Database programming with PL/SQL or T-SQL involves writing stored procedures and triggers. Integrity and security topics include enforcing constraints, user authentication, and data encryption. Database administration covers

role management and access control, while physical database design addresses storage structures and performance tuning. The course also explores distributed database systems, focusing on data replication and synchronization. Emerging database technologies like NoSQL and cloud-based services are introduced. The course concludes with a comprehensive final project and a review session to ensure mastery of advanced database systems concepts.

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

1. Fundamentals of Database Management Systems,Mark L. Gillenson, 3rd Edition, 2023
2. Advanced PLSQL Programming: The Definitive Reference (Oracle In Focus) First Edition
3. by Boobal Ganesan,1st Edition, 2017
4. Mastering NoSQL Database Design: A Comprehensive Guide to Building Scalable, High-Performance, and Flexible Data Systems. Kindle Edition, by Michael Kirshteyn (Author),2024
5. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg, 2019

Domain Elective Courses

CSDE-5204 Web Technologies Lab

Credit Hours:	3 (1-6)
Contact Hours:	1-6
Pre-requisites:	None

Course Introduction:

The aim of Web Technologies Lab is to equip students with the practical skills and knowledge necessary to develop modern, responsive, secure, and scalable web applications, preparing them for careers in web development or related fields.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Recalling relevant terminology, specific facts, or different procedures related to information and/or course topics. At this level, a student can remember something, but may not really understand it.	C1 (Remember)
CLO-2	The ability to grasp the meaning of information (facts, definitions, concepts, etc.) that has been presented.	C2 (Understand)
CLO-3	Being able to use previously learned information in different situations or in problem solving.	C3 (Apply)
CLO-4	The ability to break information down into its component parts. Analysis also refers to the process of examining information in order to make conclusions regarding cause and effect, interpreting motives, making inferences, or finding evidence to support	C4 (Analysis)

	statements/arguments	
CLO-5	The ability to creatively or uniquely apply prior knowledge and/or skills to produce new and original thoughts, ideas, processes, etc. At this level, students are involved in creating their own thoughts and ideas.	C5 (Create)

Course Outline:

Introduction to Web Development
- Overview of web technologies
- Introduction to HTML and CSS
- Setting up development environment

Frontend Development
- HTML5 semantic elements
- CSS styling techniques
- Responsive web design principles

Advanced Frontend Development
- Introduction to JavaScript and DOM manipulation
- JavaScript events and event handling
- Introduction to frontend frameworks (e.g., React, Angular, Vue.js)
- AJAX and asynchronous programming
- Introduction to CSS preprocessors (e.g., Sass, Less)

Backend Development
- Introduction to server-side programming languages (e.g., Node.js, Python, PHP)
- Setting up a basic server with Express.js (Node.js) or Flask (Python)
- Handling form submissions and user input
- Introduction to databases (SQL vs. NoSQL)

Database Management
- Database design principles
- Working with SQL databases (e.g., MySQL, PostgreSQL)
- Introduction to MongoDB (NoSQL)
- CRUD operations with databases

Advanced Backend Development
- Authentication and authorization
- RESTful API development
- Error handling and validation
- File uploads and handling

Testing and debugging techniques
Security and Deployment
Deployment strategies and platforms (e.g., Heroku, AWS)

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

5. Learning PHP, MySQL, JavaScript, and CSS, A Step-by-Step Guide to Creating Dy-namic Websites By Robin Nixon, O'Reilly Media; 6th Edition
6. WEB TECHNOLOGIES A Computer Science Perspective Kindle Edition by Jeffrey C. Jackson, Prentice Hall; (September 06, 2022).
7. Web Technologies by Uttam Kumar Roy, Oxford University Press, USA (June 13, 2011). ISBN-10: 0198066228
8. Web Application Architecture: Principles, protocols and practices by Leon Shklar and Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10: 047051860X

CSDE-6202 Mobile Application Development Lab	
Credit Hours: **Contact Hours:** **Pre-requisites:**	3 (1-6) 1-6 None

Course Introduction:

This lab-based course provides hands-on experience in developing mobile applications for various platforms. Students will learn to design, develop, test, and deploy mobile applications using industry-standard tools and frameworks.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Recall and remember the basic concepts of mobile application development	C1 (Remember)
CLO-2	Grasp the fundamental principles underlying mobile application architecture and design.	C2 (Understand)
CLO-3	Apply knowledge of programming languages and frameworks to develop mobile applications.	C3 (Apply)
CLO-4	Analyze user requirements and design mobile application interfaces accordingly.	C4 (Analyzing)
CLO-5	Develop mobile applications with innovative features and functionalities.	C5 (Create)

Course Outline:

1. Introduction to Android Development
   - Overview of the Android platform and ecosystem
   - Setting up development environment (Android Studio, SDK)
2. User Interface Design
   - UI components (layouts, views, widgets)
   - Material Design principles
   - Handling user input and events
3. Activity and Fragment Lifecycle
   - Understanding the lifecycle of Android components
   - Managing state and handling configuration changes
4. Animation and Custom Navigation Drawer
5. Data Persistence
   - Using Firebase database for data storage

- Authentication and Realtime Database
- Implementing SharedPreferences for lightweight data storage
- Dealing with images and Cloud Storage
- RecyclerView

6. Background Processing and Services
   - Implementing background tasks using AsyncTask
   - Creating and managing background services
7. Location-based Services
   - Accessing device location using GPS or network providers
   - Displaying user's location on maps and retrieving address information
8. Debugging and Testing
   - Debugging techniques using Android Studio debugger
   - Unit testing with JUnit and AndroidJUnit
9. Deployment and Distribution
   - Preparing applications for release (signing, obfuscation)
   - Uploading applications to Google Play Store
   - Beta testing and deployment strategies

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

5. "Android Programming: The Big Nerd Ranch Guide" by Bill Phillips and Chris Stewart - A comprehensive guide for Android app development with hands-on examples and practical insights 2022, 5th Edition ISBN-10: 0137645546
6. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2012, 3rd Edition, ISBN-10: 1118102274.
7. React Native in Action: Developing iOS and Android apps with JavaScript 1st Edition, Kindle Edition, 2019, ISBN-13 978-1617294051
8. Flutter in Action by Eric Windmill, 2019, .ISBN-10: 1617296147

CSDE-5205 Cyber Security Lab

Credit Hours:	3 (1-6)
Contact Hours:	1-6
Pre-requisites:	CMPC-5206

Course Introduction:

This course is designed to provide students with practical, hands-on experience in the field of cybersecurity. Utilizing a mix of theoretical knowledge and practical lab sessions, students will explore a variety of security tools and attack methods to better understand the dynamics of protecting and securing information systems.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-1	Students will demonstrate proficiency in using tools and techniques for network scanning, vulnerability assessments, and understanding wireless security vulnerabilities.	C2 (Analysis)
CLO-2	Identify and exploit vulnerabilities such as SQL injection, XSS, and buffer overflows, and implement appropriate defenses.	C3 (Apply)
CLO-3	Conduct simulations of complex attacks including DoS/DDoS, MitM, phishing, and brute force attacks, and will develop strategies for their mitigation.	C6 (Create)
CLO-4	Create and implement comprehensive security measures, including firewalls and IDS, and respond to cybersecurity incidents with effective strategies.	C6 (Create)
CLO-5	Students will analyze malware and conduct digital forensics investigations, providing detailed incident reports and evaluations of the attacks and their impacts.	C5 (Evaluation)

Course Outline:

Introduction to Cybersecurity Lab Tools
- Overview of the lab environment.
- Basic configurations and security precautions.
- Introduction to commonly used cybersecurity tools (Nmap, Wireshark).

Network Scanning and Reconnaissance
- Hands-on with Nmap for network scanning.
- Identifying active devices on the network.
- Recognizing open ports and services.

Vulnerability Assessment
- Introduction to vulnerability scanning tools (OpenVAS, Nessus).
- Scanning a pre-configured VM for vulnerabilities.
- Prioritizing vulnerabilities based on severity.

Web Application Security
- Setting up a vulnerable web application (e.g., OWASP Juice Shop).
- Exploring common web vulnerabilities (SQL Injection, XSS).

System Exploitation
- Using Metasploit to exploit known vulnerabilities in a controlled environment.
- Understanding payloads, shells, and post-exploitation techniques.
- Demonstration of buffer overflow attacks in simple applications.

Wireless Security and Brute Force Attacks
- Security measures in wireless networking.
- Conducting brute force and dictionary attacks against weak passwords.

Network Traffic Analysis and DoS/DDoS
- Capture and analyze network traffic using Wireshark.
- Simulating DoS and DDoS attacks in a controlled environment.

Man-in-the-Middle (MitM) and Phishing Attacks
- Techniques and tools for conducting MitM attacks.
- Recognizing and mitigating phishing attempts.

Malware Analysis
- Types of malware: viruses, worms, trojans, and ransomware.
- Basic techniques in malware identification and analysis.

Cybersecurity Defense Strategies
- Developing strategies to defend against common cyber attacks.
- Implementing firewalls and intrusion detection systems (IDS).

Comprehensive Cybersecurity Scenario
- A comprehensive lab exercise that involves a multi-layered attack.
- Students must identify the threat, mitigate the attack, and prepare a report detailing their response strategy and suggestions for future improvements.

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

Security Tools Covered:

Network Analysis: Wireshark, Nmap
Vulnerability Scanning: OpenVAS, Nessus
Exploitation Frameworks: Metasploit
Forensics Tools: Autopsy, FTK Imager
Incident Response: GRR, TheHive

Books:

1. "Network Security Essentials: Applications and Standards" by William Stallings
2. "Hacking: The Art of Exploitation, 2nd Edition" by Jon Erickson
3. "Web Application Hacker's Handbook: Finding and Exploiting Security Flaws" by Dafydd Stuttard and Marcus Pinto
4. "Metasploit: The Penetration Tester's Guide" by David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni
5. "Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software" by Michael Sikorski and Andrew Honig
6. "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy" by Patrick Engebretson

Chairman
Department of Computer
University of Sargodha

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.

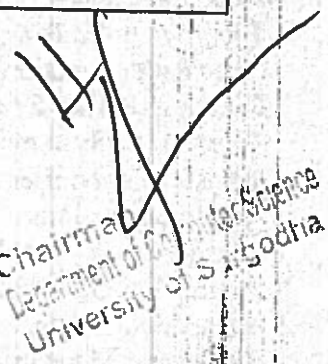
URCM-5108 Mathematics II	
Credit Hours:	Non-Credit Hour
Contact Hours:	3
Pre-requisites:	Mathematics I

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

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.

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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

General Education Courses

URCA-5123 Application of Information & Communication Technologies	
Credit Hours: **Contact Hours:** **Pre-requisites:**	3 (3-0) 3 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 02210,15th Edition." (2007). 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.

URCA-5126 Digital Skills

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

Course Introduction:

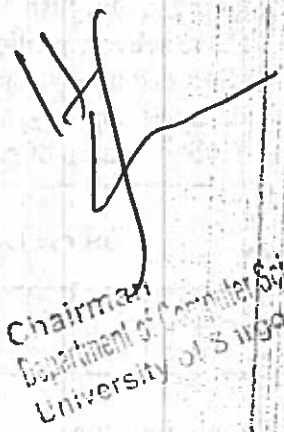
This course introduces Digital Marketing and E-commerce, offering insights into online strategies and tools for navigating the dynamic landscape of digital business. Explore effective approaches to enhance online presence, engage customers, and drive business growth in the digital realm.

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

Course Outline:

Introduction to fundamental concepts of digital marketing, digital marketing strategy and planning, emphasizing website design and user experience (UX). Search engine optimization (SEO), social media marketing, email campaigns, and pay-per-click (PPC) advertising. Introduction to e-commerce, including platform selection, operational considerations, and effective marketing strategies. Analytics and measurement techniques, legal and ethical

considerations, and exploration of emerging trends, such as influencer marketing and augmented reality, round out the comprehensive curriculum.
Reference Materials (or use any other standard and latest books):
1. Digital Marketing: Strategy, Implementation, and Practice" by Dave Chaffey and Fiona Ellis-Chadwick. 2. E-commerce Evolved: Essential Tactics to Grow Your Business" by Tanner Larsson. 3. Influence: The Psychology of Persuasion" by Robert B. Cialdini. 4. Epic Content Marketing" by Joe Pulizzi.



URCE-5118 Functional English

Credit Hours:	3 (3-0)
Contact Hours:	3
Pre-requisites:	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. Schaum's Outline of Discrete Mathematics, Fourth Edition, 2021
2. Discrete Mathematics and Its Applications, 8th edition by Kenneth H. Rosen, 2018
3. Discrete Mathematics with Applications, 5th Edition by Susanna S. Epp, 2019
4. Discrete Mathematics, 7th edition by Richard Johnson Baugh, 2007

URCQ-5102 Calculus and Analytic Geometry	
Credit Hours: **Contact Hours:** **Pre-requisites:**	3 (3-0) 3 -

Course Introduction:

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

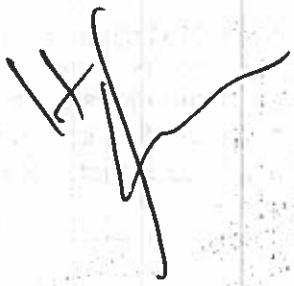
CLO No.	Course Learning Outcomes	Bloom Taxonomy
-	-	

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

URCW-5201 Applied Physics

Credit Hours:	3 (2-1)
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.

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Department of ... Science
University of S... Quetta

URCS-6101 Professional 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. Boddington, P. (2023). AI ethics: a textbook. Springer Nature.
2. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
3. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN-10: 0131112414
4. 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
5. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993).
6. Noorman, M., & Johnson, D. G. (2014). Negotiating autonomy and responsibility in military robots. *Ethics and Information Technology*, *16*(1), 51-62.

URCE-5124: Entrepreneurship

Credit Hours:	2 (2-0)
Contact Hours:	2
Pre-requisites:	None

Course Introduction:

This course helps to ignite the student's passion for innovation and business leadership. Explore the essential principles of creating and managing a successful venture, from ideation to execution. Equip them with the entrepreneurial mindset and skills necessary to navigate the dynamic world of business and turn their ideas into reality.

CLO No.	Course Learning Outcomes	Bloom Taxonomy
CLO-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.	C2 (Understand)

Course Outline:

Entrepreneurship and the Entrepreneurial Mind-Set, Entrepreneurial Intentions and Corporate Entrepreneurship. Entrepreneurial Strategy: Generating and Exploiting New Entries. Creativity and the Business Idea. Identifying and Analyzing Domestic and International Opportunities. Intellectual Property and Other Legal Issues for the Entrepreneur. The Business Plan: Creating and Starting the Venture. The Marketing Plan. The Organizational Plan. The Financial Plan. Sources of Capital. Informal Risk Capital, Venture Capital, and Going Public. Strategies for Growth and Managing the Implication of Growth. Succession Planning and Strategies for Harvesting and Ending the Venture.

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

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)

Chairman
Department of
University of

URCQ-5111: Translation of the Holy Quran - I	
Credit Hours: **Contact Hours:** **Pre-requisites:**	Non-Credit - 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 last divine 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
تیسویں پارے کی آخری بیس سورتیں (حفظ مع ترجمہ)

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

، طالق ، 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۔

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

منتخب آیات مع ترجمہ وتجوید

- البقرہ (۱۱۷، ۲۳۸، ۴۵، ۱۱۸، ۲۷۸، ۱۷۷، ۴۵، ۳۴۷، ۱۵۸، ۷۱۸، ۴۲۸، ۵۳، ۴۲۸، ۲۸۷، ۳۴۸، ۲۲، ۸۲، ۲۸۷، ۴۲۸، ۲۴۸، ۱۱۷، ۲۳۷، ۲۲۷، ۱۱۸، ۵۲۷، ۳۲۷، ۲۷۸، ۲۴۷، ۷۵۸،۲۲۷، ۱۸۸، ۲۸۸، ۱۳۸، ۲۸۸، ۲۸۸، ۷۳۸، ۱۳۸، ۴۳۸، ۱۳۸ ،۸۲ ، ۵۲۷، ۳۳۸، ۸۲۷، ۱۲۷، ۳۲)
- النساء (۴۲، ۸۲، ۲۴، ۲۳۷، ۲۲، ۱۲، ۳۷، ۲۲، ۱۲،۲۲، ۲۳، ۲۱۷، ۸۷، ۴۳، ۲۸۷، ۵۳، ۷۷، ۵، ۲۱۷، ۵۸، ۴۸، ۷۷، ۷۷، ۲۸۷، ۷۲۷، ۴۳، ۱۸، ۴۳، ۷۲۷، ۲، ۷، ۱۸، ۷، ۲۷، ۲۵۷، ۵۴، ۲۸۷، ۷۲)
- الانعام (۸۸، ۸۲،۵۷، ۱۳۷، ۷۴۷، ۲۵، ۵۴)
- آل عمران (۱۲، ۲۳، ۴۲، ۴۸۷، ۵۲، ۵۵۷، ۲۷،۷)
- المائدہ (۵۴، ۸، ۸۲، ۲۷،۲۳، ۸۲، ۸، ۴)
- الاعراف (۴۳، ۲۲۷، ۲۲۷)
- التوبہ (۱۸، ۲۷،۷۱)
- ہود (۸۷)
- الزمر (۲)
- النور (۵۴، ۸۴،۲۸، ۱۸، ۱۲، ۲۸)
- محمد (۳۳)
- انفال (۸۲، ۱۸)
- الرعد (۳)
- الطلاق (۵)
- الحج(۴)
- ابراہیم (۳۸،۵۵)
- الاسراء (۳۸، ۵۸)
- الاحقاف (۴۷)
- المومنون (۱۸)
- العنکبوت (۲۵،۴۸، ۲)
- النحل (۸۸)
- لقمان (۵،۴۷، ۵۷)
- الالحزاب (۴۳، ۱۴،۲۳، ۲۵)
- الشعراء (۱)
- الروم (۷۸)
- مریم (۲۸،۵۷)
- المجادلہ (۸۷، ۷۷)