

ANNEXURE – B

To recommend Curriculum, Course Syllabi, and Model Study Plan for Associate Degree Program (ADP) in Software Engineering in the light of the Undergraduate Policy 2023 by Higher Education Commission (HEC) of Pakistan at affiliated colleges of University of the Punjab, Lahore

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Associate Degree (AD) Software Engineering Curriculum Model

Sr.	Category/Area	Credit Hours	Courses	Remarks
1	Computing Core	34	16	Common to all AD Computing programs
2	Software Engineering Elective	15	5	Technical elective courses related to AD Software Engineering
3	Mathematics & Supporting Courses	3	1	Common to all AD computing degree programs
4	General Education Requirement	21	8	Common to all AD computing degree programs
5	Quran Translation	2	4	Common to all AD computing degree programs
6	Math Deficiency	6 (non-credited)	2	Two non-credited math deficiency courses to be offered to the students having pre-medical background during their Intermediate
Total		75	36	

Admission Requirement / Eligibility Criteria

- Eligibility criteria for Associate Degree (AD) Software Engineering would be the same as eligibility criteria for BS Software Engineering.

Nomenclature of Course Categories and Course Codes

N	Code	Description	Courses	Cr. Hrs.	
0	MD	Math Deficiency	2	6*	(6, 0)*
1	CC	Computing Core	16	34	(25, 9)
3,4	ES	Software Engineering Elective	5	15	(11, 4)
5	MS	Mathematics & Supporting Courses	1	3	(3, 0)
6,9	GE	General Education Courses	8	21	(20, 1)
8	HQ	Quran Translation	4	2	(2, 0)
Total			36	75	(61, 14)

Course Coding Scheme

Code-YNS

Code = MD, CC, ES, MS, GE, HQ

Y = Year of Offering = 1, 2

N = Numeric Code = 0, 1, ..., 9

S = Serial Number (Resets with Year) = 0, 1, 2, ..., 9

Lab Codes = Same as related theory course codes with “-L” as suffix

List of Courses

MATHEMATICS DEFICIENCY: 6 (6, 0)

Sr.	Code	Course Title	Prerequisite	Cr. Hrs.
1.	MD-001	Math Deficiency - I		3 (3,0)*
2.	MD-002	Math Deficiency - II		3 (3,0)*

COMPUTING CORE: 34 (25, 9)

Sr.	Code	Course Title	Prerequisite	Cr. Hrs.
1	CC-112	Programming Fundamentals		3 (3, 0)
2	CC-112-L	Programming Fundamentals Lab		1 (0, 1)
3	CC-211	Object Oriented Programming	Programming Fundamentals	3 (3, 0)
4	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	1 (0, 1)
5	CC-215	Database Systems		3 (3, 0)
6	CC-215-L	Database Systems Lab		1 (0, 1)
7	CC-110	Digital Logic Design		2 (2, 0)
8	CC-110-L	Digital Logic Design Lab		1 (0, 1)
9	CC-213	Data Structures	Object Oriented Programming	3 (3, 0)
10	CC-213-L	Data Structures Lab	Object Oriented Programming	1 (0, 1)
11	CC-312	Information Security		3 (2, 1)
12	CC-310	Artificial Intelligence	Data Structures	3 (2, 1)
13	CC-214	Computer Networks		3 (2, 1)
15	CC-212	Software Engineering		3 (3, 0)
16	CC-311	Operating Systems		3 (2, 1)

SOFTWARE ENGINEERING ELECTIVE: 15 (10, 5)

Sr.	Code	Course Title	Prerequisite	Cr. Hrs.
1	DS-425	Software Quality Engineering	Software Engineering	3 (2, 1)
2	ES-321	Human Computer Interaction		3 (2, 1)
3	ES-332	Web Technologies		3 (2, 1)
4	ES-334	Mobile Application Development	Object Oriented Programming	3 (2, 1)
5	ES-426	Software Project Management		3 (2, 1)

MATHEMATICS & SUPPORTING: 3 (3, 0)

Sr.	Code	Course Title	Prerequisite	Cr. Hrs.
1	MS-251	Probability and Statistics		3 (3,0)

GENERAL EDUCATION: 21 (20, 1)

Sr.	Code	Course Title	Sub – Category	Prerequisite	Cr. Hrs.
1	GE-160	Applications of Information & Communication Technologies			3 (2,1)
2	GE-190	Functional English			3 (3,0)
3	GE-191	Expository Writing			3 (3,0)
4	GE-167	Discrete Structures	Quantitative Reasoning – I		3 (3,0)
5	GE-162	Calculus and Analytical Geometry	Quantitative Reasoning – II		3 (3,0)
6	GE-163	Islamic Studies			2 (2,0)
7	GE-168	Ideology and Constitution of Pakistan			2 (2,0)
8	GE-362	Entrepreneurship			2 (2,0)

Scheme of Studies / Semester-wise workload

Semester – I						
Sr.	Code	Course Title	Pre-Requisite/Co-Requisite	Domain	Cr. Hrs.	
1	CC-112	Programming Fundamentals		CC	3	(3, 0)
2	CC-110	Digital Logic Design		CC	2	(2, 0)
3	CC-110-L	Digital Logic Design Lab		CC	1	(0, 1)
4	GE-167	Discrete Structures		GE	3	(3, 0)
5	GE-190	Functional English		GE	3	(3, 0)
6	GE-160	Applications of Information & Communication Technologies		GE	3	(2, 1)
7	CC-112-L	Programming Fundamentals Lab		CC	1	(0, 1)
8	GE-163	Islamic Studies		GE	2	(2, 0)
9	MD-001	Math Deficiency - I		MD	3*	(3, 0)*
10	HQ-001	Quran Translation – I		HQ	0.5	(0.5, 0)
Credit Hours (Semester - I)					18.5	(15.5, 3)

Semester – II						
Sr.	Code	Course Title	Pre-Requisite/Co-Requisite	Domain	Cr. Hrs.	
1	CC-211	Object Oriented Programming	Programming Fundamentals	CC	3	(3, 0)
2	MS-251	Probability and Statistics		MS	3	(3, 0)
3	CC-212	Software Engineering		CC	3	(3, 0)
4	GE-191	Expository Writing		GE	3	(3, 0)
5	GE-168	Ideology and Constitution of Pakistan		GE	2	(2, 0)
6	CC-215	Database Systems		CC	3	(3, 0)
7	CC-215-L	Database Systems Lab		CC	1	(0, 1)
8	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	CC	1	(0, 1)
9	MD-002	Math Deficiency – II		MD	3*	(3, 0)*
10	HQ-002	Quran Translation – II		HQ	0.5	(0.5, 0)
Credit Hours (Semester - II)					19.5	(17.5, 2)

Semester – III						
Sr.	Code	Course Title	Pre-Requisite/Co-Requisite	Domain	Cr. Hrs.	
1	CC-213	Data Structures	Object Oriented Programming	CC	3	(3,0)
2	CC-214	Computer Networks		CC	3	(2, 1)
3	DS-221	Software Requirement Engineering / Elective		ES	3	(2, 1)
4	GE-162	Calculus and Analytical Geometry		GE	3	(3, 0)
5	CC-311	Operating Systems		CC	3	(2, 1)
6	GE-362	Entrepreneurship		CC	2	(2, 0)
7	CC-213-L	Data Structures Lab	Object Oriented Programming	CC	1	(0, 1)
8	HQ-003	Quran Translation – III		HQ	0.5	(0.5, 0)
Credit Hours (Semester - III)					18.5	(14.5, 4)

Semester – IV						
Sr.	Code	Course Title	Pre-Requisite/Co-Requisite	Domain	Cr. Hrs.	
1	CC-312	Information Security		CC	3	(2, 1)
2	ES-334	Mobile Application Development / Elective	Object Oriented Programming	ES	3	(2, 1)
3	ES-321	Human Computer Interaction / Elective		ES	3	(2, 1)
4	CC-310	Artificial Intelligence	Data Structures	CC	3	(2, 1)
5	ES-332	Web Technologies / Elective		ES	3	(2, 1)
6	DS-426	Software Project Management / Elective		ES	3	(2, 1)
7	HQ-004	Quran Translation – IV		HQ	0.5	(0.5, 0)
Credit Hours (Semester - IV)					18.5	(12.5, 6)

Program Learning Outcomes (PLOs)¹

PLO1	Academic Education	To prepare graduates as computing professionals.
PLO2	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.
PLO3	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.
PLO4	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.
PLO5	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.
PLO6	Individual and Team Work	Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.
PLO7	Communication	Communicate effectively with the computing community and with society at large about complex

¹ derived from Graduate Attributes define by Seoul Accord www.seoulaccord.org

		computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.
PLO8	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.
PLO9	Ethics	Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.
PLO10	Life-long Learning	Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Using Bloom’s Taxonomy for Program Learning Outcomes (PLOs)

Bloom’s Taxonomy is a classification of the different outcomes and skills (PLOs). These 6 levels, shown in the table below, that can be used to structure the learning outcomes, lessons, and assessments of a course. Each level of the Bloom’s taxonomy maps to one or more PLOs.

Code	Level	Description	Key Words
C1	Remembering	Can the students <u>recall</u> or <u>remember</u> the information?	know, describe, identify, label, list, match, memorize, recall
C2	Understand	Can the students <u>explain</u> ideas or concepts?	classify, describe, cite, discuss, generalize, illustrate, restate (in own words), summarize
C3	Applying	Can the students <u>use</u> the information in a new way?	assess, choose, solve, demonstrate, dramatize, establish, extend, illustrate,
C4	Analyzing	Can the students <u>distinguish</u> between different parts?	analyze, appraise, categorize, compare, identify, contrast, criticize, differentiate, recognize
C5	Creating	Can the students <u>create</u> new product or point of view?	adapt, incorporate, individualize, integrate, intervene, invent, model, modify, communicate, construct, <u>create, design, develop</u> , formulate, generate, reconstruct, reinforce,
C6	Evaluating	Can the students <u>justify</u> a stand or decision?	appraise, argue, choose, compare, conclude, contrast, criticize, interpret, judge, justify, predict, rate

COMPUTING CORE: 34 (25,9)

Sr.	Code	Course Title	Prerequisite	Cr. Hrs.
1	CC-112	Programming Fundamentals		3 (3, 0)
2	CC-112-L	Programming Fundamentals Lab		1 (0, 1)
3	CC-211	Object Oriented Programming	Programming Fundamentals	3 (3, 0)
4	CC-211-L	Object Oriented Programming Lab	Programming Fundamentals	1 (0, 1)
5	CC-215	Database Systems		3 (3, 0)
6	CC-215-L	Database Systems Lab		1 (0, 1)
7	CC-110	Digital Logic Design		2 (2, 0)
8	CC-110-L	Digital Logic Design Lab		1 (0, 1)
9	CC-213	Data Structures	Object Oriented Programming	3 (3, 0)
10	CC-213-L	Data Structures Lab	Object Oriented Programming	1 (0, 1)
11	CC-312	Information Security		3 (2, 1)
12	CC-310	Artificial Intelligence	Data Structures	3 (2, 1)
13	CC-214	Computer Networks		3 (2, 1)
15	CC-212	Software Engineering		3 (3, 0)
16	CC-311	Operating Systems		3 (2, 1)

Course Title	Programming Fundamentals		
Course Code	CC-112		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-211: Object Oriented Programming		
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.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand basic problem-solving steps and logic constructs.	C2 (Understand)	1,2
	CLO2: Apply basic programing concepts.	C3 (Apply)	3,4
	CLO3: Design and implement algorithms to solve real world problems.	C3 (Solve)	3,4

Course Description	<p>Introduction to Problem Solving, Algorithms, Programming, and C Language: Problem Solving, a brief review of Von-Neumann Architecture., The C Programming Language, Pseudo-code, Concept of Variable, Data types in Pseudo-code, The C Standard Library and Open Source, Input/Output, Arithmetic expressions, Assignment statement, Operator precedence, Concept of Integer division, Flowchart and its notations, Typical C Program Development Environment, Role of Compiler and Linker, Test Driving C Application. Introduction to C Programming: A Simple C Program: Printing Text, Adding Two Integer, Memory Concepts, Arithmetic in C, Operators. Decision Making: Equality and Relational Operators. Structured Program Development: The if, if...else, while Nested Control Statements. Program Control: for, switch, do...while, break, continue, Logical Operators. Functions: Modularizing Program in C, Math Library Functions, Function Definitions and Prototypes, Function-Call Stack and Stack Frames, Stack rolling and unrolling, Headers, Passing Arguments by Value and by Reference, Random Number Generation, Scope Rules, Recursion, Recursion vs Iteration. Arrays: Defining Arrays, Character Arrays, Static and Automatic Local Arrays, Passing Arrays to Function, Sorting and Searching Arrays, Multidimensional and Variable Length Arrays. Pointers: Pointer Definitions and Initialization, Pointer Operators, Passing Arguments to Function by Reference, Using the const and sizeof Operator, Pointer Expressions and Arithmetic, Pointers and Arrays, Array of Pointers, Function Pointers. Characters and Strings: Strings and Characters, Character Handling Library, String Functions, Library Functions. Formatted Input/Output: Streams, Formatted Output with printf, Formatted Input with scanf. Structures: Defining Structures, Accessing Structure Member, Structures and Functions, typedef, Unions. Bit Manipulation and Enumeration: Bitwise Operators, Bit Fields, Enumeration Constants. File Processing: Files and Streams, Creating, Reading and Writing data to a Sequential and a Random-Access File. Preprocessor: #include, #define, Conditional Compilation, #error and #pragma, # and ## Operators, Predefined Symbolic Constants, Assertions. Other Topics: Variable Length Argument List, Using Command Line Arguments, Compiling Multiple-Source-File Programs, Program Termination with exit and atexit, Suffixes for Integer and Floating-Point Literals, Signal Handling, Dynamic Memory Allocation calloc and realloc, goto. Advance Topics: Self-Referential Structures, Linked Lists. Efficiency of Algorithms, Selection and Insertion Sort.</p>
Text Book(s)	Paul Deitel, Harvey Deitel, C How To Program, 9th Edition, Pearson, 2022.
Reference Material	<ol style="list-style-type: none"> 1. Tony Gaddis, Starting out with Programming Logic and Design, 5th Edition, Pearson, 2018. 2. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie 3. Object Oriented Programming in C++ by Robert Lafore <ol style="list-style-type: none"> 1. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

Title	Programming Fundamentals Lab		
Code	CC-112-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-211: Object Oriented Programming		
Course Introduction	This course provides fundamental concepts of programming to freshmen. The course 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.		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Understand basic problem-solving steps and logic constructs.	C2 (Understand)	1,2
	CLO2: Apply basic programming concepts.	C3 (Apply)	3,4
	CLO3: Design and implement algorithms to solve real world problems.	C3 (Solve)	3,4,5

Course Description	<p>Implementation and Practice of the concepts studied in “CC-112 Programming Fundamentals”</p> <p>Introduction to Problem Solving, Algorithms, Programming, and C Language: Problem Solving, a brief review of Von-Neumann Architecture., The C Programming Language, Pseudo-code, Concept of Variable, Data types in Pseudo-code, The C Standard Library and Open Source, Input/Output, Arithmetic expressions, Assignment statement, Operator precedence, Concept of Integer division, Flowchart and its notations, Typical C Program Development Environment, Role of Compiler and Linker, Test Driving C Application. Introduction to C Programming: A Simple C Program: Printing Text, Adding Two Integer, Memory Concepts, Arithmetic in C, Operators. Decision Making: Equality and Relational Operators. Structured Program Development: The if, if...else, while Nested Control Statements. Program Control: for, switch, do...while, break, continue, Logical Operators. Functions: Modularizing Program in C, Math Library Functions, Function Definitions and Prototypes, Function-Call Stack and Stack Frames, Stack rolling and unrolling, Headers, Passing Arguments by Value and by Reference, Random Number Generation, Scope Rules, Recursion, Recursion vs Iteration. Arrays: Defining Arrays, Character Arrays, Static and Automatic Local Arrays, Passing Arrays to Function, Sorting and Searching Arrays, Multidimensional and Variable Length Arrays. Pointers: Pointer Definitions and Initialization, Pointer Operators, Passing Arguments to Function by Reference, Using the const and sizeof Operator, Pointer Expressions and Arithmetic, Pointers and Arrays, Array of Pointers, Function Pointers. Characters and Strings: Strings and Characters, Character Handling Library, String Functions, Library Functions. Formatted Input/Output: Streams, Formatted Output with printf, Formatted Input with scanf. Structures: Defining Structures, Accessing Structure Member, Structures and Functions, typedef, Unions. Bit Manipulation and Enumeration: Bitwise Operators, Bit Fields, Enumeration Constants. File Processing: Files and Streams, Creating, Reading and Writing data to a Sequential and a Random-Access File. Preprocessor: #include, #define, Conditional Compilation, #error and #pragma, # and ## Operators, Predefined Symbolic Constants, Assertions. Other Topics: Variable Length Argument List, Using Command Line Arguments, Compiling Multiple-Source-File Programs, Program Termination with exit and atexit, Suffixes for Integer and Floating-Point Literals, Signal Handling, Dynamic Memory Allocation calloc and realloc, goto. Advance Topics: Self-Referential Structures, Linked Lists. Efficiency of Algorithms, Selection and Insertion Sort.</p>
Text Book(s)	A. Paul Deitel, Harvey Deitel, C How To Program, 9th Edition, Pearson, 2022.
Reference Material	<ol style="list-style-type: none"> 1. Tony Gaddis, Starting out with Programming Logic and Design, 5th Edition, Pearson, 2018. 2. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie 3. Object Oriented Programming in C++ by Robert Lafore 4. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

Title	Object Oriented Programming		
Code	CC-211		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	CC-112 Programming Fundamentals		
Co-Requisite	None		
Follow-up	CC-213 Data Structures		
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.		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Understand principles of object-oriented paradigm.	C2 (Understand)	1
	CLO2: Identify the objects & their relationships to build object-oriented solution	C4 (Identify)	2,3,4
	CLO3: Model a solution for a given problem using object-oriented principles	C3 (Apply)	4
	CLO4: Examine an object-oriented solution	C4 (Examine)	4

Course Description	Introduction to Object-oriented Design, History and Advantages of Object-oriented Design. Introduction to OOP and C++: Brief description of C++ concepts, Introduction to OOP. Introduction to Classes Objects and Member Functions: Encapsulation and Abstraction, Class and Object, Getter/Setter Functions, Access Specifiers, Constructors, Overloaded Constructor, Default Constructor, Destructor. Functions: Inline Functions, Function Overloading. Class Templates array: Function Templates, Class Templates array, Vectors and Multidimensional Array, Reference to private Data Members, Default Member wise Assignment, const Objects, const Member Functions. Composition and Aggregation: Object Composition and Aggregation, Class Separation using header. Friend Classes and Functions: Friend Functions, Friend Classes. static Members: “this” pointer, static Data Members, static Member Functions. Copy Constructor: Default Copy Constructor. Operator Overloading: Overloaded Operators of Standard Library, Operator Overloading, Overloading Binary Operators, Overloading Unary Operators, Overloading ++ Operator, Overloading – Operator, Dynamic Memory Management, Operators as Members vs Non-Members, Conversion between Types, Explicit Constructor and Conversion Operators, Overloading the Function call Operator. Stream I/O: Introduction, Streams, Streams Input, Streams Output, Object Streams, data and object serialization using object streams. Inheritance: Introduction, Base and Derived Classes, Relationships between Base and Derived Classes, Constructors in Derived Classes, Destructor in Derived Classes, public protected and private Inheritance. Polymorphism: Relationship among Objects in Inheritance, Virtual Functions, Virtual Destructors, Pure Virtual Functions, Abstract and Concrete Classes. File Processing: Files and Streams, create a Sequential File, read a Sequential File, update a Sequential File, Random Access File, create a Random-Access File, read a Random-Access File, update a Random-Access File, Exception Handling: Flow of Control, Rethrowing an Exception, Constructor Destructor and Exception handling. Generic Programming Concepts: Custom Templates, Class Templates, Function Templates, Arguments to Templates, Overloading Function Templates. Standard Library: Containers, Iterators, Adapters, Sequence Containers, Associative Containers, Container Adapters, Minimum Iterator Requirements, Lambda Expressions, Function Objects.
Text Book(s)	A. P. Deitel, H. Deitel, C++ How To Program, 10th Edition, Pearson.
Reference Material	<ol style="list-style-type: none"> 1. Robert Lafore, Object Oriented Programming in C++, 3rd Edition. 2. Tony Gaddis, Starting Out with C++ from Control Structures to Objects, 9th Edition, Pearson, 2018. 3. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

Title	Object Oriented Programming Lab		
Code	CC-211-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	CC-112 Programming Fundamentals		
Co-Requisite	None		
Follow-up	CC-213 Data Structures		
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.		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Understand principles of object-oriented paradigm.	C2 (Understand)	1
	CLO2: Identify the objects & their relationships to build object-oriented solution	C4 (Identify)	2,3,4
	CLO3: Model a solution for a given problem using object-oriented principles	C3 (Apply)	4
	CLO4: Examine an object-oriented solution	C4 (Examine)	4

Course Description	<p>Implementation and Practice of the concepts studied in “CC-211 Object Oriented Programming”</p> <p>Introduction to Object-oriented Design, History and Advantages of Object-oriented Design. Introduction to OOP and C++: Brief description of C++ concepts, Introduction to OOP. Introduction to Classes Objects and Member Functions: Encapsulation and Abstraction, Class and Object, Getter/Setter Functions, Access Specifiers, Constructors, Overloaded Constructor, Default Constructor, Destructor. Functions: Inline Functions, Function Overloading. Class Templates array: Function Templates, Class Templates array, Vectors and Multidimensional Array, Reference to private Data Members, Default Member wise Assignment, const Objects, const Member Functions. Composition and Aggregation: Object Composition and Aggregation, Class Separation using header. Friend Classes and Functions: Friend Functions, Friend Classes. static Members: “this” pointer, static Data Members, static Member Functions. Copy Constructor: Default Copy Constructor. Operator Overloading: Overloaded Operators of Standard Library, Operator Overloading, Overloading Binary Operators, Overloading Unary Operators, Overloading ++ Operator, Overloading – Operator, Dynamic Memory Management, Operators as Members vs Non-Members, Conversion between Types, Explicit Constructor and Conversion Operators, Overloading the Function call Operator. Stream I/O: Introduction, Streams, Streams Input, Streams Output, Object Streams, data and object serialization using object streams. Inheritance: Introduction, Base and Derived Classes, Relationships between Base and Derived Classes, Constructors in Derived Classes, Destructor in Derived Classes, public protected and private Inheritance. Polymorphism: Relationship among Objects in Inheritance, Virtual Functions, Virtual Destructors, Pure Virtual Functions, Abstract and Concrete Classes. File Processing: Files and Streams, create a Sequential File, read a Sequential File, update a Sequential File, Random Access File, create a Random-Access File, read a Random-Access File, update a Random-Access File, Exception Handling: Flow of Control, Rethrowing an Exception, Constructor Destructor and Exception handling. Generic Programming Concepts: Custom Templates, Class Templates, Function Templates, Arguments to Templates, Overloading Function Templates. Standard Library: Containers, Iterators, Adapters, Sequence Containers, Associative Containers, Container Adapters, Minimum Iterator Requirements, Lambda Expressions, Function Objects.</p>
Text Book(s)	A. P. Deitel, H. Deitel, C++ How To Program, 10th Edition, Pearson.
Reference Material	<ol style="list-style-type: none"> 1. Robert Lafore, Object Oriented Programming in C++, 3rd Edition. 2. Tony Gaddis, Starting Out with C++ from Control Structures to Objects, 9th Edition, Pearson, 2018. 3. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

Course Title	Database Systems		
Course Code	CC-215		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up			
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		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: To understand the basic concepts of database systems and Database System environment.	C2 (Understand)	1
	CLO2: To develop strong concepts of data modeling techniques	C2 (Understand)	1,2
	CLO3: Understanding of database design phases and techniques for performance improvement	C2 (Understand)	1,2
	CLO4: To understand the concept of transaction management, concurrency control, database recovery, and distributed databases	C2 (Understand)	1,2
	CLO5: To learn SQL and develop expertise in writing SQL queries	C3 (Apply)	3,4,5
	CLO6: To develop the fundamental knowledge of PL/SQL, stored procedures, and database triggers	C3 (Apply)	3,4,5
	CLO7: To be able to design a database system for small business organizations	C5 (Design)	3,4,5,7
Course Description	<p>File Systems and Databases: Introduction, A File system Critique, Database Systems, Database approach vs file-based system, database architecture, three level schema architecture, data independence, Database Models. Introduction to RDBMS: Logical view of Data; Entities and Attributes, Tables and their Characteristics, Keys; relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints. Relational Algebra: Relational Database Operators, selection, projection, Cartesian product, types of joins. Entity Relationship (E-R) Modeling: Basic Modeling Concepts, entity sets, attributes, relationship, entity-relationship diagrams, Normalization of Database Tables: Objectives, Forms, Normalization and Database Design, functional dependencies, normal forms, Denormalization, Structured Query Language (SQL): Introduction, DDL Commands, Joins and subqueries in SQL, Grouping and aggregation in SQL, DML Commands, DCL Commands, Complex Queries and SQL Functions, Procedural SQL; Triggers, Stored procedures. Database Design: The System Development Life Cycle (SDLC), The Database Life Cycle (DBLC), Database Design Strategies, Transaction Management and Concurrency Control: Introduction, Transaction Properties and Types, Concurrency Control Issues, Database Recovery Management. DDBMS: Evolution, Components, Distributed processing and distributed databases, Distributed database transparency features. Distributed database design, Data fragmentation, Data replication, NoSQL systems.</p>		

Text Book(s)	1. Carlos Coronel, Steven Morris, Database Systems: Design, Implementation & Management, 13 th Edition, Cengage Learning, 2017. ISBN-10: 1337627909.
Reference Material	<ol style="list-style-type: none">1. Jeffrey A. Hoffer, Ramesh Venkataraman, Heikki Topi, Modern Database Management, 12th Edition, Pearson, 2015. ISBN-10: 0133544613.2. Thomas Connolly, Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation and Management, 6th Edition, Pearson, 2015. ISBN-10: 1292061189.3. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, 7th Edition, Pearson, 2016. ISBN-10: 1292097612.

Course Title	Database Systems Lab		
Course Code	CC-215-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up			
Course Introduction	The course aims to introduce the Structured Query Language (SQL). It covers the set of commands related to Data Retrieval, Data Definition Language (DDL), Data Manipulation Language (DML), Data Control Language (DCL). It will followed up by procedural flavor of SQL (PL/SQL).		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: To learn SQL and develop expertise in writing SQL queries	C3 (Apply)	3,4,5
	CLO2: To develop the fundamental knowledge of PL/SQL, stored procedures, and database triggers	C3 (Apply)	3,4,5
	CLO3: To be able to design a database system for small business organizations	C5 (Design)	3,4,5,7
Course Description	<p>Introduction to SQL environment: Writing Basic SQL Statements; SELECT Statement: Arithmetic Expressions, Operator Precedence, Null Value, Column Alias, Concatenation Operator, FROM Clause: Table list, Table Alias. Restricting and Sorting Data; WHERE Clause: Comparison operators, Logical operators, ORDER BY clause, Display table Structure.</p> <p>Single row functions: character functions, number functions, date functions, type conversion functions. Multi row Functions: Sum, Average, Standard deviation, Variance, Subgrouping of data, Group by Clause, use of Having clause. Join: Cross product, natural join, Equi-join, Non equi-join, left outer-join, right outer-join, self-join. Subquery: use of subquery, subquery syntax, Multiple Column Subqueries, pairwise comparison, Non-pair wise comparison, Null Value in a subquery, Subquery in From Clause. Creating and Altering SQL tables: Create table statement, Defining Constraints, Column Level and Table Level, NOT NULL Constraint, UNIQUE Key Constraint, PRIMARY Key Constraint, FOREIGN Key Constraint, CHECK Constraint, Alter table statement, drop statement, Data Manipulation: Insert, Update, Delete statements. SQL Objects: Views, Sequences, Indexes. User Management: Create user, user privileges, user groups, Grant, Revoke statements.</p> <p>Introduction to Procedural SQL (PL/SQL), Sections of a PL/SQL block, Variable declaration and initialization, SELECT statement in PL/SQL, Arithmetic expressions, Selection, Repetition, Exception Handling, Cursors, Stored Procedures and Functions, Introduction to Database Triggers</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. Introduction to Oracle 9i: SQL 2. Michael McLaughlin, Oracle Database 11g PL/SQL Programming, 1st Edition, McGraw-Hill Education, 2008, ISBN: 0071494456. 		
Reference Material	<ol style="list-style-type: none"> 1. Jason Price, Oracle Database 11g SQL, McGraw Hill. ISBN: 0071498508. 		

Course Title	Digital Logic Design		
Course Code	CC-110		
Credit Hours	3 (2,1)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up			
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.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Acquire the basic knowledge of logic gates and digital logic circuits	C2 (Understand)	1
	CLO2: Understand the working of the fundamental digital circuits used in digital systems and computers.	C2 (Understand)	1,2
	CLO3: Designing a digital circuit for implementing a given scenario.	C3 (Apply)	3,4
Course Description	<p>Topics: Introduction to Digital Systems, Number Systems, Introduction to Boolean Algebra, Basic theorems and properties of Boolean Algebra, Boolean Functions, Logic Gates, NAND and NOR Implementation, Representation of Function in Sum of Minterms or Product of Maxterms, Simplification of Boolean function using Karnaugh Map, Don't care Conditions, The Tabulation Method, Introduction to Combinational Logic, Design of Adders, Design of Subtractors, Code Convertors, Analysis Procedure of Combinational Circuits, Binary Parallel Adders, Decimal Adders, Magnitude Comparator, Decoders and its applications, Multiplexers, Demultiplexers, Encoders, ROM, Programmable Logic Array (PLA), Introduction to Sequential Circuits, Basic Flip Flop, Clocked RS Flip Flop, Clocked D Flip Flop, Clocked JK Flip Flop, Clocked T Flip Flop, Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Flip Flop Excitation tables, Design Procedure, Design of Counters, Design with State Equations, Introduction to Registers, Shift Registers, Ripple Counters, Synchronous Counters, Timing Sequences, Memory Unit, Random Access Memory. Introduction Programmable Logic Devices (CPLD, FPGA), Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim. Familiarization with Digital Electronic Trainer, Logic gates operations, Half Adder Operation, Full Adder Operation, Half Subtractor Operation, Full Adder Operation, 7-Segment Display Operation, Decoder Operation, BCD To 7-Segment Display, Multiplexer Operation, Using Multiplexer and Demultiplexer / Decoder, Multiplexing 7-Segment Displays, Comparator Operations, D Latch and Flip-Flop Operation, Latching BCD Data for Displaying On 7-Segment Display, JK Flip-Flop Operation, Random Access Memories</p>		
Text Book(s)	M. Morris Mano, Digital Logic and Computer Design, 1 st Edition, Pearson, 1979, ISBN: 0132145103.		
Reference Material	<ol style="list-style-type: none"> 2. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Prentice Hall, 2008, ISBN: 0132359235. 3. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e 		

Course Title	Digital Logic Design Lab		
Course Code	CC-110-L		
Credit Hours	1 (0, 3)		
Category	Computing core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	CC-210 Computer Organization & Assembly Language		
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.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Acquire the basic knowledge of Digital Electronic Trainer	C1 (Acquire)	1
	CLO2: Understand the pin configuration and working of commonly used ICs for digital circuit design	C2 (Understand)	1,2
	CLO3: Designing a digital circuit for implementing a given scenario.	C3 (Apply)	3,4
Syllabus	Topics: Familiarization with Digital Electronic Trainer, Implementation of logic gates using ICs, Illustration of basic properties and theorems Boolean algebra using circuit design, Implementation of given Boolean functions, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Design of 7-Segment Display, BCD To 7-Segment Display, Decoder, Multiplexer, Demultiplexer, Implementation of Boolean function(s) using Decoder and Multiplexer, Magnitude Comparator, D Latch and Flip-Flop Operation, Latching BCD Data for Displaying On 7- Segment Display, JK Flip-Flop Operation, Random Access Memories		
Suggested Instructional/ Reading Material	<ol style="list-style-type: none"> 1. M. Morris Mano, Digital Logic and Computer Design, 1st Edition, Pearson, 1979, ISBN: 0132145103. 2. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Prentice Hall, 2008, ISBN: 0132359235. 3. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e 		

Title	Data Structures		
Code	CC-213		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	CC-211 Object Oriented Programming		
Co-Requisite	None		
Follow-up			
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.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)	1,2
	CLO2: Analyze simple algorithms and determine their complexities.	C4 (Analyze)	3
	CLO3: Apply the knowledge of data structure to other application domains	C3 (Apply)	3,4
	CLO4: Design new data structures and algorithms to solve problems	C6 (Design)	4,5
Course Description	<p>Algorithm Specification: Properties of Algorithm, examples, performance, analysis, measurement, and Big Oh notation. Introduction to ADTs: Array and Polynomial as an ADT, Sparse Matrices, and Representation of Arrays. The Stack ADT: Linked list and array implementations, Expressions, Postfix Notation, and Infix to postfix conversion. The Queue ADT: Linked and array implementations of circular and double ended queue. Recursion: Recursive Definition and Processes, Writing Recursive Programs. Divide and Conquer Algorithms, Self-Referencing Classes and Dynamic Memory Allocation, Garbage Collection. Linked List: Singly Linked Lists, Circular Lists, Linked Stacks and Queues (Double Ended List), Doubly Linked Lists. Trees: Introduction to Trees, Logical construction and Traversing of Binary Trees, Implementation of Binary Trees (Insertion and Traversing), Searching and deletion in Binary Trees, Binary Search Tree, Introduction to Balanced and AVL Trees. Heaps: Heaps and Heaps as Priority Queues, Double Ended Priority Queue. Searching: Linear Search, Binary Search, and Types of Indexing. Hashing: Hash Functions: Division, Open Addressing; Overflow Handling: Chaining; Introduction to advanced topics: B-Trees, M-Way Trees, Generalized List etc. Sorting: Selection, Insertion, Merge, Quick, Bubble, Heap, Shell, Radix, and Bucket sorts. Graphs: Graph terminology, Adjacency List and Adjacency Matrix and Adjacency list representation of Graph; Elementary Graph Operations: Breadth First Search and Depth First Search, Spanning Trees (BFSST, DFSST), topological order, shortest path.</p>		
Text Book(s)	A. Ellis Horowitz, Sartaj Sahni, and D. Mehta, "Fundamentals of Data Structures in C++", 2 nd Ed., Computer Science Press		

Reference Material	<ol style="list-style-type: none">1. Adam B. Drozdek, Data Structure and Algorithm in C++, 4th Ed., Cengage Learning2. Mark Allen Weiss, “Data Structure and Algorithms in C++”, 2nd Ed., Pearson Education3. D. Malhotra and N. Malhotra. Data Structures and Program Design Using C++.4. Tenenbaum, M. Augenstein, and Y. Lang Sam, “Data Structures using C and C++” 2nd Ed., Prentice Hall
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Title	Data Structures Lab		
Code	CC-213-L		
Credit Hours	1 (0,3)		
Category	Computing Core		
Prerequisite	CC-211 Object Oriented Programming		
Co-Requisite	None		
Follow-up			
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.		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Implement various data structures and their algorithms and apply them in implementing simple applications	C3 (Apply)	1,2
	CLO2: Analyze simple algorithms and determine their complexities.	C4 (Analyze)	3
	CLO3: Apply the knowledge of data structure to other application domains	C3 (Apply)	3,4
	CLO4: Design new data structures and algorithms to solve problems	C6 (Design)	4,5
Course Description	<p>Implementation and Practice of the concepts studied in “CC-213 Data Structures”</p> <p>Algorithm Specification: Properties of Algorithm, examples, performance, analysis, measurement, and Big Oh notation. Introduction to ADTs: Array and Polynomial as an ADT, Sparse Matrices, and Representation of Arrays. The Stack ADT: Linked list and array implementations, Expressions, Postfix Notation, and Infix to postfix conversion. The Queue ADT: Linked and array implementations of circular and double ended queue. Recursion: Recursive Definition and Processes, Writing Recursive Programs. Divide and Conquer Algorithms, Self-Referencing Classes and Dynamic Memory Allocation, Garbage Collection. Linked List: Singly Linked Lists, Circular Lists, Linked Stacks and Queues (Double Ended List), Doubly Linked Lists. Trees: Introduction to Trees, Logical construction and Traversing of Binary Trees, Implementation of Binary Trees (Insertion and Traversing), Searching and deletion in Binary Trees, Binary Search Tree, Introduction to Balanced and AVL Trees. Heaps: Heaps and Heaps as Priority Queues, Double Ended Priority Queue. Searching: Linear Search, Binary Search, and Types of Indexing. Hashing: Hash Functions: Division, Open Addressing; Overflow Handling: Chaining; Introduction to advanced topics: B-Trees, M-Way Trees, Generalized List etc. Sorting: Selection, Insertion, Merge, Quick, Bubble, Heap, Shell, Radix, and Bucket sorts. Graphs: Graph terminology, Adjacency List and Adjacency Matrix and Adjacency list representation of Graph; Elementary Graph Operations: Breadth First Search and Depth First Search, Spanning Trees (BFSST, DFSST), topological order, shortest path.</p>		
Text Book(s)	A. Ellis Horowitz, Sartaj Sahni, and D. Mehta, “Fundamentals of Data Structures in C++”, 2 nd Ed., Computer Science Press		

Reference Material	<ol style="list-style-type: none">1. Adam B. Drozdek, Data Structure and Algorithm in C++, 4th Ed., Cengage Learning2. Mark Allen Weiss, “Data Structure and Algorithms in C++”, 2nd Ed., Pearson Education3. D. Malhotra and N. Malhotra. Data Structures and Program Design Using C++.4. Tenenbaum, M. Augenstein, and Y. Lang Sam, “Data Structures using C and C++” 2nd Ed., Prentice Hall
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Course Title	Information Security		
Course Code	CC-312		
Credit Hours	3 (2,1)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course provides a broad overview of the threats to the security of information systems, the responsibilities and basic tools for information security, and the levels of training and expertise needed in organizations to reach and maintain a state of acceptable security. It covers concepts and applications of system and data security. Areas of particular focus include secure network design, implementation and transition issues, and techniques for responding to security breaches.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain key concepts of information security such as design principles, cryptography, risk management, and ethics.	C2 (Explain)	1,2
	CLO2: Discuss legal, ethical, and professional issues in information security.	A2 (Discuss)	1,2
	CLO3: Apply various security and risk management tools for achieving information security and privacy.	C3 (Apply)	3,4,5
	CLO4: Identify appropriate techniques to tackle and solve problems in the discipline of information security.	C4 (Identify)	3,4,5
Course Description	Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.		
Text Book(s)	1. M. Whitman and H. Mattord, Principles of Information Security, 6th edition.		
Reference Material	1. William Stallings, Computer Security: Principles and Practice, 3rd edition. 2. Dieter Gollmann, Computer Security, 3rd edition. 3. William Easttom, Computer Security Fundamentals, 3rd edition.		

Course Title	Artificial Intelligence		
Course Code	CC-310		
Credit Hours	3 (2,1)		
Category	Computing core		
Prerequisite	CC-213 Data Structures		
Co-Requisite	None		
Follow-up	None		
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.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the fundamental constructs of Python programming language.	C2 (Understand)	1,2
	CLO2: Understand key concepts in the field of artificial intelligence	C2 (Understand)	1,2
	CLO3: Implement artificial intelligence techniques and case studies	C3 (Apply)	3,4,5
Course Description	<p>An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Symbolic AI: the physical symbol system hypothesis. Search: exhaustive & heuristic search techniques. 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, Game playing, Genetic algorithms, Introduction to Machine Learning for AI, Decision Trees, Bayesian classification, Artificial Neural Networks, Computer Vision.</p> <p>Introduction to Python programming, Logic programming: knowledge representation & search in the context of logic programming. Reasoning in logic programming: unification, horn clause logic, and resolution, Knowledge Representation Schemas: Logic, frames, semantic nets, scripts; problems in knowledge representation. Expert systems.</p>		
Text Book(s)	1. Stuart Russell and Peter Norvig, Artificial Intelligence. A Modern Approach, 3rd edition, Prentice Hall, Inc., 2010.		
Reference Material	<ol style="list-style-type: none"> 1. Luger, G.F. and Stubblefield, W.A., 2009. AI algorithms, data structures, and idioms in Prolog, Lisp, and Java. Pearson Addison-Wesley. 2. George F. Luger, Artificial Intelligence - Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson, 2008, ISBN-13: 978-0321545893. 3. Hart, P.E., Stork, D.G. and Duda, R.O., Pattern classification. John Willey & Sons, 2001. 4. Ivan Bratko, Prolog: Programming for Artificial Intelligence, 4th Edition, Pearson, 2011, ISBN-13: 978-0321417466. 5. P. Winston, Artificial Intelligence, 3rd Edition, Pearson, 1992, ISBN-13: 978-0201533774. 		

Course Title	Computer Networks		
Course Code	CC-214		
Credit Hours	3 (2,1)		
Category	Computing Core		
Prerequisite	None		
Co- Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the lab, the students will be able to:	BT	PLO
	CLO1: Describe the key terminologies and technologies of computer networks	C2 (Describe)	1
	CLO2: Explain the services and functions provided by each layer in the Internet protocol stack	C2 (Explain)	1
	CLO3: Identify various internetworking devices and protocols and their functions in a networking	C4 (Identify)	1,2
	CLO4: Analyze working and performance of key technologies, algorithms and protocols	C4 (Analyze)	3
	CLO5: Build Computer Network on various Topologies.	P3 (Build)	4,5
Course Description	<p>Introduction: 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, subnetting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks.</p> <p>The lab contents are divided into two parts.</p> <p>After completion of the first part, the students will be able to understand Computer Networks basics, network types, layered communication models and protocols. The contents have been organized in such a way as to form the base for learning the concepts to be taught in the next part. The assimilation of the networking concepts will enable the students to apply them for solving practical problems.</p> <p>After completion of this part, the students will be familiar with networking, routing, switching, and Setting up of networks from scratch, major protocols involved in communication and their configurations. Students will also be made aware of the state of the art areas in case they would like to pursue this course in future.</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 6th Edition, Pearson, 2012, ISBN: 0132856204. 2. T. Lammle, CCNA Cisco Certified Network Associate Deluxe Study Guide, 6th Edition, Sybex, 2011, ISBN: 978-0-470-90108-3. 		

Reference Material	<ol style="list-style-type: none">1. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, 5th Edition, Prentice Hall, 2010, ISBN: 9332518742.2. William Stallings, Data and Computer Communications, 10th Edition, Pearson, 2013, ISBN: 0133506487.3. Behrouz A. Forouzan, Data Communication and Computer Networks, 5th Edition, McGraw-Hill, 2012, ISBN: 0073376221.4. R. Perlman, Interconnections: Bridges, Routers, Switches, and Internetworking Protocols, 2nd Edition, Addison-Wesley, 1999, ISBN: 0201634481.
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Course Title	Software Engineering		
Course Code	CC-212		
Credit Hours	3 (3,0)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Describe various software engineering processes and activates	C1 (Describe)	1
	CLO2: Apply the system modeling techniques to model a medium size software system	C3 (Apply)	1,2
	CLO3: Apply software quality assurance and testing principles to medium size software systems	C3 (Apply)	2,3
	CLO4: Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation, and risk analysis	C2 (Discuss)	1, 2
Course Description	<p>Introduction: Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software Process Models: Waterfall Model, Incremental Model, Prototyping Model, Spiral Model, RAD Model. Agile Software Development: Agile process models, Agile development techniques. Introduction to Project Management, Introduction to Requirements Engineering, Functional and non-functional requirements. Analysis Model: Context models, Interaction models, Structural models, behavioral models, model driven engineering, Data modeling, Functional Modeling, Behavioral Modeling. Software Design: Data Design, Architectural Design, Component Level Design, User Interface Design. Object Oriented Analysis & Design Basics: Introduction to UML, UML Diagrams. Use Case Modeling, Rational Rose overview, Use case modeling in Rational Rose. Domain Model: Identifying business classes, Domain Model Associations, Domain Model Attributes, Implementation of Sequence Diagram and Domain model in Rational Rose. Interaction Diagram: Sequence diagrams, Collaboration Diagrams, Implementation of Sequence and Collaboration diagrams in Rational Rose. Design Class Diagram, Mapping Design to Code. Software Testing Fundamentals. Design patterns, Software testing and quality assurance. Software evolution. Project Management: Project planning, configuration management. Software Process improvement.</p>		
Text Book(s)	1. Ian Sommerville, Software Engineering, 10th Edition, Pearson, 2015, ISBN-13: 978-0133943030.		
Reference Material	1. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd Edition, Pearson, 2002, ISBN-13: 978-0133056990.		

Course Title	Operating Systems		
Course Code	CC-311		
Credit Hours	3 (2,1)		
Category	Computing Core		
Prerequisite	None		
Co-Requisite	None		
Follow-up	DI-323: System and Network Administration		
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.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the characteristics of different structures of the Operating Systems and the core functions of the Operating Systems	C2 (Understand)	1,2
	CLO2: Analyze and evaluate the algorithms of the core functions of Operating Systems and explain major performance issues with regard to the core functions	C6 (Evaluate)	3
	CLO3: Demonstrate knowledge in applying system software and tools available in modern operating systems	C3 (Demonstrate)	3,4
Course Description	<p>Introduction: 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.</p> <p>Interacting with Linux Operating System: Virtualization and Hypervisors. File System Architecture: Schematic view of a standard UNIX file system. File System Mounting: Introduction to the concept of file system mounting. Linux configuration files related to file system mounting. File Permissions: standard file permissions. Use of chmod and chown commands. Device files: Seven File Types in Linux and the concept of device files. Terminal Attributes: Overview of Terminal Devices and current attributes of the terminal driver. Hard and Soft Links. Managing services using systemd: Introduction to Linux system daemon. Shell commands to manage services using systemctl. Bootting process of a Linux system.</p> <p>Linux System Programming: Linux System Call Interface, Use of GNU gcc compiler Process Creation and Termination: getpid(), getppid(), fork(), exit(), wait() and execl() system calls. File management in Linux. Concept of PPFDT. Concept of input, output and error redirection. Inter Process Communication: Linux IPC tools, Pipes, FIFOS and Sockets. Use of pipes and fifos on a Linux terminal. Signals: Signal delivery and execution of a signal handler. Synchronous and Asynchronous signals. Threads</p>		

	and Scheduling: Writing multi-threaded C programs using library calls from the POSIX pthread library like pthread_create(), pthread_join(), and pthread_exit().
Text Book(s)	1. A. Silberschatz, P. B. Galvin, G. Gagne, Operating Systems Concepts, 9 th Edition, Wiley, 2012, ISBN: 1118063333.
Reference Material	1. Andrew S. Tanenbaum, Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, 2014, ISBN: 013359162X. 2. William Stallings, Operating Systems: Internals and Design Principles, 9th Edition, Pearson, 2017, ISBN: 0134670957.

ELECTIVE: 15 (10, 5)

Sr.	Code	Course Title	Prerequisite	Cr. Hrs.
1	DS-425	Software Quality Engineering		3 (2, 1)
2	ES-321	Human Computer Interaction		3 (2, 1)
3	ES-332	Web Technologies		3 (2, 1)
4	ES-334	Mobile Application Development	Object Oriented Programming	3 (2, 1)
5	DS-426	Software Project Management		3 (2, 1)

Course Title	Software Quality Engineering		
Course Code	DS-425		
Credit Hours	3(2, 1)		
Category	Domain Core		
Prerequisite	CC-212 Software Engineering		
Co-Requisite	None		
Follow Up	None		
Course Introduction	This course is designed to introduce students to the core principles, methods, and practices of Software Quality Assurance. Through a blend of theory and hands-on exercises, learners will gain a deeper understanding of what it takes to ensure software products meet the required standards of quality before they reach the end-user.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Outline software testing and software quality assurance principles.	C1 (Remember)	1, 2
	CLO2: Prepare test case and test suites for completely testing all aspects of a system under test (SUT)	C3 (Apply)	4, 5
	CLO3: Analyze which of the software testing techniques are relevant for a particular case and know software reliability analysis tools and techniques.	C4 (Analyze)	3
	CLO4: Compile findings of a quality assurance cycle.	C5 (Create)	3
Course Description	Software Quality, Software Quality Attributes, Quality Engineering., Testing: Concepts, Issues, and Techniques, Software testing lifecycle., Testing Scopes., Testing Approaches., Testing Concepts., Test Planning Process, Introduction to testing process, Requirement of software test planning, Testing documentation, Reporting and historical data recording., Software testing techniques, Testing philosophies , Testing strategies, Model based testing, Software testing techniques, Testing using models, Domain and combinatorial testing, Unit and integration testing, Acceptance testing, Test automation, Slicing, Software reliability models and engineering, Introduction, Exponential model., Reliability growth models, Modeling process, Software inspections, Software reviews, Inspection checks and metrics, Quality Models, Models for quality assessment, Product quality metrics, Quality Measurements, In-Process metrics for software testing, In-Process quality management, Effort/outcome models, System testing, Introduction to sub-system testing, From functional to system aspects of testing, System testing, Introduction to system testing, Scenarios development, System testing, Use-cases for testing, Specification-based testing, Open issues on software testing		
Text Book/s	1. Paul Jorgensen, Software Testing, A Craftsman's Approach, 4th Ed. CRC Press, Taylor and Francis Group, 2015		
Reference Material	1. Bernard Homes, Fundamentals of Software Testing, ISTE, Wiley, 2012 2. Software Engineering, "Ian Sommerville, 9th Edition, Addison Wesley, 2011		

Course Title	Human Computer Interaction		
Course Code	ES-321		
Credit Hours	3 (2, 1)		
Category	Software Engineering Elective		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: HCI Interaction Paradigms.	C2 (Understand)	1, 2
	CLO2: Explain HCI design rules and evaluation techniques.	C2 (Explain)	1, 2
	CLO3: Understand cognitive models.	C2 (Understand)	1, 2
	CLO4: Understand computer mediated communication, ubiquitous computing, and related tools & technologies	C2 (Understand)	2,3,4,5
Course Description	<p>Topics: Interaction Paradigms: Batch Processing, Time sharing, Networking, Graphical Displays, Microprocessor, WWW, Ubiquitous Computing. Human: Fitt's Law, Human Information Processor, Emotions, Psychology and Design of Interactive Systems, Accessibility. Computers: capabilities and limitations of Computer Systems, Color Models, New Interactive Systems: Speech, touch, gestures, handwriting recognition. Interactions: Models of Interaction, Frameworks, Interaction Styles, User Experience, Interaction Design. Usability: HCI in software Process, Learnability, Flexibility, Robustness. Design Rules: Principles, Standard (ISO9241), Guidelines, Heuristics (Neilson, Norman, Shneiderman), HCI Patterns (Mobile & Web Application UI). Implementation Support: jQuery, User Interface Management System and architectural Patterns. Evaluation Techniques: expert analysis (Heuristic Evaluation), Evaluation through user participation: Empirical methods and experiment design, statistical measures, Observational Techniques. User Support: Tutorial help, documentation, Wizards, adaptive help. Cognitive Models: KLM-GOMS Task Analysis: Hierarchical Task Analysis, Knowledge based Analysis, Entity Relationship based Techniques. Dialog Design: Diagrammatic Notations: State Transition Networks, Petri Nets, state charts, flow charts. Overview of Textual Notation: Grammars, Production Rules. Computer Mediated Communication: groupware, computer mediated communication, Meeting and decision support systems, argumentation Tools, shared application and Artefacts. Issues of Groupware implementation. Ubiquitous Computing: Introduction, information and data visualization overview.</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. Alan Dix, Janet Finlay Gregory D Abowd, and Russel Beale, "Human Computer Interaction", 3rd Ed. Pearson Prentice Hall, 2004, ISBN-13: 978-0130461094. 2. Julie A Jacko and Andrew Sears, "The Human Computer Interaction Handbook," 2nd Ed., CRC, 2007, ISBN 0-8058-5870-9. 		
Reference Material	<ol style="list-style-type: none"> 1. Ben Shneiderman, "Designing the User Interface: Strategies for Effective Human-Computer Interaction", 6th Ed., Addison Wesley, 2016, ISBN -13: 978-0134380384: 2. William Albert and Thomas Tullis, "Measuring the User Experience", Morgan Kaufmann, 2013, Paperback ISBN: 9780124157811 3. Helen Sharp, Jenny Preece and Yvonne Rogers, "Interaction Design: Beyond Human-Computer Interaction", Wiley, 2002, ISBN-13: 978-0470665763 4. http://www.ui-patterns.com 5. http://www.androidpatterns.com 6. http://www.usability.gov 		

Course Title	Web Technologies		
Course Code	ES-332		
Credit Hours	3 (2,1)		
Category	Software Engineering Elective		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know web application architecture and, languages and application.	C1 (Know)	1
	CLO2: Describe various approaches to web application development.	C2 (Describe)	1
	CLO3: Develop web applications.	C3 (Apply)	1,3
Course Description	<p>Introduction: Web Applications, TCP/IP Application Services. Web Servers: Basic Operation, Virtual hosting, Chunked transfers, Caching support, Extensibility. SGML, HTML5, CSS3. XML Languages and Applications: Core XML, XHTML, XHTML MP. Web Services: SOAP, REST, WML, XSL. Operations, Processing HTTP Requests, Processing HTTP Responses, Cookie Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery. Server Configuration. Server Security. Web Browsers Architecture and Processes: Active Browser Pages: JavaScript, DHTML, AJAX. JSON. Approaches to Web Application Development: Programing in any Scripting language. Search Technologies, Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework.</p> <p>Implementation on compiler of all the concepts/topics discussed in the course which includes, Introduction to Java, Variables, data types, Control Structures, Methods, Classes, Interfaces, Method Overloading and Overriding, Revision of Object oriented programming courses in Java, GUI development, Event Handling, Database Connectivity, Exception Handling, File handling, HTML, CSS, Java Script, Server side Programming in Java, Http Request and Response, Servlets, Servlet Life Cycle, Java Beans, MVC.</p>		
Text Book(s)	1. Paul J. Deitel and Harvey Deitel, Java How to Program, 11 th Edition, Pearson, 2017, ISBN-10: 0134743350, ISBN-13: 978-0134743356.		
Reference Material	1. Marty Hall and Larry Brown, Core Servlets and Java Server Pages, 2 nd Edition, Pearson, 2017, ISBN-10: 8131701638, ISBN-13: 978-8131701638.		

Course Title	Mobile Application Development		
Course Code	ES-334		
Credit Hours	3 (2,1)		
Category	Software Engineering Elective		
Prerequisite	CC-211: Object Oriented Programming		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain characteristics of mobile application.	C2 (Explain)	1,2
	CLO2: Use Android platform for application development.	C3 (Apply)	1,2,3
	CLO3: Identify potential and applications of data storage technologies.	C4 (Identify)	1,2,3
	CLO4: Use Android Native Development Kit in a mobile application development.	C3 (Apply)	3,4,5
Course Description	<p>Introduction: Mobile Computing Domain, Comparison of different Mobile Platforms, Revision of Java. Android Platform: Dalvik Virtual Machine, Android Constructs (Activity, Intent, Content Provider, Service, Broadcast Receiver), Activity Lifecycle, Project Structure, Manifest File, Emulators (AVD), Debugging (DDMS), R.java, Inter Activity Communication (Intent), Event Handlers, Layout XML, @ Sign, Layouts, Adapters, Dynamic Lists, Holder Pattern, Menus and dialogs, Menu, Menu Group, Menu Item, Icon Menu, Sub Menu, Context Menu, Sub Menu, Dynamic Menu, Using XML Files for Menus, Services, Intents. Data Storage: Key Value Sets, Files, Intro to SQLite, Web Service Integration, JSON, HTTPClient, Graphics, Widgets & Notifications, Multimedia and telephony API, Android Native Development Kit (NDK).</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. Mark L. Murphy, Beginning Android 2, Apress, ISBN 978-1-4302-2629-1 2. Zigurd Mednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura Programming Android, 2nd Edition, O Reilly Press, ISBN: 978-1-449-31664-8 3. Syed Hashmi, Satya Komatineni, Dave Maclean, Pro Android 2, Apress, ISBN 978-1-4302-2659-8 		
Reference Material	<ol style="list-style-type: none"> 1. http://developer.android.com/develop/index.htm 2. http://developer.android.com/guide/components/services.html 3. http://developer.android.com/guide/components/intents-filters.html 4. http://developer.android.com/guide/topics/data/data-storage.html 5. http://developer.android.com/guide/topics/graphics/index.html 6. http://developer.android.com/guide/topics/sensors/index.html 		

Course Title	Software Project Management		
Course Code	DS-426		
Credit Hours	3 (2,1)		
Category	Software Engineering Elective		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Introduction	This course provides an introduction to the key concepts, methods, and best practices needed to effectively manage software projects. Through a combination of lectures, case studies, and interactive discussions, students will gain insights into the entire software development lifecycle, from ideation to deployment, while emphasizing time management, budgeting, stakeholder communication, and risk management.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Articulate the various phase in project management stages of SDLC and recognize the importance of each phase in the context of project management.	C2 (Explain)	1,2
	CLO2: Allocate and manage project resources, including human capital, time, and budget, to maximize efficiency and effectiveness.	C3 (Apply)	1,2,3,4
	CLO3: Identify potential project risks, assess their impact, and devise strategies to mitigate or respond to these risks.	C4 (Identify)	3,4
	CLO4: Implement modern project management tools and software to aid in task tracking, collaboration, and project monitoring.	C3 (Apply)	3,4,5
	CLO5: Determine the criteria for project success and employ evaluation techniques post-project to assess outcomes and derive lessons for future projects.	C4 (Differentiate)	3,4
Course Description	<p>Introduction: Project Management. The Project Management Process Groups. Scope triangle, The S curve. Five Phases of Project Management Life Cycle: Defining, planning, executing, controlling, closing, Scope of project, Project Work Breakdown Structure (WBS), Project Time Management. Estimate Activity Duration: Causes of variation in activity duration, five methods of Estimating Activity Duration. Project Networks: Critical Path Method (CPM), Build the project network, Analysis of the project network, Project Evaluation Review Technique (PERT), Activity on Arrow, Activity on Node, GANTT Chart, Using MS-Project to draw GANTT chart and project Networks. Project Proposal: Purpose of the project proposal, Contents of the project proposal, Format of the Project Proposal. Staffing and Personnel Planning: Personnel Plan, Team structures, Democratic decentralized, Controlled Decentralized, Controlled Centralized, Coordination and communication issues, Maslow’s need theory of motivation, Software Project Team Roles and Responsibilities, Risk Identification, Analysis and Management. Project Management: Integration Management. Scope Management. Cost Management. Quality Management. Human Resource Management. Communications Management. Risk Management. Procurement Management. Management Tools. Configuration Management: Change Management and Control, baselines, Version Control, Earned Value Analysis for Project Monitoring and Control. Examples of Earned</p>		

	Value Analysis, Project Quality Assurance Plans, SQA Process Project Quality Standards, Project Documents.
Text Book(s)	1. Guide to the Project Management Body of Knowledge (PMBOK® Guide), 6 th Edition, Project Management Institute, 2017, ISBN-10: 1628251840.
Reference Material	1. Teresa Luckey, Joseph Phillips, Software Project Management for Dummies, 1st Edition, For Dummies Publisher, 2006, ISBN 0471749346.

MATHEMATICS & SUPPORTING: 3 (3, 0)

Sr.	Code	Course Title	Prerequisite	Cr. Hrs.
1	MS-251	Probability and Statistics		3 (3,0)

Course Title	Probability and Statistics		
Course Code	MS-251		
Credit Hours	3 (3,0)		
Category	Mathematics & Supporting		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concept and applications of probability and statistics.	C1 (Know)	1
	CLO2: Describe expectation and distributions	C2 (Describe)	1
	CLO3: Solve single sample and one- and two- sample estimation.	C3 (Apply)	1,3
	CLO4: Use regression techniques.	C3 (Apply)	1,3
Course Description	<p>Introduction: 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. Probability Distributions: Discrete Probability Distributions, Continuous Probability Distributions. Fundamental Sampling Distributions: Sampling Distributions and Data Descriptions, Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S^2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two-Sample Estimation Problems: Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests). Regression: 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.</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. Dimitri P. Bertsekas, John Tsitsiklis, Introduction to probability, Athena Scientific, 2nd Edition, 2008, ISBN: 978-1886529236. 2. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning, 9th Edition, 2015, ISBN: 978-1305251809. 3. R.E. Walpole, R.H. Myers and S.L Myers, "Probability and Statistics for Engineers and Scientists", 9th Edition. 		
Reference Material	<ol style="list-style-type: none"> 1. MIT open courseware: https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/ 		

GENERAL EDUCATION: 21 (20, 1)

Sr.	Code	Course Title	Sub – Category	Prerequisite	Cr. Hrs.
1	GE-160	Applications of Information & Communication Technologies			3 (2,1)
2	GE-190	Functional English			3 (3,0)
3	GE-191	Expository Writing			3 (3,0)
4	GE-167	Discrete Structures	Quantitative Reasoning – I		3 (3,0)
5	GE-162	Calculus and Analytical Geometry	Quantitative Reasoning – II		3 (3,0)
6	GE-163	Islamic Studies			2 (2,0)
7	GE-168	Ideology and Constitution of Pakistan			2 (2,0)
8	GE-362	Entrepreneurship			2 (2,0)

Course Title	Applications of Information & Communication Technologies		
Course Code	GE-160		
Credit Hours	3 (2,1)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow Up	None		
Course Introduction	The course is designed to provide students with an exploration of the practical applications of Information and Communication Technologies (ICT) and software tools in various domains. Students will gain hands-on experience with a range of software applications, learning how to leverage ICT to solve daily life problems, enhance productivity and innovate in different fields. Through individual and interactive exercises and discussions, students will develop proficiency in utilizing various software related to ICT.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Explain the fundamental concepts, components, and scope of ICT.	C2 (Explain)	1,2
	CLO2: Identify uses of various ICT platforms and tools for different purposes.	C4 (Identify)	1,2,3
	CLO3: Apply ICT platform and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.	C3 (Apply)	3,4,5
	CLO4: Understand ethical and legal considerations in use of ICT platforms and tools.	C2 (Understand)	1,2,3
Course Description	<p>Introduction to ICT Components of ICT (basics of hardware, software, ICT platforms, networks, local and cloud data storage, etc.), Scope of ICT (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.), Emerging technologies and future trends.</p> <p>Basic ICT Productivity Tools: Effective use of popular search engines to explore WWW, Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.) Microsoft Office Suites (Word, Excel, PowerPoint), Google Workspace (Google Docs, Sheets, Slides), Google Drive, Dropbox (cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft integration), Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas), Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.), social media applications (LinkedIn, Facebook, Instagram, etc.)</p> <p>ICT in Education: Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.), Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.), Interactive multimedia and virtual classrooms</p> <p>ICT in Health and Well-being: Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkeeper, etc.), Telemedicine and online health consultations (OLADOC, Sehat Kahani, Mahram, etc.)</p>		

	<p>ICT in Personal Finance and Shopping: Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, ILink and MNET, Keenu Wallet, etc.), E-commerce platforms.</p> <p>Digital Citizenship and Online Etiquette: Intellectual property and copyright issues, Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources, Content accuracy and integrity (ensuring that the content share through ICT platforms is free from misinformation, fake news, and manipulation).</p>
<p>Practical Requirements</p>	<ol style="list-style-type: none"> 1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software, (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools. Students may be assigned practical tasks that require them to create documents, presentations, and spreadsheets etc. 2. Assigning of tasks that involve creating, managing, and organizing files and folders on both local and cloud storage systems. Students will practice file naming conventions, creating directories, and using cloud storage solutions (e.g., Google Drive, OneDrive). 3. The use of online learning management systems (LMS) where students can access course materials, submit assignments, participate in discussion forums, and take quizzes or tests. This will provide students with the practical experience with online platforms commonly used in education and the workplace.
<p>Suggested Instructional/ Reading Material</p>	<ol style="list-style-type: none"> 1. “Discovering Computers” by Vermaat, Shaffer, and Freund. 2. Deborah Morley and Charles S. Parker, Understanding Computers: Today and Tomorrow, 16th edition, Cengage Learning, 2016, ISBN-13: 978-1337251853 3. “Computing Essentials” by Morley and Parker. 4. “GO! With Microsoft Office” Series by Gaskin, Vargas, and McLellan. 5. “Exploring Microsoft Office” Series by Grauer and Poatsy. 6. “Technology in Action” by Evans, Martin and Poatsy. 7. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017. 8. Joan Lambert, Curtis Frye, Microsoft Office 2019 Step by Step, First Edition. ISBN: 978-1-50-930597-1.

Title	Functional English		
Code	GE-190		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	GE-191 Expository Writing		
Course Introduction	<p>This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and analytical skills in listening and reading. Moreover, the course encompasses a range of practical communication aspects including professional writing, public speaking, and everyday conversation, ensuring that students are equipped for both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact in their functional interactions.</p>		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure.	C4 (Apply)	1,6,7,10
	CL2: Comprehend a variety of literary / non-literary written and spoken texts in English.	C2 (Understand)	1,6,7,10
	CLO3: Effectively express information, ideas and opinions in written and spoken English.	C2 (Explain)	1,6,7,10
	CLO4: Recognize inter-cultural variations in the use of English language and to effectively adapt their communication style and content based on diverse cultural and social contexts.	C4 (Identify)	1,6,7,10
Course Description	<p>Foundations of Functional English: Vocabulary building (contextual usage, synonyms, antonyms and idiomatic expressions), Communicative grammar (subject-verb-agreement, verb tenses, fragments, run-ons, modifiers, articles, word classes, etc.), Word formation (affixation, compounding, clipping, back formation, etc.), Sentence structure (simple, compound, complex and compound-complex), Sound production and pronunciation. Comprehension and Analysis: Understanding purpose, audience and context, Contextual interpretation (tones, biases, stereotypes, assumptions, inferences, etc.), Reading strategies (skimming, scanning, SQ4R, critical reading, etc.), Active listening (overcoming listening barriers, focused listening, etc.). Effective Communication: Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.), Structuring documents (introduction, body, conclusion and formatting), Inclusivity in communication (gender-neutral language, stereotypes, cross-cultural communication, etc.), Public speaking (overcoming stage fright, voice modulation and body language), Presentation skills (organization content, visual aids and engaging the audience), Informal communication (small talk, networking and conversational skills), Professional writing (business e-mails, memos, reports, formal letters, etc.)</p>		

<p>Practical Requirements</p>	<p>As part of the overall learning requirements, students will also be exposed to relevant simulations, role-plays and real-life scenarios and will be required to apply skills acquired throughout the course in the form of a final project.</p>
<p>Suggested Instructional / Reading Material</p>	<ol style="list-style-type: none"> 1. “Understanding and Using English Grammar” by Betty Schramper Azar. 2. “English Grammar in Use” by Raymond Murphy. 3. “The Blue Book of Grammar and Punctuation” by Jane Straus. 4. “English for Specific Purposes: A Learning-Centered Approach” by Tom Hutchinson and Alan Waters. 5. “Cambridge English for Job-hunting” by Colm Downes. 6. “Practical English Usage” by Michael Swan. 7. “Reading Literature and Writing Argument” by Missy James and Alan P. Merickel. 8. “Improving Reading: Strategies, Resources, and Common Core Connections” by Jerry Johns and Susan Lenski. 9. “Comprehension: A Paradigm for Cognition” by Walter Kintsch. 1. “Communication Skills for Business Professionals” by J.P. Verma and Meenakshi Raman.

Title	Expository Writing		
Code	GE-191		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	GE-261: Technical and Business Writing		
Course Introduction	Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation of the pre-requisite course, Functional English, this course will enhance students' abilities of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the essentials of the writing process integrating pre-writing, drafting, editing and proof reading to produce well-structured essays.	C2 (Understand)	1,6,7,10
	CLO2: Demonstrate mastery of diverse expository types to address different purposes and audiences.	C3 (Apply)	1,6,7,10
	CLO3: Uphold ethical practices to maintain originality in expository writing.	C3 (Demonstrate)	1,6,7,9

<p>Course Description</p>	<p>Introduction to Expository Writing: Understanding expository writing (definition, types, purpose and applications), Characteristics of effective expository writing (clarity, coherence and organization), Introduction to paragraph writing. The Writing Process: Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.), Drafting (three stage process of drafting techniques), Revising and editing (ensuring correct grammar, clarity, coherence, conciseness etc.), Proof reading (fine-tuning of the draft), Peer review and feedback (providing and receiving critique). Essay Organization and Structure: Introduction and hook (engaging readers and introducing the topic), Thesis statement (crafting a clear and focused central idea), Body Paragraphs (topic sentences, supporting evidence and transitional devices), Conclusion (types of concluding paragraphs and leaving an impact), Ensuring cohesion and coherence (creating seamless connections between paragraphs). Different Types of Expository Writing: Description, Illustration, Classification, Cause and effect (exploring causal relationships and outcomes), Process analysis (explaining step-by-step procedures), Comparative analysis (analyzing similarities and differences). Writing for Specific Purposes and Audiences: Different types of purposes (to inform, to analyze, to persuade, to entertain etc.), Writing for academic audiences (formality, objectivity, and academic conventions), Writing for public audiences (engaging, informative and persuasive language), Different tones and styles for specific purposes and audiences. Ethical Considerations: Ensuring original writing (finding credible sources, evaluating information etc.), Proper citation and referencing (APA, MLA, or other citation styles), Integrating quotes and evidences (quoting, paraphrasing, and summarizing), Avoiding plagiarism (ethical considerations and best practices)</p>
<p>Practical Requirements</p>	<p>As part of the overall learning requirements, students will be required to build a writing portfolio having a variety of expository texts and present the same at the end of the course showcasing proficiency in expository writing.</p>
<p>Suggested Instructional / Reading Material</p>	<ol style="list-style-type: none"> 1. "The St. Martin's Guide to Writing" by Rise B. Axelrod and Charles R. Cooper. 2. "They Say / I Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein. 3. "Writing Analytically" by David Rosenwasser and Jill Stephen. 4. "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup. 5. "The Elements of Style" by William Strunk Jr. and E.B. White. 6. "Good Reasons with Contemporary Arguments" by Lester Faigley and Jack Selzer. 7. "Writing to Learn; How to Write – and Think – Clearly About Any Subject at All" by William Zinsser. 8. "The Norton Field Guide to Writing" by Richard Bullock, Maureen Daly Goggin, and Francine Weinberg. 9. "The Art of Styling Sentences" by Ann Longknife and K.D. Sullivan. 1. "Writing Today" by Richard Johnson-Sheehan and Charles Paine.

Course Title	Discrete Structures		
Course Code	GE-167		
Credit Hours	3 (3,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs and Trees etc.	C2 (Understand)	1,3
	CLO2: 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)	1,3
	CLO3: Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.	C3 (Apply)	1,2,3,4
	CLO4: 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)	1,2,3,4
Course Description	<p>Mathematical Reasoning: Propositional and predicate logic. Propositional Logic: Logical operators, translations between symbolic expressions and formal English expression, logical equivalences. Predicate Logic: Quantifiers, Nested quantification, equivalences, translations between symbolic forms and formal English. Rules of Inference: Proof methods and strategies, Direct proof, Proof by contraposition, proof by induction, proof by implication, Existence proof, Uniqueness proofs, trivial proofs, vacuous proofs. Sets: Notations, set operations, Venn diagrams, countable and uncountable sets, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings. Functions: Injective, surjective, bijective, special types of functions, function composition, inverse functions, recursive functions, compositions, number theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations. Integers and Divisibility: Division theorem, modular arithmetic, LCM, GCD, Euclidean and Extended Euclidean method, finding solutions to congruence. Primes: Fundamental theorem of arithmetic, characterizations of primes, Mersenne primes. Induction: Weak induction, strong induction. Recursion and Recurrences: Formulation of recurrences, closed formulas, Counting: product rule, sum rule, principle of inclusion-exclusion, combinations and permutations, binomial coefficients, Pascal's identity and Pascal's triangle, binomial theorem, pigeonhole principle. Relations: Reflexive, symmetric, transitive, antisymmetric, equivalence relations and equivalence classes, partial orders. Graph Theory: Terminologies, elements of graph theory, planar graphs, graph coloring, Euler graph, Hamiltonian path, rooted trees, traversals, handshaking lemma and corollary, special families of graphs, isomorphism, planarity, Eulerian and Hamiltonian graphs, trees.</p>		
Text Book(s)	1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, 7 th Edition, McGraw Higher-Ed, 2011, ISBN: 0073383090.		
Reference Material	1. Susanna S. Epp, Discrete Mathematics with Applications, 4th Edition. 2. Richard Johnsonbaugh, Discrete Mathematics, 7th Edition.		

	<ol style="list-style-type: none">3. Kolman, Busby & Ross, Discrete Mathematical Structures, 4th Edition.4. Ralph P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition.5. Winifred Grassman, Logic and Discrete Mathematics: A Computer Science Perspective, 1st Edition.
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Course Title	Calculus and Analytical Geometry		
Course Code	GE-162		
Credit Hours	3 (3,0)		
Category	Mathematics & Supporting		
Prerequisite	None		
Co-Requisite	None		
Follow Up	MS-253: Multivariable Calculus		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concepts and applications of calculus and analytical geometry.	C1 (Know)	1
	CLO2: Describe functions, limit, continuity chain rule and related techniques.	C2 (Describe)	1
	CLO3: Identify and solve problems related to differentiation and integration.	C3 (Apply)	1,3
	CLO4: Know the concepts analytical geometry.	C1 (Know)	1
Course Description	Motivation and applications of the course. Introduction to limits: Limits and Continuity, Techniques of finding limits, Indeterminate forms of limits, Introduction to functions: 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 Normal 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 R ³ , Equations for planes.		
Text Book(s)	1. Howard Anton, Irl C. Bivens and Stephen Davis, Calculus, 11 th Edition, Wiley, 2016, ISBN-10: 1119228581, ISBN-13: 978-1119228585.		
Reference Material	1. Thomas and Finney, Calculus and Analytic Geometry, 9 th Edition, ISBN-13: 978-0201531749, ISBN-10: 0201531747.		

Title	Islamic Studies		
Code	GE-163		
Credit Hours	2 (2,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to provide students with a comprehensive overview of the fundamental aspects of Islam, its benefits, practices, history and influence on society. It will further familiarize the students with a solid foundation in understanding Islam from an academic and cultural perspective. Through this course, students will have an enhanced understanding of Islam’s multifaceted dimensions which will enable them to navigate complex discussions about Islam’s historical and contemporary role, fostering empathy, respect, and informed dialogue.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Demonstrate enhanced knowledge of Islamic foundational beliefs, practices, historical development, fundamental sources of Shiarah, spiritual values and ethical principles.	C1 (Knowledge)	1,7,9,10
	CLO2: Describe basic sources of Islamic law and their application in daily life.	C2 (Understand)	1,7,9,10
	CLO3: Identify and discuss contemporary issues being faced by the Muslim world including social challenges, gender roles and interfaith interactions.	C4 (Analyze)	1,6,7,9,10

<p>Course Description</p>	<p style="text-align: right;">1 قرآن مجید</p> <p>1- قرآن مجید: معنی و مفہوم، اہمیت و قدیمیت، آداب و شرائط تلاوت</p> <p>2- وحی کا معنی و مفہوم، وحی کی اقسام</p> <p>3- قرآن مجید کی جمع و تدوین، حفاظت قرآن</p> <p>2- حبیبہ نبوی صلی اللہ علیہ وآلہ وسلم</p> <p>1- حبیبہ کا معنی و مفہوم، اقسام حبیبہ (قولی۔ فعلی۔ تقریری)</p> <p>2- ضرورت و اہمیت حبیبہ</p> <p>3- مطالعہ حبیبہ (ترجمہ 6 + تشریح 4 = 10 نمبر)</p> <p>1. عَنْ عَبْدِ بْنِ نُظَيْمٍ لَمْبَرِيِّ - اللَّهُ عَزَّ وَجَلَّ قَالَ سَمِعْتُ رَسُولَ اللَّهِ ﷺ يَقُولُ: يَهَيِّأُ اللَّهُ لِيَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ، فَيَهْجَرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ، وَفِي ذَلِكَ يَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ، وَفِي ذَلِكَ يَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ (صحيح بخاری: 1)</p> <p>2. عَنْ عَمْرِو بْنِ عَبْدِ الرَّحْمَنِ - اللَّهُ عَزَّ وَجَلَّ قَالَ سَمِعْتُ رَسُولَ اللَّهِ ﷺ يَقُولُ: يَهَيِّأُ اللَّهُ لِيَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ، وَفِي ذَلِكَ يَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ (صحيح بخاری: 502)</p> <p>3. عَنْ مَالِكِ بْنِ سُلَيْمٍ - اللَّهُ عَزَّ وَجَلَّ قَالَ سَمِعْتُ رَسُولَ اللَّهِ ﷺ يَقُولُ: يَهَيِّأُ اللَّهُ لِيَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ، وَفِي ذَلِكَ يَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ (صحيح مسلم: 113)</p> <p>4. عَنْ عَبْدِ اللَّهِ بْنِ حَمْرٍ - اللَّهُ عَزَّ وَجَلَّ قَالَ سَمِعْتُ رَسُولَ اللَّهِ ﷺ يَقُولُ: يَهَيِّأُ اللَّهُ لِيَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ، وَفِي ذَلِكَ يَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ (صحيح مسلم: 113)</p> <p>5. عَنْ عَبْدِ اللَّهِ بْنِ حَمْرٍ - اللَّهُ عَزَّ وَجَلَّ قَالَ سَمِعْتُ رَسُولَ اللَّهِ ﷺ يَقُولُ: يَهَيِّأُ اللَّهُ لِيَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ، وَفِي ذَلِكَ يَوْمِ يَمُوتُ أُمَّتِي مِنْ كُنَى كُنَى فَيَجْرُتُهُ إِلَى النَّيُورِ سُبُورِيهِ (صحيح مسلم: 113)</p>
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	<p>5- خلافتِ راشدہ</p> <p>1- خلفائے راشدین (حضرت ابو بکر صدیقؓ، حضرت عمر فاروقؓ، حضرت عثمان غنیؓ، حضرت علی المرتضیٰؓ) کے شخص احوال</p> <p>2- عہدِ خلافتِ راشدہ کے اہم خصائص</p> <p>6- فقہِ اسلامی</p> <p>1- فقہِ اسلامی کے حذو (آن، سنی، اجماع، قیاس، اجتہاد)</p> <p>2- ائمہ اربعہ کا تعارف (امام ابو حنیفہؒ، امام مالکؒ، امام شافعیؒ، امام احمد بن حنبلؒ)</p> <p>7- اسلام کی سماجی تعلیمات</p> <p>1- خاندان کا تعارف و اہمیت</p> <p>2- اسلام میں عورت کا مقام</p> <p>3- اسلام کا تصور حقوق العباد</p> <p>4- اسلام کی اخلاقی تعلیمات</p> <p>8- اسلام اور جدید دنیا</p> <p>1- عالمگیری - اور اس کے مسائل و تقاضے</p> <p>2- اسلاموفوبیا</p> <p>3- تکثیری معاشرہ Pluralistic Society اور اسلامی تعلیمات</p>
<p>Suggested Instructional/ Reading Material</p>	<p>1. "Introduction to Islam" by Dr. Muhammad Hamidullah</p> <p>2. "Principles of Islamic Jurisprudence" by Dr. Ahmad Hasan</p> <p>3. "Muslim Jurisprudence and the Quranic Law of Crimes" by Mir Waliullah</p> <p>4. "Sirat-un-Nabi" by Shibli Nomani and Sulaiman Nadvi</p>

Title	Ideology and Constitution of Pakistan		
Code	GE-168		
Credit Hours	2 (2,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistan citizens to enable them function in a socially responsible manner.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding father of Pakistan.	C3 (Demonstrate)	1,10
	CLO2: Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.	C3 (Demonstrate)	1,10
	CLO3: Explain about the guiding principles on rights and responsibilities of Pakistan citizens as enshrined in the Constitution of Pakistan 1973.	C2 (Understand)	1,3,10
Course Description	<p>1. Introduction to the Ideology of Pakistan: Definition and significance of ideology, Historical context of the creation of Pakistan (with emphasis on socio-political religious and cultural dynamics of British India between 1857 till 1947), Contributions of founding fathers of Pakistan of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc. Contributions of women and students in the freedom movement for separate homeland for Muslims of British India. Two-Nation Theory: Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal’s Presidential Address 1930, Congress Ministries 1937 Lahore Resolution 1940).</p> <p>Introduction to the Constitution of Pakistan: Definition and importance of a constitution, Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).</p> <p>Constitution and State Structure: Structure of Government (executive, legislature, and judiciary), Distribution of powers between federal and provincial governments, 18th Amendment and its impact on federalism. Fundamental Right, Principles of Policy and Responsibilities: Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28), Overview of Principles of Policy (Articles 29-40), Responsibilities of the Pakistan citizens (Article 5). Constitutional Amendments: Procedures for amending the Constitution, Notable Constitutional amendments and their implications</p>		

Suggested Instructional / Reading Material	<ol style="list-style-type: none">1. “The Idea of Pakistan” by Stephen P. Cohen.2. “Ideology of Pakistan” by Javed Iqbal.3. “The Struggle for Pakistan” by I.H. Qureshi.4. “Pakistan the Formative Phase” by Khalid Bin Sayeed.5. “Pakistan: Political Roots and Development” by Safdar Mahmood.6. “Ideology of Pakistan” by Sharif-ul-Mujahid.7. “The Struggle for Pakistan: A Muslim Homeland and Global Politics” by Ayesha Jala.8. “Jinnah, Pakistan and Islamic Identity: The Search for Saladin” by Akbar S. Ahmed.9. “The Making of Pakistan: A Study in Nationalism” by K.K. Aziz.10. “Pakistan: A New History” by Lan Talbot.11. “Pakistan in the Twentieth Century: A Political History” by Lawrence Ziring.12. “The Constitution of Pakistan 1973”. Original.13. “Constitutional and Political Development of Pakistan” by Hamid Khan.14. “The Parliament of Pakistan” by Mahboob Hussain.15. “Constitutional Development in Pakistan” by G.W. Choudhury.16. “Constitution-Making in Pakistan: The Dynamics of Political Order” by G.W. Choudhury.
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Course Title	Entrepreneurship		
Code	GE-362		
Credit Hours	2 (2,0)		
Category	General Education		
Prerequisite	None		
Co-Requisite	None		
Follow-up	None		
Course Introduction	This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge; skills and abilities, enabling them seize the identified opportunities for initiating of business (including requirements for registration and incorporation with regulators such as SECP and others), market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation, overall, the course is geared towards personal growth and professional development for pursuing innovative ideas, availing opportunities and initiating start-ups.		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Knowledge of fundamental entrepreneurial concepts, skills and process	C1 (Knowledge)	1
	CLO2: Understanding of different personal, social and financial aspects associated with entrepreneurial activities	C2 (Understand)	1,3,10
	CLO3: Basic understanding of regulatory requirements to set up an enterprise in Pakistan, with special emphasis on exports	C2 (Understand)	1,3,10
	CLO4: Ability to apply knowledge, skills and abilities acquired in the course to develop a feasible business plan for implementation	C5 (Create)	4,5,6,10
Course Description	<p>Introduction: Definition and concept of entrepreneurship, Why to become an entrepreneur? Entrepreneurial process, Role of entrepreneurship in economic development. Entrepreneurial Skills: Characteristics and qualities of successful entrepreneurs (including stories of successes and failures), Areas of essential entrepreneurial skills and abilities such as creative and critical thinking innovation and risk taking. Opportunity Recognition and Idea Generation: Opportunity identification, evaluation and exploitation, Innovative ideas generation techniques for entrepreneurial ventures. Marketing and sales: Four P's of Marketing, Developing a marketing strategy, Branding. Financial Literacy: Basic concepts of income, savings and investments, Basic concepts of assets, liabilities and equity, Basic concepts of revenue and expenses, Overview of cash-flows, Overview of banking products including Islamic modes of financing, Sources of funding for startups (angel financing, debt financing, equity financing etc.) Team Building for Startups: Characteristics and features of effective teams, Team building and effective leadership for startups. Regulatory Requirements to Establish Enterprises in Pakistan: Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.), Intellectual property rights and protection, Regulatory requirements to register an enterprise in Pakistan, with special emphasis on exports firms, Taxation and financial reporting obligation.</p>		
Practical Requirements	As part of the overall learning requirements, students shall be tasked with creating and presenting a comprehensive business plan at the end of the course for a hypothetical or real		

	<p>business idea. This practical exercise shall allow them to apply the knowledge, skills and abilities acquired in the course to develop a feasible business plan and where possible explore the possibility of implementing the plan with support and assistance from established business-persons and entrepreneurs.</p>
<p>Suggested Instructional/ Reading Material</p>	<ol style="list-style-type: none"> 1. B. R. Barringer, and R. D. Ireland, Entrepreneurship: Successfully Launching New Ventures, 6th Edition, Prentice Hall, 2019, ISBN: 978-0134729534. 2. “Entrepreneurship: Theory, Process, and Practice” by Donald F. Kuratko. 3. “New Venture Creation: Entrepreneurship for the 21st Century” by Jeffrey A. Timmons, Stephen Spinelli Jr., and Rob Adams. 4. “Entrepreneurship: A Real-World Approach” by Rhonda Abrans. 5. “The Lean Startup: How Today’s Entrepreneurs use Continuous Innovation to Create Radically Successful Businesses” by Eric Ries. 6. “Effectual Entrepreneurship” by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valeric Ohlsson.

Mathematics Deficiency (6 non-credit), 2 Courses

Course Title	Math Deficiency - I		
Course Code	MD-001		
Credit Hours	3*		
Category	Mathematics & Supporting (Deficiency Course)		
Prerequisite	None		
Co-Requisite	None		
Follow Up	Math Deficiency-II		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concepts and applications of sets, relations, functions, systems of equations, trigonometric functions and matrix algebra	C1 (Know)	1
	CLO2: Describe system of linear equations, matrix algebra, trigonometry and related techniques.	C2 (Describe)	1
	CLO3: Solve problems related to system of linear equations, matrix algebra, trigonometry.	C3 (Apply)	1,3
	CLO4: Know the general form of Conic, polar coordinate and parametric equations.	C1 (Know)	1
Course Description	<p>Sets: Definition, various types of set representation and operations. Relation and Function: Graphical transformation of one and two dimensional functions, Properties of functions, composition and inverses of functions, domain and range of the functions, Maximum and minimum values of functions, increasing and decreasing functions, zeros and intercept of functions, piecewise functions, continuity and Discontinuity of functions, Polynomials and rational functions, Polynomial long division and Synthetic division, Solution of rational functions, Absolute valued function, properties of absolute valued functions, Asymptotes (Horizontal, vertical and oblique), Exponential functions and their properties, Logs functions and their properties. Systems of Equations: Systems of Two Equations and Two Unknowns, Systems of Three Equations and Three Unknowns. Matrix Algebra: Addition, subtraction and multiplication. Row Operations and Row Echelon Forms, Augmented Matrices, Determinant of Matrices (2 x 2 and higher order matrices), Cramer’s Rule, Inverse Matrices. Series and Sequences. Trigonometry: Angles in Radians and Degrees, Right Triangle Trigonometry, Law of Cosines & Sines, Area of Triangle, Graphs of Other Trigonometric Functions , Graphs of Inverse Trigonometric Functions, Basic Trigonometric Identities (Pythagorean, Sum and Difference, Double, Half, and Power Reducing), Trigonometric Equations. General Form of a Conic: Parabolas, Circles, Ellipses, Hyperbolas, Degenerate Conics. Polar and Parametric Equations: Polar and Rectangular Coordinates.</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan. 2. Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore, Pakistan 		
Reference Material	<ol style="list-style-type: none"> 1. Gilbert, S. S., B. C. Andy and B. Andrew, B. 2005. Linear Algebra and Its Applications. 4th Ed. Thomson Brooks/Cole, Belmont, CA, USA. 		

Course Title	Math Deficiency - II		
Course Code	MD-002		
Credit Hours	3*		
Category	Mathematics & Supporting (Deficiency Course)		
Prerequisite	None		
Co-Requisite	None		
Follow Up	Calculus and analytic Geometry		
Course Learning Outcomes (CLOs)	At the end of the course, the students will be able to:	BT	PLO
	CLO1: Know the concepts and applications of complex number, sequences, series, permutations and combinations, integration and differentiation	C1 (Know)	1
	CLO2: Describe functions, limit, continuity chain rule and related techniques.	C2 (Describe)	1
	CLO3: Identify and solve problems related to differentiation and integration.	C3 (Apply)	1,3
Course Description	<p>Complex Numbers: Complex Numbers, Arithmetic with Complex Numbers (Add, subtract, multiply and divide complex numbers), Trigonometric Polar Form of Complex Numbers, De Moivre's Theorem and nth Roots, Recursion. Sequences and Series: Sigma Notation, Arithmetic Series, Geometric Series (Sum infinite and finite geometric series and categorize geometric series). Counting with Permutations and Combinations. Basic Probability. Binomial Theorem. Limit: Notation, Graphs to Find Limits, Tables to Find Limits, Substitution to Find Limits, Rationalization to Find Limits, One Sided Limits and Continuity. Rate of Change: Instantaneous Rate of Change, Tangent Lines and Rates of Change. Derivatives: The Derivative Function, Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions, The Chain Rule, Derivatives of Logarithmic Functions, Derivatives of Exponential and Inverse Trigonometric Functions. Increase, Decrease, and Concavity, Relative Extrema, Absolute Maxima and Minima. Integrals: An Overview of the Area Problem, Area Under a Curve, The Indefinite Integral, Integration by Substitution, The Definition of Area as a Limit; Sigma Notation, The Definite Integral.</p>		
Text Book(s)	<ol style="list-style-type: none"> 1. Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan. 2. Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore, Pakistan 		
Reference Material	<ol style="list-style-type: none"> 1. Mark J. Christensen, Computing for Calculus, 1st Edition, Academic Press, (1st January 1981), 240 pages, ISBN: 9781483271088. 2. Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9th Ed. Cengage Learning, Boston, MA, USA. 3. Howard, Anton, Irl Bivens, Stephen Davis, Calculus, 11th Ed, 2011, John Wiley & Sons, Inc. (1318 Pages) 		