

**REVISED CURRICULUM
OF
B.Sc. SOFTWARE ENGINEERING
(Fall 2021 SESSION ONWARDS)**

**Department of Software Engineering
Army Public College of Management & Sciences, Rawalpindi**

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1. APCOMS Mission

To fulfil the needs of the country by producing responsible graduates equipped with sound knowledge and skills along with highest moral values through conducive learning environment.

2. APCOMS Vision

To be a quality conscious institution of international standing imparting knowledge in the field of engineering and management sciences in a caring environment for the socio-economic development of the country.

3. Software Engineering Department Vision

Aims to be recognized as software engineering professional and expert through learning state of the art(s) knowledge and skills.

4. Software Engineering Department Mission

The Software engineering department (SED) has a well-defined and published mission that is stated below:

“To provide high-quality education to our students at undergraduate level so they can serve for the socio-economic growth of the country and humanity.”

5. Program Education Objectives (PEOs) of B.Sc. Software Engineering Program

The BSc. Software Engineering programs have well-defined and published program educational objectives (PEOs) and are given below:-

- PEO-1: The graduates will be skilled engineers in industry, academia or manage self-initiated business activity.
- PEO-2: The graduates will be able to serve and lead for socio-economic development of the country.

- PEO-3: The graduates will demonstrate lifelong learning attitude and soft skills with highest moral values.

Program Learning Outcome(s) (PLOs)	Program Education Outcome(s) (PEOs)		
	PEO-1	PEO-2	PEO-3
Engineering knowledge	√		
Problem Analysis	√		
Design / Development of solutions	√		
Investigation	√		
Modern Tool Usage	√		
The Engineer & Society		√	
Environment & Sustainability		√	
Ethics		√	
Individual & Teamwork		√	
Communication			√
Project Management			√
Lifelong Learning			√

6. PEO's Mapping with department Vision

Software Engineering Department Vision	Program Education Outcome (PEO)
State of the art knowledge and skills	PEO 1, PEO 3
Socio-economic growth	PEO 2

7. PEO's Mapping with department Mission

Software Engineering Department Mission	Program Education Outcome (PEO)
Technical skills	PEO 1
Socio-economic growth	PEO 2
Leadership, Life-long Learner	PEO 3

8. Courses Detail

8.1 Introduction to Computing

Course Contents: Introduction to computer systems (main categories, its hardware and software and their interaction with each other), Number Systems, Binary number system, Boolean logic, History of computer systems, basic machine organization, Von Neumann Architecture,

Algorithm definition, design, and implementation, flow charts, Programming paradigms and languages, Overview of Software Engineering and Information Technology, Operating system, Compiler, Computer networks and internet, Computer graphics, Artificial Intelligence.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe the main components of computer systems, their interaction with each other and internal working.	C - 2	1
Analyse algorithms using pseudo code or flow chart to demonstrate problem-solving skills.	C - 4	2

Week-wise Course Plan	
Week	Topics
1	Introduction to Computer Systems: What is computer, Digital and Analog Computers, Computers for individual users and for organizations
2	Looking inside the computer systems: Parts of Computer system, Information processing cycle, Essential computer hardware, Processing devices, Memory devices, Input and output devices, Overview of computer graphics, Storage devices, Computer software, Computer data, Computer users
3	Interacting with your Computer: Input devices, Keyboard, Mouse, Variants of the mouse, Devices for the hand, Optical input devices, Audio/visual input devices
4	How do computers represent data: Number systems, Binary number system, Decimal to binary conversion, Example, Binary to decimal conversion, Example
5	Binary Arithmetic: Binary addition, Binary multiplication, Binary subtraction and their Examples
6	Binary Arithmetic: Binary division, Signed numbers, 1's complement, 2's complement, Subtraction with signed numbers, Octal number system, Hexadecimal number systems
7	Boolean algebra: AND, OR, NOT
8	Processing in a computer: VON Neumann architecture, Machine cycles
9	Processing in a computer: Machine cycles Memory
10	Factors affecting processing speed: Registers, Memory and Computing power, The computer's internal clock, The bus, The system bus, The data bus, The address bus, Cache memory
11	Algorithms, flowchart, pseudo code

12	basic programming techniques
13	Operating system basics
14	Networking basics LAN, WAN
15	Programming Language introduction
16	How to write simple program in C language

8.2 Discrete Structure

Course Contents: Introduction to propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, Euler graph, Hamiltonian path, rooted trees, traversals.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Identify the knowledge of elementary discrete probability concepts and solve problems which involve discrete data structures such as sets, relations, functions etc.	C - 1	1
To Discuss the complex problems and find their solution using mathematical developed skills	C - 2	2
Apply the mathematical concepts learned to various areas of computer science	C - 3	5

Week-wise Course Plan	
Week	Topics
1	Introduction/importance of Discrete Mathematics. Logic, Simple Statements, Compound Statements, Truth Table Basic Logic Connectives, Tautologies, Contradiction
2	Translating word statement to symbolic form and vice versa, Negation of compound statements, conditional statements, Bi-conditional statements, Logical equivalence, DE Morgan's law
3	Introduction to Predicates and quantifiers, natural deduction, logical equivalence through quantifiers
4	Rules of inference & proofs (valid and invalid arguments)
5	Set theory, types of set, Notation of set, empty and universal set
6	Set operations, Venn diagram, Truth table representation of set operations
7	Subset, Superset, Set equality, Algebra of set operations, proving set equality using venn diagram, truth table

8	Relations (order pair, Cartesian product, binary relation, universal/ empty relation), Arrow diagram and matrix, matrix representation of a relation
9	Introduction to Functions, Machines and functions, Types of functions, inverse function, composition of functions
10	Principle of mathematical induction, Relation and their properties-I & II
11	Introduction to sequence and series with their application & examples
12	Introduction to trees, binary tree, binary search tree, tree traversal
13	Cardinality, combinatorics, sampling, permutation with examples, combination and selection, counting and probability basics and examples
14	Prims Algorithm, Kruskal Algorithm, Spanning tree, minimum spanning tree
15	Graphs: terminology, operations and representation, Types of graphs
16	Paths and circuit

8.3 Applied Physics

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

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
State the fundamental of physics to understand Electrostatics, Electronics and Magneto statics	C - 1	1
Discuss the problem for electromagnetic field in the region surrounded by different static and moving charge configuration.	C - 2	1

Week-wise Course Plan

Week	Topics
1	Introduction to Electric Charge, Conductors, Insulators and Induced Charges
2	Coulomb's Law, Electric Field and Electric Forces, Electric-Field Calculations
3	Electric-Field Lines, Electric Dipole
4	Charge and Electric Flux, Calculating Electric Flux
5	Gauss's Law, Applications of Gauss's Law, Charges on Conductors
6	Introduction to Electric Potential Energy, Electric Potential, Calculating Electric Potential
7	Equi-potential Surfaces, Potential Gradient
8	Capacitors and Capacitance, Capacitors in Series and Parallel
9	Energy Storage in Capacitors and Electric-Field Energy, Dielectrics
10	Molecular Model of Induced Charge, Gauss's Law in Dielectrics
11	Current, Resistance and Electromotive force
12	Electromotive Force and Circuits, Energy and Power in Electric Circuits, Theory of Metallic Conduction
13	Magnetism, Magnetic Field, Magnetic Field Lines and Magnetic Flux
14	Motion of Charged Particles in a Magnetic Field, Application of Motion of Charged Particles
15	Magnetic Force on a Current Carrying Conductor, Force and Torque on a Current Loop, Direct Current Motor
16	The Hall Effect

8.4 Functional English

Course Contents: Making introductions , Making effective self and peer introductions , Taking useful introductory notes, Expressing requests and enquiries Forming appropriate requests and enquiries , Responding to enquiries, Requests versus commands, Practicing practical classroom English , Using different classroom , language routines and functions for effective classroom management, Developing effective classroom language by following provided examples , Demonstrating and practicing practical classroom language routines, Greetings, Gratitude, Invitations, Writing styles , Changing narration: Converting a dialogue into a report , Converting a story into a news report , Converting a graph or picture into a short report or story, Writing mechanics, Punctuation and structure , Sentences, sentence fragments, and run-on sentences, Subject-predicate and pronoun-reference agreement.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
State knowledge and improve the skills of communication in their respective domain.	C - 1	09
Apply the practice for improving the students' vocabulary and grammar errors	C - 3	10

To enable student to contribute towards drafting of text for technical and research documents	A-2	10
Be aware of effective communication with diverse audiences in a variety of ways for different purposes	A-1	12

Week-wise Course Plan	
Week	Topics
1	Punctuation Principles and Spelling Rules.
2	Writing Mechanics and Frequently Misused Words, Phrases, Synonyms, Antonyms, Idioms.
3	Use of Articles Kins of Nouns.
4	General Vocabulary
5	Prepositions
6	Classes of Verbs. Usage of May, Can, Ought, Should, Must, Have To, Need for Obligation, Must, Have, Will and Should
7	The Auxiliaries Dare and Used.
8	The Gerund & The Participles. Commands, Requests, Invitations, Advice, Suggestions
9	The Subjunctive. The Passive Voice
10	Indirect Speech. Conjunctions.
11	Purpose. Clauses: Noun Clauses; Clauses of Reason,
12	Result, Concession, Comparison, Time.
13	Numerals, Dates, Weights and Measures.
14	Phrasal Verbs. Irregular Verbs.
15	Overview of Present, Past, Future and Perfect Tenses.
16	Possessive, Personal, Reflexive, and Relative Pronouns and Clauses.

8.5 Calculus & Analytical Geometry

Course Contents: Complex Numbers, DeMoivre's Theorem and its Applications, Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Limit and Continuity, Differentiation and Functions, Derivative as Slope of Tangent to Curve and Rate of Change, Application to Tangent and Normal, Linearization, Maxima/Minima and Point of Inflexion, Taylor and Maclaurin Expansions and their convergence, Integral as Anti-derivative, Indefinite Integration of Simple Functions, Methods of Integration: Integration by substitution,

by Parts, and by Partial Fractions, Definite Integral as Limit of a Sum, Application to Area, Arc Length, Volume and Surface of Revolution.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
State knowledge related to basic concepts of calculus (limits, functions etc.)	C - 1	1
Apply concepts for analysis and solution engineering related problems	C - 3	2

Week-wise Course Plan	
Week	Topics
1	Complex numbers, Demoivers theorem
2	Application of Demoivers theorem. Functions
3	Graphs of functions, Limits and techniques of finding limits
4	Continuity of functions
5	Techniques of Differentiation
6	Chain Rule, Implicit Differentiation
7	Derivative as Slope of Tangent to a curve and as rate of change
8	Maxima / Minima and point of inflexion
9	Taylor and Maclaurin Expansions and their Convergence
10	Techniques of Integration, Integration by substitution, Integration by Partial Fractions
11	Integration by Parts, Properties of Definite Integrals
12	Definite Integrals and their Reduction Formulas
13	Improper Integrals
14	Definite Integral as limit of a Sum
15	Application to Area under a Curve
16	Application to Arc Length of a Curve

8.6 Introduction to Software Engineering

Course Contents: Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements,

Context models, Interaction models, Structural models, behavioral models, model driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Define the basic concepts of Software Engineering, its generic processes, and activities.	C - 1	1
Apply software engineering concepts to model a medium size software system/given problem.	C - 3	1

Week-wise Course Plan	
Week	Topics
1	Introduction to the course, SE discipline, introductory topics in SE, Introduction to software (the product), generic view of SE Framework.
2	Software engineering ethics, Case studies, Software processes Software process models
3	Process activities, Coping with change, Process activities
4	Agile software development Agile methods Plan-driven and agile development
5	Extreme programming Agile project management Scaling agile methods
6	Requirements engineering Functional and non-functional requirements The software requirements document
7	Requirements specification Requirements engineering processes Requirements elicitation and analysis
8	Requirements validation Requirements management
9	System modeling Context models Interaction models

10	Structural models Behavioral models Model-driven engineering
11	Architectural design decisions Architectural views
12	Introduction to UML, Object-oriented design using the UML
13	Development testing, Test Driven development
14	Evolution Processes
15	Sociotechnical systems Complex systems
16	Systems engineering Dependability and security

8.7 Digital Logic& Design

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

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe different number systems, binary codes, logic gates, Boolean algebra and circuit minimization.	C - 2	1
Analyze small-scale combinational and sequential circuits	C - 4	2
Design combinational and sequential circuits using various minimization techniques	C - 5	3
Apply techniques related to the design and analysis of digital electronic circuits.	C-3	4

Week-wise Course Plan	
Week	Topics
1	Number Systems, Complements, Subtraction with Complements, Signed Numbers
2	Signed Numbers, Arithmetic Operations, Binary Codes
3	BCD Addition, Gray Code, ASCII, Error Detection, Boolean Algebra

4	Boolean Function Implementation, Canonical forms, Canonical Form Conversions Using Algebraic Method
5	Possible Functions, positive and negative logic, Karnaugh Map, Four Variable Karnaugh Map
6	Prime and Essential Implicants, Five Variable Map, Product of Sum Form, Don't `Care Conditions, NAND and NOR gate Implementation
7	Other two level implementation, Other two level implementation Continued and XOR gate propertiesXOR Application
8	Analysis and Design of Combinational Circuit, Binary adders
9	Look Ahead Carry Generator, Binary Subtractors, BCD Adder, Multiplier, Magnitude Comparator and Intro to Decoder
10	Decoder Circuit, Types of Decoder, Larger Decoders, Combinational logic using Decoder, Multiplexer, Demultiplexer, Combinational Circuit Implementation using Multiplexers, Tristate Buffer
11	Multiplexer application, Encoder, Priority Encoder, Sequential Circuits, Latches, Construction of Latches
12	D Latch, Flip Flop Circuit, Other Flip Flops, Analysis of Sequential Circuits
13	Analysis of Sequential Circuits, Design of Sequential Circuits, Design of Sequential Circuits Example
14	Registers, Serial Addition, Ripple Counter, Synchronous Counters, Other Counters
15	Practical Problem Solving
16	Revision

8.8 Programming Fundamental

Course Contents: Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists. Standard template library.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Define the basic concept and knowledge of programming	C - 1	1
Analyze the specialized knowledge of programming and comprehend their structures.	C - 4	4
Apply new movement patterns and suitable techniques to create basic level programs for beginner's	C - 3	3

Week-wise Course Plan

Week	Topics
1	Introduction to computers software and hardware. Problem solving and programming.(high level languages vs. low level languages) Compilers vs. interpreters. Phases of a C++ program.
2	Structure of a C++ program, input and output statements. Algorithms, Pseudo code
3	Flow Charts, Data Types , variables, Operators
4	Selection statements (if and if else statement)
5	else if statement, nested if's , and break statement
6	Switch statement , conditional operator, manipulators
7	Iteration statements : While loop , for loop
8	Do-while loop , nested loops
9	Arrays , declaration , initialization , printing .Basic operations : searching , sorting , insertion , removal
10	2D arrays : declaration, initialization , printing Basic operations : searching , insertion , removal
11	Function : declaration , initialization , parameters , return types , return statement , local vs. Global variables
12	Functions parameters passing techniques: pass by value and pass by reference Passing Arrays to function.
13	Introduction to user defined data type Structures: declaration, initialization. Structure operations: copy, comparison.
14	String handling :Basic operations: string length , sorting , copy , concatenation , comparisons
15	Standard template library
16	Practical problem solving

8.9 Linear Algebra and Differential Equations

Course Contents: Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms. Ordinary Differential Equations of the First Order: Geometrical Considerations, Isoclines, Separable Equations, Equations Reducible to Separable Form, Exact Differential Equations, Integrating Factors, Linear First-Order Differential Equations, Variation of Parameters.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Define the concepts of matrices and matrix algebra, systems of linear equations and their solutions, vector spaces, subspaces, bases, Linear transformations, eigen values, eigen vectors.	C - 1	1

Solve the Solutions of Initial value problems(IVP's) and Higher order differential Equations	C - 3	1
Combine the knowledge of linear systems and ordinary differential equations concepts to model physical systems	C - 5	5

Week-wise Course Plan	
Week	Topics
1	Basic Concepts. Matrix Addition. Scalar Multiplication
2	Matrix Multiplication
3	Linear Systems of Equations. Gauss Elimination
4	Solution of Linear Systems: Existence, Uniqueness, General Form
5	Inverse of a Matrix. Gauss-Jordan Elimination.
6	Vector Spaces, Sub Spaces and Linear Transformations
7	Linear dependence, linear independence, spanning set, basis
8	Eigenvalues and Eigenvectors
9	Introduction to ordinary differential equation
10	Ordinary differential equation types
11	Separable Variables.
12	Homogeneous Equations.
13	Exact Equations and Integrating Factors.
14	Linear Equations.
15	Equations of Bernoulli, Ricatti and Clairaut.
16	Applications of Linear and Non-Linear First Order ODEs.

8.10 Communication Skills

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

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Understanding the basics of effective communication skills.	C - 1	1
Apply the communication abilities for developing better interpersonal skills.	C - 3	10
Express communication as a dynamic interactive process that involves the effective transmission of facts, ideas, thoughts, feelings and values	A - 3	8
Adapt communication skills to use English in professional life	A-4	9
Pay attention to communication errors usually made by the learners of English	A1	12

Week-wise Course Plan	
Week	Topics
1	Communication types: Importance, barriers, principals of communication
2	Ethical and Global Communication, Team Communication
3	Job search communication, Self and Market Analysis+ Advertisements
4	Writing resumes and cover letters
5	Interview types and importance, preparation for an interview
6	Giving Interviews and steps after the interview
7	Meeting types and Importance, planning meeting and writing minutes of meeting, manners and language during the meeting
8	Planning business messages and types of messages
9	Oral communications, verbal and non-verbal communication
10	Conducting meetings
11	Letter formats, mechanics of writing business letters
12	Presentation skills
13	Preparation and the delivery of presentation, after the presentation
14	Presentations
15	Rhetoric, Arts of persuasion
16	Communication and technology

8.11 Software Requirement Engineering

Course Contents: Introduction to Requirements Engineering, Software Requirements, classification of requirements, Requirements process, Levels/layers of requirements, Requirement characteristics, Analyzing quality requirements, Software requirements in the context of systems engineering, Requirement evolution, requirement traceability, requirement

prioritization, trade-off analysis, risk analysis and impact analysis, Requirement management, interaction between requirement and architecture, Requirement elicitation, elicitation sources and techniques, Requirement specification and documentation, specification sources and techniques, Requirements validation and techniques, Management of Requirements, Introduction to Management, Requirements Management Problems , Managing Requirements in an Acquisition Organization, Supplier Organizations, Product Organizations, Requirements engineering for agile methods.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Discuss the Software Requirements Engineering Process and different types of software requirement	C - 2	1
Apply the core principles of Requirement Engineering	C - 3	2
Construct Software Requirement Specification document by analyzing the customer needs	C - 5	4
Use standard communication techniques to elicit requirements	C-3	10

Week-wise Course Plan	
Week	Topics
1	Introduction to Requirement Engineering <ul style="list-style-type: none"> ● RE Definitions ● Role of requirements in Software Engineering ● Sources, levels & Importance of Software Requirements ● Cost of requirement errors ● Importance of RE ● Challenges of Requirement Engineering ● Requirements Engineering Process
2	Requirement Management <ul style="list-style-type: none"> ● Why we need RM ● Benefits of High level Requirements ● Problem/ Solution Domain ● Levels of requirements (Business, user, functional and no functional requirements) FURPS+ Classification of Requirements
3	Team Skills <ul style="list-style-type: none"> ● Six Team Skills ● Required to address requirement challenge ● Characteristics of INDIVIDUAL Requirement Statements (with examples) ● Characteristics of Requirement Specification SET (SRS)

4	<p style="text-align: center;">Analyzing Problem</p> <ul style="list-style-type: none"> ● Five steps in problem analysis ● Gain agreement on problem definition, ● Understand the root causes, identify stakeholders and the users, define solution system boundary, and identify constraints.
5	<p>Understating the User needs</p> <ul style="list-style-type: none"> ● Challenges of requirement elicitation ● Managing complexity ● Attribute of product feature ● Interview
6	<p>Features of product or system</p> <ul style="list-style-type: none"> ● Stakeholders needs, features, attributes of features <p style="text-align: center;">Requirement gathering techniques</p> <ul style="list-style-type: none"> ● requirement workshops ● Brainstorming and idea reduction, ● Story boarding, ● Applying use cases ● Role playing, ● Prototyping
7	<p>Defining the system</p> <ul style="list-style-type: none"> ● Use cases ● Organizing the Requirements
8	<p>Defining the system</p> <ul style="list-style-type: none"> ● Vision document ● Product Management ● Delta vision document
9	<p>Managing scope</p> <ul style="list-style-type: none"> ● Problems of project scope ● Components of project scope ● Establishing project scope ● Managing your customer
10	<p>Scope management and software development process methodology</p> <ul style="list-style-type: none"> ● The waterfall model, the spiral model, ● The iterative approach <p style="text-align: center;">Refining the system definition</p> <ul style="list-style-type: none"> ● Software requirements ● Relationship between features and requirements
11	<p>Refining the system definition</p> <ul style="list-style-type: none"> ● Developing the supplementary specification ● On ambiguity and specificity

12	Technical methods for Requirements Specification <ul style="list-style-type: none"> ● Pseudo code ● Finite state machines ● Decision trees ● Object Oriented Modeling ● Class Diagram ● Sequence Diagram ● Entity-relationship models and many others.
13	Building the right system <ul style="list-style-type: none"> ● From use case to implementation ● Orthogonality problem ● 4+1 view of architecture ● Structural and behavioral aspect of collaboration
14	Building the right system <ul style="list-style-type: none"> ● Role of use case model in architecture ● Realizing use cases in the design model ● From use cases to test cases
15	Using Traceability to support verification <ul style="list-style-type: none"> ● Role of traceability in verification ● Implicit versus explicit traceability ● Using a traceability tool
16	Using Traceability to support verification <ul style="list-style-type: none"> ● Maintenance of traceability relationships ● Revision

8.12 Data Structure and Algorithm

Course Contents: Abstract data types, complexity analysis, Big Oh notation, Arrays (static and dynamic) Stacks (linked lists and array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe the fundamentals of data structure and algorithms designing	C - 2	1

Develop data structures with their operations in programming language	C - 5	3
Solve computational problems by applying the appropriate algorithm on structured data	C - 3	2
Propose data structure according to their typical usage, strengths and weakness for designing optimised computer based systems	C-5	4

Week-wise Course Plan	
Week	Topics
1	Introduction to Data Structures- Need and Significance, Linear vs non-linear data structure, introduction to Algorithm, Analyzing Algorithm
2	Overview of pointers, object oriented programming concepts review
3	Introduction to Arrays, memory representation, static and dynamic Array, Algorithms on arrays. Multi-dimensional Arrays – applications and algorithms
4	Introduction of Link List, Operations and Representations, Types
5	Dynamic implementation of singly Linked List and examples
6	Doubly link list, operations and comparison with singly link list, Comparison of different operations on Link List & Arrays
7	Stacks: Basic functions, Static and Dynamic Representations, Array and link list based implementation
8	Recursion Complexity of Recursive Algorithms
9	Queues: Basic Functions, Static and Dynamic Representations Queue, Priority Queue, Circular Queue
10	Trees: Introduction and terminology, tree types, Binary Tree representation, basic operations, , tree traversals
11	Write expressions from tree, conversion from one type tree into another type, Binary search tree implementation
12	AVL Trees
13	Hash tables, searching techniques (Linear search, binary search)
14	Sorting techniques: Bubble sort, Insertion etc
15	Graphs: terminology, operations and representation Graph traversals and searching algorithms (BFS-DFS)
16	Shortest path finding algorithm; Dijkstra's Algorithms

8.13 Technical Report Writing

Course Contents: Overview of technical reporting, use of library and information gathering, administering questionnaires, reviewing the gathered information; Technical exposition; topical arrangement, exemplification, definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy, Organizing information and generation solution: brainstorming, organizing material, construction of the

formal outline, outlining conventions, electronic communication, generation solutions. Polishing style: paragraphs, listening sentence structure, clarity, length and order, pomposity, empty words, pompous vocabulary, document design: document structure, preamble, summaries, abstracts, table of contents, footnotes, glossaries, cross-referencing, plagiarism, citation and bibliography, glossaries, index, appendices, typesetting systems, creating the professional report; elements, mechanical elements and graphical elements. Reports: Proposals, progress reports, Leaflets, brochures, handbooks, magazines articles, research papers, feasibility reports, project reports, technical research reports, manuals and documentation, thesis. Electronic documents, Linear verses hierarchical structure documents.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain technical writing memos, proposals, covering letter, fliers, brochures, newsletters, business letter skills	C - 2	10
Demonstrate in group Presentations using different techniques	C - 3	9
Adopt ethical measures to produce the technical report and internship report for the better presentation of work	A-3	8
Adopt all the technicalities of formal writing to be used in professional lives	A-3	12

Week-wise Course Plan	
Week	Topics
1	Overview of technical reporting
2	Administering questionnaires and Technical exposition
3	Definition, classification and division, casual analysis, effective exposition, technical narration, description and argumentation, persuasive strategy.
4	Organizing information and generation solution: brainstorming, organizing material, construction of the formal outline
5	Outlining conventions, electronic communication, generation solutions. Polishing style
6	Pompous vocabulary, document design: document structure, preamble, summaries
7	Glossaries, index, appendices, typesetting systems, creating the professional report
8	Elements, mechanical elements and graphical elements. Reports.
9	Proposals, progress reports, Leaflets, brochures, handbooks.
10	Magazines articles
11	Research papers, feasibility reports, project reports.
12	Technical research reports
13	Manuals and documentation
14	Electronic documents

15	Thesis
16	Linear verses hierarchical structure documents

8.14 Numerical & Symbolic Computing

Course Contents: Mathematical preliminaries and error analysis, round-off errors and computer arithmetic, Calculate Divided Differences. Use Divided-difference Table. Find Newton's Interpolation Polynomial. Calculate Interpolation with Equally Spaced Data. Find the Difference Table. Calculate, Newton's Forward & Backward Difference Formulae. Use Gauss Formulae. Use Stirling's Interpolation Formula. Use Bessel's Interpolation Formula. Use Everett's Interpolation Formula. Solve Nonlinear Equations. Solve Equations by Bisection Method. Solve Equations by Regula Falsi Method. Solve Equations by Secant Method. Solve Equations by Newton-Raphson Method. Find Fixed Point Iteration. Solve Equations by Jacobi Iterative Methods. Solve Equations by Gauss Seidel Method Calculate Numerical Differentiation. Find Numerical Differentiation Formulae Based on Equally Spaced Data. Find Numerical Differentiation Based on Newton's Forward Differences. Find Numerical Differentiation Based on Newton's Backward Differences. Find Numerical Differentiation Based on Stirling's Formula. Find Numerical Differentiation Based on Bessel's Formula. Find Numerical Differentiation Based on Lagrange's Formula. Calculate Error Analysis of Differentiation Formulae. Solve Richardson Extrapolation. Calculate Numerical Integration. Use Trapezoidal Rule with Error Term. Use Simpson's 1/3 Rule with Error Term. Use Simpson's 3/8 Rule with Error Term. Use Composite Numerical Integration. Use Composite Trapezoidal Rule. Use Composite Simpson's Rule. Find Richardson's Extrapolation

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Apply numerical analysis methods and using software for simpler to complex problems of applied engineering and defined the practical examples.	C - 3	1
Analyse analytical methods in solving complex engineering as well as daily life problems.	C - 4	4

Week-wise Course Plan	
Week	Topics
1	<ul style="list-style-type: none"> • Error analysis, • round-off errors, gross error truncating error • computer arithmetic, • Calculate Divided Differences.

2	<ul style="list-style-type: none"> ● Use Divided-difference Table. ● Find Newton's Interpolation Polynomial. ● Calculate Interpolation with Equally Spaced Data. ● Find the Difference Table
3	<ul style="list-style-type: none"> ● Calculate, Newton's Forward & Backward Difference Formulae. ● Use Gauss Formulae.
4	<ul style="list-style-type: none"> ● Use Stirling's Interpolation Formula. ● Use Bessel's Interpolation Formula. ● Use Everett's Interpolation Formula.
5	<ul style="list-style-type: none"> ● Solve Nonlinear Equations. ● Solve Equations by Bisection Method. ● Solve Equations by Regula Falsi Method. ● Solve Equations by Secant Method.
6	<ul style="list-style-type: none"> ● Solve Equations by Newton-Raphson Method. ● Find Fixed Point Iteration. ● Solve Equations by Jacobi Iterative Methods. ● Solve Equations by Gauss Seidel Method
7	<ul style="list-style-type: none"> ● Find Numerical Differentiation Formulae Based on Equally Spaced Data. ● Find Numerical Differentiation Based on Newton's Forward Differences. ● Find Numerical Differentiation Based on Newton's Backward Differences.
8	<ul style="list-style-type: none"> ● Find Numerical Differentiation Based on Stirling's Formula. ● Find Numerical Differentiation Based on Bessel's Formula.
9	<ul style="list-style-type: none"> ● Find Numerical Differentiation Based on Lagrange's Formula. ● Calculate Error Analysis of Differentiation Formulae. Solve Richardson Extrapolation
10	<ul style="list-style-type: none"> ● Use Trapezoidal Rule with Error Term.
11	<ul style="list-style-type: none"> ● Use Simpson's 1/3 Rule with Error Term.
12	<ul style="list-style-type: none"> ● Use Simpson's 3/8 Rule with Error Term.
13	<ul style="list-style-type: none"> ● Use Composite Numerical Integration. Use Composite Trapezoidal Rule.
14	<ul style="list-style-type: none"> ● Use Composite Simpson's Rule. Find Richardson's Extrapolation.
15	<ul style="list-style-type: none"> ● Find Newton-Cotes Closed Quadrature Formulae
16	<ul style="list-style-type: none"> ● Revision

8.15 Islamic Study

Course Contents: Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
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Explain the concept of faith and basic pillars of Islam, its relation with human life and impact on society	C - 2	6
Exemplify the Holy Prophet (PBUH) life style to learn Islamic ethics, culture and personal grooming.	A - 5	8
Outline fundamental problems in the Islamic law framework from the perspectives of economic, and social cultures.	C - 4	6

Week-wise Course Plan	
Week	Topics
1	Introduction to Islamic studies & Quranic Studies <ul style="list-style-type: none"> ● Scope of Islamic Studies in present scenario ● Significance of Quranic Studies Textual study of Ahadith
2	Beliefs(Imaniyat) <ul style="list-style-type: none"> ● Introduction of Belief(Al Aqeeda) ● Meaning & definition of belief ● The essence & significance of Iman ● Some Basic Beliefs
3	Textual study of Surah al Bakra, verse:3-5,285 <ul style="list-style-type: none"> ● Textual study of Surah Saaf, verse: 10-14
4	Textual study of Surah al Hujjarat, verse:14-18 <ul style="list-style-type: none"> ● Textual study of Ahadith
5	Belief in Allah(Tuheed) Meaning & definition,significance& kinds of Tuheed <ul style="list-style-type: none"> ● Textual study of Surah al Bakara, verse:284 ● Textual study of Surah al Furqan, verse:68-71 ● Textual study of Surah al Saff, verse:01 ● Textual study of Surah al Hujjarat, verse:16
6	Forms of institutionalized Shirk <ul style="list-style-type: none"> ● Concept of Intercession & Wasila ● Textual study of Ahadith
7	Belief in Prophet hood <ul style="list-style-type: none"> ● Necessity & attributes of Risalat ● Last prophet hood &its attributes ● Respect of Prophet (PBUH)
8	Belief in Prophet hood <ul style="list-style-type: none"> ● Textual study of Surah al Ahzab, verse:6,21,32-33,40,56-59 ● Textual study of Surah al Saff, verse:5-9 ● Textual study of Surah al Hujjarat, verse:1-8 ● Textual study of Surah al Fath, verse:29
9	Belief in the day of Judgment <ul style="list-style-type: none"> ● Concept of Akhirah ● Rational behind Akhirah ● Influence of belief in life after death Textual study of Ahadith

10	<p>Worships(Ibadat)</p> <ul style="list-style-type: none"> • Definition & Meaning of worship • Forms of worship <p>Textual study of Surah al Furqan, verse:64-66</p>
11	<p>Prayer(Salat)</p> <ul style="list-style-type: none"> • Meaning of establishment of prayer • Significance & obligation of prayer • Basic requirement of Prayer <p>Textual study of Surah al Hashr, verse:18-20</p>
12	<p>Zakat, Fasting & Hajj</p> <ul style="list-style-type: none"> • Meaning & Definition of Zakat • Significance of Zakat and its obligation • Basic rules & regulations of Zakat • Meanings and significance of Ramadan • Objectives of Fasting according to Quran • Basic rules & obligation of Fasting • Basic concept of Hajj • Comprehensive act of worship • Conditions of accepted Hajj
13	<p>Seerah of Holy Prophet (PBUH)-I</p> <ul style="list-style-type: none"> • Life of Holy prophet(PBUH) as vision for workplace & social environmental improvement • Life of holy prophet(PBUH) in Makkah • Core policies behind spreading of Islam • Life of holy prophet(PBUH) in Madinah <p>Philosophical thoughts behind Mithaq e- Madinah, Conquer of Makkah & Hijjatu widah for regional and global relations</p>
14	<p>Seerah of Holy Prophet (PBUH)-II</p> <ul style="list-style-type: none"> • Life of holy prophet(PBUH) in Madinah <p>Philosophical thoughts behind Mithaq e- Madinah, Conquer of Makkah & Hijjatu widah for regional and global relations</p>
15	<p>Social system of Islam</p> <ul style="list-style-type: none"> • Basic concept of social system of Islam • Fundamental Human Rights • Ethical values of Islam • Importance of honest character • Amr bil maruf wa nai an al Munkar
16	<p>Religious & Social Tolerance in Islam & Rights of Non Muslims :</p> <ul style="list-style-type: none"> • Quranic point of view about social tolerance • The prophet's example about tolerance • The Islamic history with reference to tolerance • Fundamental Human Rights in Islam • Rights of Non-Muslims in Islam <p>Significance of reconciliation in Islam</p>

8.16 Pak-Studies

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

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Illustrate the concept behind Pakistan's formation and the process that happened to create it.	C - 3	10
Communicate concise overview of post-partition political and legal developments.	A - 2	12
Examine Pakistan's emerging environmental and social problems, as well as their sources and strategies to solve them.	C - 4	7

Week-wise Course Plan	
Week	Topics
1	Introduction and overview of the course
2	General overview of the history of the territories comprising Pakistan up to the British advent in the region
3	British Colonial rule with particular reference to the emergence of Muslim responses of different kinds between 1857 and 1906
4	The genesis and development of Muslim national consciousness, 1906-1937
5	The rise of the All-India Muslim League, 1937-1946
6	Pakistan in the Formative Phase
7	Constitutional Crisis and the advent of the Ayub Khan military regime, 1947-1958
8	The "Decade of Development" and growing disenchantment in East Pakistan, 1958-1969
9	The break-up of Jinnah's Pakistan and the independence of Bangladesh, 1969-1971
10	The Zulfikar Ali Bhutto government and the return to military rule, 1971-1977
11	Decade of democracy, 1988-1999
12	Environment and Culture in Pakistan
13	Pakistan's economic performance, 1947-Present
14	Determinants of Pakistan's Foreign Policy

15	Pakistan in the new Millennium
16	Pakistan in the new Millennium

8.17 Operating Systems

Course Contents: 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.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain the basic OS principles, processes, threads, IPC, files etc	C - 2	1
Analyze Operating Systems core functions such as process and memory management.	C - 4	2
Prepare the solution of real world problems by analysis of OS tools and techniques	C - 3	4

Week-wise Course Plan	
Week	Topics
1	What does an operating system do? Operating systems structure Service provided by OS Multiprocessor systems Different computing environments Clustered systems Hand-held systems and real-time operating systems.
2	Computer system operation I/O handling Storage structure and hierarchy Coherency and consistency Dual mode operation I/O protection Memory protection Protection and Security

3	Components and services System calls and programs Layered versus simple structure Virtual machines System design and implementation
4	Process states Process Control Block Schedulers and scheduling queues Context switching Operation on processes
5	Independent and co-operating processes Threading mechanism Message passing system Methods for the implementation of communication a link IPC in various OSs Sockets, RPCs and RMI in IPC.
6	Multithreading processes and their models Types of threads Threading issues Pthreads Solaris 2 threads Windows 2000 threads Linux threads
7	Scheduling concepts Scheduling Criteria FCFS Scheduling Algorithm Shortest Job First Scheduling Algorithm Priority Scheduling
8	Round Robin scheduling Multilevel Queue Scheduling Real time scheduling and evaluation techniques of various algorithms
9	Necessary conditions for deadlocks Resource-allocation graph, Methods for handling deadlocks Deadlock prevention
10	Deadlock avoidance Banker's and Safety Algorithms, Deadlock detection Recovery methods and combined approach.
11	Multi-step processing of a user program Loading and linking Memory mapping Swapping Contiguous allocation methods Fragmentation

12	Paging operation and structure Paging method & hardware support Segmentation Hardware implementation and segmentation with paging
13	Virtual Memory Sharing libraries using virtual memory Demand paging and its performance Copy on Write
14	Page replacement algorithms Allocation of frames, Thrashing and other considerations. Memory mapped files
15	File attributes File operations File types and structures Access methods Directory structure General graph directory Protection and consistency semantics
16	Disk structures Scheduling and space management algorithms.

8.18 Object Oriented Programming

Course Contents: Introduction to object oriented design, history and advantages of object oriented design, introduction to object oriented programming concepts, classes, objects, data encapsulation, constructors, destructors, access modifiers, const vs non-const functions, static data members & functions, function overloading, operator overloading, identification of classes and their relationships, composition, aggregation, inheritance, multiple inheritance, polymorphism, abstract classes and interfaces, generic programming concepts, function & class templates, standard template library, object streams, data and object serialization using object streams, exception handling.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe the basic concept and knowledge of object oriented programming	C - 2	1
Apply the major object-oriented concepts and implement object oriented programs in C++, encapsulation, inheritance and polymorphism	C - 3	3
Analyse object oriented programming principles to implement small and medium scale C++ programs with simple graphical user interface	C-4	4

Week-wise Course Plan	
Week	Topics
1	<ul style="list-style-type: none"> ● Overview of C++ Function ● Function with default arguments ● Function Overloading.
2	<ul style="list-style-type: none"> ● The language of Object Orientation ● Classes and Objects
3	<ul style="list-style-type: none"> ● Abstraction & Encapsulation ● Procedural vs. Object Oriented approach.
4	<ul style="list-style-type: none"> ● Fundamental of classes ● User Defined Data Types
5	<ul style="list-style-type: none"> ● Defining a Class, public and private Access Levels ● The Scope Resolution Operator
6	<ul style="list-style-type: none"> ● Array of Objects ● Passing Objects to Functions ● Returning Objects From Functions ● static Class Members
7	<ul style="list-style-type: none"> ● Constructors ● Parameterized vs. Default Constructor ● Order of execution ● Member Initialization Lists, ● Copy Constructor
8	<ul style="list-style-type: none"> ● Destructor ● Order of execution.
9	<ul style="list-style-type: none"> ● Friend Functions ● Operator Overloading
10	<ul style="list-style-type: none"> ● Inheritance ● Public Base Classes ● What Isn't Inherited
11	<ul style="list-style-type: none"> ● Order of execution of Constructor and destructors. ● Assignments between Base and Derived Objects.
12	<ul style="list-style-type: none"> ● Composition vs. Inheritance ● Compile-Time vs. Run-Time Binding ● virtual Functions
13	<ul style="list-style-type: none"> ● Polymorphism
14	<ul style="list-style-type: none"> ● Pure virtual Functions ,Abstract Class
15	<ul style="list-style-type: none"> ● Multiple Inheritance

16	<ul style="list-style-type: none"> ● Recursion, Memory Management in C++. ● Introduction to pointers, Pointer operations, using pointer for array traversal, pointer arithmetic.
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8.19 Software Architecture Design

Course Contents: Software Design Concepts, Design principles, Object-Oriented Design with UML, System design and software architecture, Object design, Mapping design to code, User interface design, Persistent layer design, Web applications design, State machine diagrams and modeling, Agile software engineering, Design Patterns, Exploring inheritance, Interactive systems with MVC architecture, Software reuse. Architectural design issues, , Software Architecture, Architectural Structures & Styles-, Architectural Patterns, Architectural & Design Qualities, Quality Tactics, Architecture documentation, Architectural Evaluation, Model driven development.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain major activities and main role of design involved in object oriented software development process	C - 2	1
Design a solution to a given problem using one or more design models and implement in a programming language.	C - 5	3
Use existing solutions i.e architectural styles and software design patterns of a particular software system design problem for evaluation	C-4	4

Week-wise Course Plan	
Week	Topics
1	INTRODUCTION Putting Software Architecture in Context Software Architecture as a Design Plan Software Architecture as an Abstraction Software Architecture Terminology
2	INTRODUCTION Four Views of Software Architecture Loose Coupling between Views Engineering Concerns Addressed by Different Views Using the four Views

3	GLOBAL ANALYSIS An Overview of Global Analysis Analyze Factors Develop Strategies Analyze Organization Factors Begin Developing Strategies
4	GLOBAL ANALYSIS Analyze Technological Factors Continue Developing Strategies Analyze Product Factors Continue Developing Strategies
5	CONCEPTUAL ARCHITECTURE VIEW Design Activities for the Conceptual Architecture View Central Design Tasks: Components, Connectors, and Configuration
6	CONCEPTUAL ARCHITECTURE VIEW Final Design Tasks: Resource Budgeting, Traceability Uses for the Conceptual Architecture View.
7	MODULE ARCHITECTURE VIEW Design Activities for the Module Architecture View Central Design Tasks: Modularization and layering
8	MODULE ARCHITECTURE VIEW Final Design Tasks: Interface Design, Traceability Uses for the Module Architecture View
9	EXECUTION ARCHITECTURE VIEW Design Activities for the Execution Architecture View Central Design Tasks: Runtime Entities, Communication Paths, and Configuration
10	EXECUTION ARCHITECTURE VIEW Final Design Tasks: Resource Allocation, Traceability
11	EXECUTION ARCHITECTURE VIEW Uses for the Execution Architecture View
12	CODE ARCHITECTURE VIEW Design Activities for the Code Architecture View Central Design Tasks
13	CODE ARCHITECTURE VIEW Final Design Tasks Traceability Uses for the Code Architecture View
14	ROLE OF ARCHITECT The Architect as Key Technical Consultant The Architect Makes Decisions The Architect Coaches
15	The Architect Coordinates The Architect Implements
16	The Architect Advocates Software Architecture as a Career

8.20 Introduction to Database System

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

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Defining basic concepts database management systems and models	C - 1	1
Identify the functional dependencies and resolve them using normalization	C - 1	2
Use SQL language to perform database manipulation operations	C - 3	3
Compare different stages of database development using various data models	C-4	4

Week-wise Course Plan	
Week	Topics
1	Introduction to the course. Advantages of DBMS and its User.
2	Database Architecture (Three Level ANSI SPARC) and Database Development Process.
3	Database Designing and Database Modeling. Business Rules and Conceptual Data Modeling.
4	Type of Cardinalities, Degree and Type of Relationships. Constraints and Limitations.
5	Defining Key's and its different types (Super, Candidate, Unique, Primary, Alternate, Foreign, Secondary, Cumbersome and Surrogate Key)
6	Relation (Properties of a Relation) Well Structured Relations (Removal of different type of Anomalies in a Relation)
7	Logical Database Design (Transformation of Conceptual Data Models into Logical Data Models) Introduction to SQL and its basic commands.

8	Enhanced Entity Relationship Diagram (Super Type, Sub Type, Generalization and Specialization, Disjoint Constraints, Total and Partial Specialization Rules) Entity Clustering.
9	Functional Dependency and Normalization (0NF, 1NF, 2NF and 3NF)
10	Joining and its types Cross, Inner, Outer, Right, Left, Full, Right Join If Null and Left Join If Null.
11	Relational Algebra (Unary, Set, Join, Division, Aggregate and Grouping Operations)
12	Indexes and Views.
13	Query Optimization Concepts.
14	File Organizations, Hashing and Transaction.
15	Database Security.
16	Project Week.

8.21 Principles of Management

Course Contents:

Introduction to Project Management, the Project Management and Information Technology Context, the Project Management Process Groups, Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Project Human Resource Management, Project Communications Management, Project Risk Management, Project Procurement Management, Project Management Tools.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Adopt critical thinking and focus on managerial problems in an articulate way to figure out the solution	A -3	7
Follow the management process and know the contemporary management practice in different applications	A - 2	11
Classify various management theories and apply effectively	A-4	9
Demonstrate the ability to recognise the need and adaptation to change	C-3	12
Apply foundation knowledge of management principles and functions	C-3	10

Week-wise Course Plan	
Week	Topics
1	Foundation of management. Definition Scope and Function of Management, Different levels, Roles and Skills of Management, Management & Organization
2	Current trends & Issues of Management; workforce diversity, globalization, IT development, Knowledge Management, Innovation and Creativity etc.

3	Management theories and perspectives. Evolution of Management Theories, Scientific Management, Administrative Management, Bureaucratic Management
4	Behavioral theories, Hawthorne Studies, System Approach, Contingency Approach, Organizational culture & environment: Different Views and Sources of Culture.
5	. External & Internal Environmental Factors, Task & Mega Environment, Corporate social responsibility, Views on CSR, value based management
6	Ethics in management, factors affecting ethics and improving ethical behaviors, Decision making: Decision making process of eight steps and its Conditions.
7	Decision Making Errors and Biases, Types of Problems and Respective Decisions., Foundation of planning: Conceptual View of Planning and its Purpose and importance.
8	Challenges and Types of Planning, Types and characteristics of Goals and Plans, Developing Organizational Goals. Traditional Approach and MBO
9	Organizing; Foundation of Organizational Structure and design, Contingency Factors. Types of Organizational Structure, Departmentalization & Chain of Command.
10	Span of Control & Formalization, Centralization and Decentralization, Work division, Mechanistic & Organic Organizations, Traditional & Contemporary Designs.
11	Environmental Uncertainty, Scanning and dynamism effects on Organizational Design. Leadership and management: Differences and Similarities, Who are Leaders? What is Leadership?
12	Early Leadership Theories: Trait & behavioral theories, Different Leadership Styles. Models of Leadership: Fielders Model, Path Goal Theory, Blanchard Situational Theory.
13	Contemporary Theories of Leadership: Transactional, Transformational and LMX Theory. Foundation of Control: Importance of Control, Control Process of different steps.
14	Elements, Approaches and Types of Controlling, Organizational Performance. Measures to Control Organizational Performance. Control Strategies for deviations.

8.22 Formal Methods in Software Engineering

Course Contents: Introduction to the use of mathematical models for specification and validation, Finite state machine models, models of concurrent systems, verification of models, and limitations. Analyzing well-formedness (e.g. completeness, consistency, robustness, etc.), Analyzing correctness (e.g. static analysis, simulation, model checking, etc.), Formal analysis, An introduction to VDM-SL, Sets, Sequences, Composite objects, Maps, VDM-SL, Comparative Formal Methods, Proofs, Introduction to Z.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain the fundamental concepts of formal methods.	C - 2	1
Carry out formal specifications and verification by applying formal method concepts.	C - 3	4

Interpret and apply the formal languages of the formalisms for modeling distributed systems	C-6	4
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Week-wise Course Plan	
Week	Topics
1	Introduction to Course Problems in software development Formal Methods Formal Logic
2	Programming paradigms Developing and acquiring Formal Methods Formal specification
3	Abstraction Logic and set theory
4	Propositional Logic Rules of Inference and logical Deduction
5	Propositional Logic - rules of elimination and introduction
6	Predicate Logic Quantifiers Mixing quantifiers
7	Scope of quantifiers Practice examples
8	Resolution in Predicate Logic
9	Hoare's Logic Assignment statements of program: Conditional rule
10	Hoare's Logic Empty statement axiom schema Sequencing/composition rule Consequence rule Loop rule
11	Cartesian Product of sets Weakest precondition State spaces Purpose of state space The notation $[S] P$ Assignment Multiple Assignment statements Conditional Statements Begin and End

12	Relations Why relations? Domain of relation Range of relation Domain restriction Range restriction
13	Functions and Sequences Functions Partial Function Total Function Injective Function Surjective Function Bijective Function Lambda Notation of functions Sequences
14	Introduction to Z specification language Fundamental concepts
15	The Z specification language (cont'd)
16	Z specification examples/case studies

8.23 Software Verification & Validation

Course Contents: Introduction to the course and course policies, Critical analysis of software requirements and analysis of proposed solutions, Overview of software testing, test levels, scope and test types, Testing lifecycle and methodologies , Non-functional testing, Testing artifacts and deliverables , Test management metrics and reporting, management, Tools and techniques to support the testing process, Formal methods for software verification (including higher order logic, natural deduction, lambda calculus, term rewriting, data types and recursive functions, induction principles, calculation reasoning, mathematical proofs, decision procedures for a variety of logical domains, and proofs about programs.)

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Define software verification and validation concept, principles and fundamentals	C - 1	1
Demonstrate the software development process, The testing process, concepts on which state-of-the-art software testing techniques are based	C - 3	4
Analyse all testing artefacts and produce deliverables	C-4	2

Design test cases to validate and verify software	C-5	3
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Week-wise Course Plan	
Week	Topics
1	Introduction to the course and course policies.
2	Basic concepts, fundamentals, principles and methods
3	Critical analysis of software requirements and analysis of proposed solutions
4	Planning , Establishing the V&V Requirements Risk Management, Identify,
5	The Verification and Validation Life Cycle
6	Design Analysis
7	Test levels, scope and test types Test Analysis V&V Testing
8	Design Analysis Code Analysis
9	Traceability Analysis Interface Analysis
10	Test management metrics and reporting, management,
11	Managing the Plan, Effectiveness Measures,
12	Formal methods for software verification V&V model
13	Hierarchy of test documents that make up V&V testing.
14	Break down of design for project
15	Requirement Analysis
16	Project Demo and Presentation

8.24 Object Oriented Software Engineering

Course Contents: Introduction to Software Engineering, Modelling with UML, Project Organization and Communication, Requirements Elicitation, Analyses, System Design: Decomposing the System, System Design: Addressing Design Goals, Object Design: Reusing Pattern Solutions, Object Design: Specifying Interfaces, Mapping Models to Code, Testing, Rationale Management, Configuration Management, Project Management, Software Life Cycle, Methodologies: Putting It All Together.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning
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		Outcome(s) - PLO
Identify various O-O concepts along with their applicability contexts.	C - 1	1
Solve the problem using objected oriented software engineering principles	C - 3	2
Analyse object oriented software engineering principles to implement small and medium scale software.	C-4	4

Week-wise Course Plan	
Week	Topics
1	Introduction to object oriented Software Engineering
2	UML Modelling
3	Project Organization and Communication
4	Requirements Elicitation
5	Requirements Analyses
6	System Design Decomposing the System
7	Addressing Design Goals Object Design
8	Reusing Pattern Solutions,
9	Object Design
10	Specifying Interfaces
11	Mapping Models to Code,
12	Testing, Rationale Management
13	Configuration Management, String Buffer
14	Project Management
15	Software Life Cycle
16	Methodologies: Putting It All Together.

8.25 Software Engineering Economics

Course Contents: Programming aspects, economic aspects, human relations aspects, software trends: cost, social impact, the plurality of SE Means, The GOALS Approach to Software Engineering, The Software Work Breakdown Structure (WBS), Software Maintenance, introduction to COCOMO, definitions and assumptions, development effort and schedule, phase distribution, The Rayleigh Distribution, interpolation, basic software maintenance effort estimation. Performance Models, Optimal Performance, Sensitivity Analysis, Cost-Effectiveness Models. Cost Drivers: Project Attributes–Modern Programming Practices, Use of Software Tools, Schedule Constraint.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe and understand the importance of economics in software engineering	C - 2	1
Apply different tools for economic analysis	C - 3	5

Week-wise Course Plan	
Week	Topics
1	Programming aspects, economic aspects, human relations aspects
2	Software trends: cost, social impact
3	The plurality of SE
4	The GOALS Approach to SE
5	The Software Work Breakdown Structure (WBS)
6	Software Maintenance
7	Introduction to COCOMO
8	Definitions and Assumptions
9	Development effort and schedule
10	Phase distribution
11	The Rayleigh distribution
12	Interpolation
13	Basic software maintenance effort estimation
14	Performance models
15	Project Presentation
16	Project Presentation

8.26 Probability & Statistics

Course Contents: Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions,

Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of 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), 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.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Define the basic concept of probability and statistics	C - 1	1
Apply probability concepts to solve engineering problems	C - 3	4

Week-wise Course Plan	
Week	Topics
1	Descriptive statistics, inferential statistics, parameter and statistics
2	Sampling, methods of sampling, scale of measurement, methods of data collection.
3	Frequency table, frequency distribution, charts and curves
4	Bar chart, Pie Charts, Histogram, Boxplot
5	Frequency polygon and some other graphs
6	Mean, Median, Mode, Types of Mean, combined Mean, Weighted Mean, Trimmed Mean, Winsor zed Mean
7	Range, Variance & Properties, Standard Deviation
8	Mean Deviation Quartile Deviation, Quartiles, Box & Whisker Plots
9	Testing of Mean, Testing of Difference of Means, Testing of Proportions, Testing of Difference of Proportions
10	Confidence Intervals, Means, Proportions, Paired Observations Testing
11	Sample Spaces and Events, Types of Events, ME, CE, EL Events, Arrangements, Factorials, Permutations and Combinations
12	Definition of Probability, Addition Law Of Probability, Multiplication Law of Probability, Normal Distribution standard Case, General Normal Distribution
13	Correlation between two Variables, Testing of Correlation Coefficient
14	Simple Linear Regression Model, Testing of Betas and Interpretation
15	Multiple Linear Regression Model, Testing of Betas and Interpretation
16	Revision

8.27 Web Engineering

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

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Define the concepts, principles and methods of web engineering	C - 1	1
Design and develop web applications using client side/server-side programming languages.	C - 5	3
Analyse the impact of web standards on software development	C - 4	4

Week-wise Course Plan	
Week	Topics
1	Internet History, www History, Analyzing IP Address, www Components, www Structure, HTTP Basics, Uniform Resource Identifiers, Explain the purpose of a web browser
2	Identifying types of web sites, Identifying steps required for web publishing, Web 1.0 to Web 3.0
3	HTML Page Format, Body Element, Headings, Paragraph, Lists, Physical Character Styles, Logical Character styles, Hyper Links, Naming a Section, Displaying Images, Tables, Frames, Division, HTML Form Elements
4	New features in HTML5, Audio and video elements, Geolocation API, New Input Elements, Server sent events, Web sockets
5	JavaScript Need, Where to place javascript, Referring external Javascript file, Javascript Variable, Javascript Popup Boxes, Functions in Javascript, Javascript Events, Javascript Event Handlers, Javascript Objects, Getting coordinates of mouse clicked, Creating dropdown menus
6	Style Sheets Usage, Advantage of Style Sheets Including Style Sheets, Defining Style Rules, Selectors , Margins, Defining Independent Styles, Basic Page Link Styles, Floating layouts

7	Responsive Web Design, Bootstrap CDN, Adding doctype, Mobile First approach, Bootstrap containers, Bootstrap Grid systems, Bootstrap Tabs and Pills, Bootstrap Forms, Bootstrap Form Inputs
8	jQuery Syntax, jQuery Selectors, jQuery Events, jQuery Callback, jQuery Chaining, jQuery and HTML, jQuery Filtering
9	Variable Operations, Object-Based Manipulation, Conditional Logic, Loops, Methods, The Basics About Classes, Building a Basic Class, Value Types and Reference Types, Understanding Namespaces and Assemblies, Advanced Class Programming
10	Introduction to MVC, What do we need for doing Asp.Net MVC ? ASP.NET vs MVC vs Web Forms, Why ASP.NET Web Forms? Problems with Asp.Net Web Forms, MVC – Pattern, MVC – Life Cycle, MVC – Routing
11	MVC – Controllers MVC – Actions MVC – Filters MVC – Selectors MVC – Helpers MVC – Validation MVC – Model Binding
12	Creating Websites, Websites and Web Projects, Adding Web Forms, Designing a Web Page, Adding Web Controls, The Anatomy of a Web Form, Writing Code Adding Event Handlers, IntelliSense and Outlining, Visual Studio Debugging
13	The Anatomy of an ASP.NET Application, ASP.NET File Types, ASP.NET, Application Directories, Introducing Server Controls, Converting an HTML Page to an ASP.NET Page, View State, The HTML Control Classes, HTML Control Events, Understanding Validation, The Validator Controls, Server-Side Validation, Client-Side Validation
14	Themes, Applying a Simple Theme, Creating Multiple Skins for the Same Control, Master Page Basics, Advanced Master Pages
15	Understanding Data Management, Configuring Your Database, SQL Basics, ADO.NET Basics, Direct Data Access
16	Disconnected Data Access, Introducing Data Binding, Single-Value Data Binding, Repeated-Value Data Binding

8.28 Digital Image Processing

Course Contents: The human visual system, electromagnetic system, working and components inside digital camera, pixels, image representation, sampling, quantization, mathematics of

image formation, convolution, point-based image processing, Fourier theory, image filtering in spatial and frequency domain, morphological operations, color models, Image compression, multispectral images, feature detection, image segmentation, etc.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe the fundamental knowledge of image and use their mathematical interpretation.	C - 2	1
Design various transformation functions for image enhancement for binary, grayscale and colour images.	C - 5	2
Evaluate algorithms for real-time problem-solving using tools like MATLAB and/or Python	C - 6	3
Compare various image processing algorithms	C-4	4

Week-wise Course Plan	
Week	Topics
1	Introduction to Digital Image Processing Digital Images and Videos Image Types Digital Image Representation
2	Applications of Digital Image Processing EM Spectrum Applications for Human perception in Image Processing Noise Filtering Content Enhancement Medical Imaging Remote Sensing
3	Digital Image Fundamentals-II Light and EM Spectrum Visual Perception Structure Of Human Eyes Image Formation on the Eye Optical Illusion Brightness Adaptation and Discrimination Image Acquisition Image Acquisition using Point Sensor Image Acquisition using Line Sensor Image Acquisition using Array Sensor Image Formation Model

4	Adjacency Connectivity Path Regions and Boundaries Distance between pixels
5	Image Enhancement in Spatial Domain-I Image Enhancement Basic Operations of Image Enhancement Point Operations Local Operations Global Operations Gray Level Transformation Function Identity Function Image Negation Power Law transform Log Transform Piece Wise Linear Transform Contrast Stretching Gray level Slicing Bit Plane Slicing
6	Image Enhancement in Spatial Domain-II Arithmetic operations on Images Logical operations on Images Local/ Neighborhood Operations on images Local Enhancement through Spatial Filtering Smoothing Spatial Filtering Linear Filters Non-Linear Filters Linear Smoothing Spatial Filtering Average Filters Weighted Average Filters Non-Linear Smoothing Spatial Filtering Median Filters Minimum Filters Maximum Filters

7	Image Enhancement in Spatial Domain-III Image Histogram Histogram Equalization Image Enhancement via Histogram Statistics Sharpening Spatial Filtering Edge Detection Derivatives 1st Order Derivative 2nd Order Derivative Gradient Operators Sobel Operator Prewitt Operator Robert Cross Operator
8	Image Enhancement in Spatial Domain-IV Laplacian Operator Unsharp Masking High Boost Filtering Canny Edge Detection
9	Color Image Processing-I Color Image Processing Color Spectrum Color Fundamentals Human Perception Primary color of lights vs primary color of pigments Chromaticity Diagram
10	Color Models RGB CMY CMYK HIS YIQ
11	Color Image Processing-II Color Image Processing Pseudo Color Processing Intensity Slicing Gray to Color Conversion Full Color Image Processing Color Complements

12	Color Slicing Color Correction Tone Correction Histogram Processing Color Image Smoothing Color Image Sharpening Noise in Color Images
13	Morphological Image Processing-I Introduction Basic Concepts from Set Theory Reflection Translation Structuring Element Dilation Erosion
14	Morphological Image Processing-II Opening Closing Boundary Extraction Fitting and Hitting Hit and Miss Transform Thinning Thickening Medial Axis Transform Convex Hull Connected Components Extraction
15	Image Enhancement in Frequency Domain Introduction to Fourier Series Introduction to Fourier Transform Continuous and Discrete Fourier Transform Butterworth Low Pass Filters Ideal Low Pass Filters Gaussian Low Pass Filters Butterworth High Pass Filters Ideal High Pass Filters Gaussian High Pass Filters Band Pass Filters Notch Filter
16	Real Time Applications and Problems in DIP

8.29 Mobile Application and Development

Course Contents: Mobiles Application Development Platform; Android OS: Architecture, Framework and Application Development; Android Studio; Fragments; Lists; Recycler View; Calling Built-in Applications using Intents; Displaying Notifications; Components of a Screen; Adapting to Display Orientation; Managing Changes to Screen Orientation; Utilizing the Action Bar; Creating the User Interface; Listening for UI Notifications; Views; User Preferences; Persisting Data; Sharing Data; Sending SMS Messages; Displaying Maps; Publishing, Android Applications; Deployment on App Stores; Mobile Programming Languages.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Discuss different architectures & framework for Mobile Application development.	C - 2	1
Develop/Create mobile applications using current software development environments.	C - 5	3
Compare the different performance tradeoffs in mobile application development.	C - 4	5
Describe the mobile application development fundamentals and flow on multiple devices and publishing it online.	C-2	6
Adopt basic and advance concepts for generating sustainable solutions	A-4	7
Use resources to develop mobile application individually or team based	A-3	9
Formulate project planning activities that accurately forecast project cost, timeline and quality	A-4	11

Week-wise Course Plan	
Week	Topics
1	Introduction to Mobile Computing, Android Architecture and Android Studio programming environment.
2	Application Fundamentals, Main building blocks of the android application development
3	Applications and Activities: Activity LifeCycle
4	User Interface: UI and Widgets Layout design in Android Studio
5	First Android Program: Create first simple application,
6	Laying out User Interface: Multiple Activities
7	Introduction to Intents :Strings and Widgets: Transition between multiple activities

8	Android and Model view Controller
9	Advanced UI Interactions – View Controllers
10	Generating getters and setters, Web Services: Accessing and Creating; Threading; Publishing, Android Applications
11	Debugging of Android Application. Deployment on App Stores; Mobile Programming Languages; Challenges with Mobility and Wireless Communication;
12	Introduction to iOS programming
13	Introduction to iOS programming II
14	Case Study Assessment I
15	Case Study Assessment II
16	Project

8.30 Advance Database systems

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

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Compare advance data models, technologies and approaches for building distributed database systems	C - 4	2
Design the models and approaches in order to become enabled to select and apply appropriate methods for a particular case	C - 5	3
To assess a database solution for a given scenario/ challenging problem in the domain of distributed database systems.	C - 6	4

Week-wise Course Plan	
Week	Topics
1	Introduction to the course

2	Basics of DBMS
3	Theoretical concepts: Relational model conformity and Integrity
4	Advanced SQL programming: Query optimization
5	Concurrency control and Transaction management
6	Database performance tuning Distributed relational systems
7	Data Replication
8	Object oriented, deductive, spatial, temporal database management systems
9	constraint database management systems
10	New database applications and architectures: e.g. Data Warehousing; Multimedia; Mobility
11	NoSQL, Native XML databases (NXD), Document orientated databases
12	SQL standards development
13	Standards for interoperability and integration e.g. Web Services
14	Database security - Data Encryption
15	Redaction and masking techniques
16	Authentication and authorization. Database auditing

8.31 Artificial intelligence

Course Contents: Introduction (Introduction, basic component of AI, Identifying AI systems, branches of AI, etc.); Reasoning and Knowledge Representation (Introduction to Reasoning and Knowledge Representation, Propositional Logic, First order Logic); Problem Solving by Searching (Informed searching, Uninformed searching, Local searching.); Constraint Satisfaction Problems; Adversarial Search (Min-max algorithm, Alpha beta pruning, Game-playing); Learning (Unsupervised learning, Supervised learning, Reinforcement learning) ;Uncertainty handling (Uncertainty in AI, Fuzzy logic); Recent trends in AI and applications of AI algorithms (trends, Case study of AI systems, Analysis of AI systems)

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Discuss fundamentals of AI, different searching algorithms in AI like heuristic informed/uninformed search and knowledge based systems.	C - 2	1
Ability to apply AI techniques with machine learning to solve dynamic problems	C - 3	3
Analyse various AI models	C-4	4

Week-wise Course Plan	
Week	Topics
1	Introduction , Goals of AI, AI Approaches, AI Techniques, Branches of AI, Applications of AI.
2	Problem Solving Problem Representation, Components of Problem Solving, Searching, Tree and Graphs Terminology Graph theory, Strategies for state space search,
3	Problem Solving and Search Strategies Search Strategies Simple Search Algorithm, Depth First Search Breadth First Search, Progressive Deepening, Heuristically Informed Searches, Hill Climbing
4	Search Strategies Beam Search, Best First Search Optimal Searches, Branch and Bound, Improvements in Branch and Bound
5	Game Playing (Search Strategies) Overview, Adversarial Search, Mini-Max search procedure, Game playing with Mini-Max, Alpha-Beta pruning.
6	Genetic Algorithms Introduction, Encoding, Operators of genetic algorithm, Basic genetic algorithm. Mutation Crossover , Applications of Genetic algorithm
7	Knowledge Representation, Predicate Logic, Rules Knowledge representation, KR using predicate logic, KR using rules .
8	Reasoning System - Symbolic and Statistical Reasoning Reasoning , Symbolic reasoning, Statistical reasoning
9	Expert System Introduction, Knowledge acquisition, Knowledge base, Working memory, Inference engine, Expert system shells, Explanation, Application of expert systems
10	Fundamentals of Neural Networks Introduction and history, Model of artificial neuron, neural network Characteristics, Mapping of Contents and CLOs Learning methods,
11	Neural Network Topologies of ANN Single-layer network system, Applications
12	Machine Learning What is machine learning Clustering , Analogy,
13	Neural net and genetic learning, Reinforcement learning.
14	Supervised Learning <ul style="list-style-type: none"> ● K-Nearest Neighbor Algorithm
15	Un-supervised Learning <ul style="list-style-type: none"> ● K-Mean Clustering ● PCA ● 3. Dimensionality Reduction
16	Project Presentation

8.32 Computer Communication & Networks

Course Contents: Introduction and protocols architecture, basic concepts of networking, network topologies, layered architecture, physical layer functionality, data link layer functionality, multiple access techniques, circuit switching and packet switching, LAN

technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, sub netting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe the basics of computer networks	C - 2	1
Compare the functionality and services of network layers	C - 4	2
Analyze the different algorithms and performance of protocols	C - 4	4

Week-wise Course Plan	
Week	Topics
1	<ul style="list-style-type: none"> ● Introduction to computer networks ● Data Communication characteristics ● Data flow: Simplex, Half Duplex, Full Duplex ● Network Topologies: Mesh, Star, Bus, Ring, Hybrid ● Network Categories: LAN, WAN ● Request For Comment (RFC)
2	<ul style="list-style-type: none"> ● OSI vs. TCP/IP model ● 7 Layers in OSI Model: Application, Presentation, Session, Transport, Network, Data Link, Physical ● Addressing: IP, MAC, Port
3	<ul style="list-style-type: none"> ● Analog vs. Digital Signals ● Transmission Impairment: Attenuation, Distortion, Noise ● Digital Transmission: D-to-D, A-to-D ● D-to-D: Line Coding: Unipolar, Bipolar, Manchester ● A-to-D: PCM, DM
4	<ul style="list-style-type: none"> ● Analog Transmission: D-to-A, A-to-A ● D-to-A: ASK, FSK, PSK, QAM ● A-to-A: AM, FM, PM
5	<ul style="list-style-type: none"> ● Communication Networks: Circuit Switching, Packet Switching ● Circuit Switching : FDM, TDM ● Transmission Media ● Cabling Standards ● Cabling Types

6	<ul style="list-style-type: none"> • Error Detection: • Simple Parity Check • 2-D Parity Check • CRC • Checksum • Error Correction: • Single bit error correction • Redundancy
7	<ul style="list-style-type: none"> • Flow Control • Stop and Wait • Sliding Window
8	<ul style="list-style-type: none"> • Error Control • Stop and Wait ARQ • Go Back N ARQ • Selective Repeat ARQ
9	<ul style="list-style-type: none"> • WAN Protocols • HDLC • PPP
10	<ul style="list-style-type: none"> • Multiple Access • Random Access • ALOHA • CSMA/CD • CSMA/CA • Controlled Access • Token Passing • Reservation • Polling • Channelization protocols • FDMA • TDMA • CDMA • Ethernet • IEEE Standards • Ethernet Types
11	<ul style="list-style-type: none"> • Ethernet • Token Ring
12	<ul style="list-style-type: none"> • IPv4 Classes: Class A, Class B, Class C, Class D, Class E • Loopback IP Address, Private IP Address, APIPA • Subnetting: • Given: No of subnets • Given: No of hosts • VLSM

13	<ul style="list-style-type: none"> • Delivery • Forwarding: Next hop vs Route, Network vs Host specific, Default Method • Routing: Static vs Dynamic Routing • Dynamic Routing: IGP, RGP • IGP: RIP, OSPF, EIGRP • EGP: BGP
14	<ul style="list-style-type: none"> • UDP • TCP • Congestion Control
15	<ul style="list-style-type: none"> • DNS • DHCP
16	<ul style="list-style-type: none"> • SNMP • FTP • Email

8.33 Software Testing

Course Content: Testing techniques. Black Box testing, White Box and Grey Box testing techniques. Quality Assurance planning and execution. Automated testing topics include constructing a framework, scripting techniques, generating a test data, generating test architecture, pre/post-processing, test maintenance, and job specific metrics. Current research topics in Software Testing and Quality Assurance.

COURSE LEARNING OUTCOME (CLO)	Blooms Taxonomy	PROGRAM LEARNING OUTCOME (PLO)
State the principal approaches to software testing, together with their associated techniques.	C-1	1
Compare the distinction between the functional and structural based testing techniques.	C-4	4
Illustrate the Plan, design, implementation, documentation and execution of testing a software component or a system that implements a given software specification.	C-3	1
Apply test automation techniques and testing tools in support of test execution and documentation.	C-5	3

Week-wise Course Plan

Week	Topic
1	Introduction to Testing techniques.
2	Black Box testing Techniques
3	White Box Testing Techniques
4	Grey Box testing techniques.
5	Quality Assurance planning and execution
6	Automated testing
7	Constructing a framework
8	Scripting techniques
9	Generating a test data
10	Generating test architecture
11	Pre/post-processing
12	Test maintenance
13	Job specific metrics
14	Current research topics in Software Testing and Quality Assurance
15	Current research topics in Quality Assurance
16	Software Testing Latest Trends

8.34 Artificial Neural Networks (Elective General)*

Course Content: Introduction to the course and motivation, Machine learning introduction, advantages and applications, Machine learning basics (supervised, unsupervised, reinforcement learning), Training data, Training objectives, over-fitting, under-fitting problem, Classification and Regression problem, Introduction to neural networks, What are artificial neural networks?, Multi-layered feed-forward network I, Multi-layered feed-forward network II, Back propagation Neural Network, Gradient descent in neural networks I, Gradient descent in neural networks II, Implementing the neural network in Python, Application of Neural Networks in Telecommunication, Application of Neural Networks in Bioinformatics

COURSE LEARNING OUTCOME	BLOOM's TAXONOMY LEVEL	PROGRAM LEARNING OUTCOME (PLO)
Explain the basics of artificial neural networks	C-2	1
Apply supervised and unsupervised Learning in machine learning using neural networks	C-3	3
Design and implementation of small problems	C-5	2
Outline the application of artificial neural networks	C-4	6
Explain how ANNs can be trained for sustainable solutions	C-2	7

Week-wise Course Plan	
Week	Topics
1	Introduction to the course and motivation
2	Machine learning introduction, advantages and applications
3	Machine learning basics (supervised, unsupervised, reinforcement learning)
4	Training data, Training objectives, over-fitting, under-fitting problem
5	Classification and Regression problem
6	Introduction to neural networks
7	What are artificial neural networks?
8	Multi-layered feed-forward network I
9	Multi-layered feed-forward network II
10	Back propagation Neural Network
11	Gradient descent in neural networks I
12	Gradient descent in neural networks II
13	Implementing the neural network in Python
14	Implementing the neural network in Python continued
15	Application of Neural Networks in Telecommunication
16	Application of Neural Networks in Bioinformatics

8.35 Software Project Management

Course Content: Software Crisis and Software Engineering, Classic Mistakes, Overview of Project Management, PMI Process Groups, Software project Phases, Project charter, Statement of Work (SOW), Planning Phase: Development lifecycle models, matching lifecycles to projects, Project plans, Work Breakdown Structures (WBS), Estimation of effort and cost (Expert Judgment, FP and Use Case point methods), Scheduling: Project network diagram fundamentals, CPM, PERT, Gantt charts, Critical chain scheduling, Using MS-Project, Assigning Resources, Resource leveling, Team models, Managing conflict and motivating, Project Monitoring and Control: Status reporting, Project metrics, EVM, Communications Techniques, Risk management and Change control Project Recovery, Documentation, Cutover/Migration, Post Project Reviews, Closing.

COURSE LEARNING OUTCOME (CLO)	Bloom's Taxonomy Level	PROGRAM LEARNING OUTCOME (PLO)
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1. State the concepts of project management in the context of software development management process and MS Project as a modeling tool.	C-2	1
2. Analyse various techniques for planning and managing a software project, for the given problem.	C-4	4
3. Develop Software project management artefacts i.e SOW, SRS, and Project Planning documents to manage the project based on client needs.	C-5	11
4. Be aware of the role of professional ethics in successful software development	A-1	8
5. Illustrate an appropriate project management approach through an evaluation of the business context and scope of the project	C-3	11
Apply the knowledge of software project management practices on real time case studies	C-3	12

Week-wise Course Plan	
Week	Topic
1	Software Crisis and Software Engineering
2	Classic Mistakes Overview of Project Management
3	PMI Process Groups Software project Phases Project charter Statement of Work (SOW)
4	Planning Phase Development lifecycle models Matching lifecycles to projects Project plans
5	Work Breakdown Structures (WBS) Estimation of effort and cost (Expert Judgment, FP and Use Case point methods)

6	Scheduling Project network diagram fundamentals CPM PERT Gantt charts
7	Critical chain scheduling
8	Using MS-Project Assigning Resources,
9	Resource leveling Team models Managing conflict and motivating
10	Project Monitoring and Control Status reporting
11	Project metrics EVM
12	Communications Techniques Risk management
13	Change control
14	Project Recovery
15	Documentation Cutover/Migration
16	Post Project Reviews Closing.

8.36 Human Resource Management:

Course Content: Need for Human Resources Management. Matching HR Needs and People. Developing People. Compensation and Recognition. Recruitment and Selection. Developing a Healthy Work Environment and Effective Employee Relations.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
State the theoretical Knowledge and current Practices of Human Resource Management	C-1	11
Apply the knowledge of human resource management in different Situations/Case studies/Scenarios.	C-3	12
Asses the Practices of Human Resource Management in modern workplaces, in a group.	C-6	9

Describe competence in development and problem solving in areas of HR management	C-2	11
Identify and appreciate the significance of the ethical issues in HR	C-1	8
Formulate innovative and sustainable solutions to problems in the filed of HR.	A-4	7
Demonstrate the competence in communicating and exchanging ideas in a group context.	P-4	10
Evaluate HR related social, cultural, ethical and environmental responsibilities and issues in a group context	C-6	6

Week-wise Course Plan	
Week	Topics
1	Human Resources Management-Roles and Responsibilities
2	The Changing Role of HRM and Growing Professionalism within the HR Function
3	HRM Challenges in the Twenty-First Century
4	Legal issues in HRM
5	Job Design
6	Job Analysis
7	Human Resources Planning
8	Understanding a Shifting Labour Market
9	Employee Orientation and Socialization
10	Training and Development
11	Performance Management
12	HR's Role in Setting a Climate for People Development
13	Employee Compensation
14	Incentives and Rewards
15	Employee Benefits and Services
16	Trends in Compensation and Benefits

8.37 Human Computer Interaction

Course Contents: Contexts for HCI, Psychology of usable things, Processes for User-Centered Design, Metrics and Measures for Evaluation, Usability heuristics and principles of Usability testing, Physical capabilities, Cognitive and social models for interaction design, Principles of good interaction design, Accessibility, Principles of GUI, Visual design elements, Data gathering, Task analysis, Prototyping, Help and user documentation, Internationalization, Usability inspection methods, Usability testing methods, New Interaction Technologies,

Usability in practice, Visual Design and Typography, Icon Design, Ubiquitous, Augmented and Virtual Reality.

COURSE LEARNING OUTCOME (CLO)	Blooms Taxonomy Level	PROGRAM LEARNING OUTCOME (PLO)
Explain context of HCI and different measures for evaluation.	C-2	2
Apply the principles of good design for people from the perspective of age and disabilities.	C-3	3
Analyze techniques for user centred design for a medium sized software.	C-5	4
Evaluate the usability of a medium size software user interface.	C-5	4

Week-wise Course Plan	
Week	Topic
1	Contexts for HCI Psychology of usable things
2	Processes for User-Centered Design Metrics and Measures for Evaluation
3	Usability heuristics and principles of Usability testing
4	Physical capabilities Cognitive and social models for interaction design
5	Principles of good interaction design Accessibility
6	Principles of GUI
7	Visual design elements Data gathering
8	Task analysis Prototyping
9	Help and user documentation
10	Internationalization Usability inspection methods
11	Usability testing methods
12	New Interaction Technologies
13	Usability in practice

14	Visual Design and Typography
15	Icon Design
16	Ubiquitous, Augmented and Virtual Reality

8.38 Professional Ethics

Course Content: Computing Profession, Computing Ethics, Philosophy of Ethics. The Structure of Organizations, Finance and Accounting, Anatomy of a Software House, Computer Contracts, Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe moral and ethical concepts in professional practices/organizations and standard codes of conduct/ethics.	C-2	8
Explain the structure of different organizations with respect to implementation/ consideration of professional ethics and societal concerns	C-2	6
Evaluate multiple ethical/unethical situations in different contexts.	C-6	12
Demonstrate effective team membership skills and contribute collaboratively with diverse team environment	C-3	7
Communicate effectively in written and spoken English to transfer complex knowledge related to professional behaviour to technical and non-technical audiences.	A-2	10

Week-wise Course Plan	
Week	Topic
1	Introduction to Ethics and their importance in Computing

2	Academic Integrity and Plagiarism, Plagiarism and its types, Copyright, Patent, The Basis of property law, Legal Aspects
3	Computer Crime and Security, What is Computer Crime? Who are the Computer Criminals? Computer Fraud
4	Computer Crime and Security, Hackers and Hacking, Cracking, Computer Sabotage, Security, Legislation, and Education
5	Privacy and Anonymity, The Invasion of Privacy, The Right of Privacy, Methods of Privacy Violation
6	Intellectual Property, The Problem of Information ownership, Arguments For and Against property, Intellectual Property Rights
7	Intellectual Property Protecting Intellectual Property Free Software, Adware & Spyware Pirated software
8	Software Piracy The Moral Implications of Software Piracy Islamic Perspective of software piracy Piracy vs Plagiarism
9	Mid Term Examination
10	Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice.
11	Bioinformatics and computational genomics, Introduction & Basic issues, Judgments about individuals (Employment/ Insurance), Ethical concern on ownership of genetic data, Ethical concerns in plants and animals genomics, Cloning, Genetic Engineering
12	The Structure of Organizations, Anatomy of a Software House, Finance and Accounting, JD (Job Descriptions) & Contracts
13	Case Study: Exploiting Professional Practices in IT Industry
14	Ethics aspects in managing HR
15	Social Application of Ethics Accountability and Auditing Pirated software\license issues Computers and Health Medical Robots Telemedicine
16	Ethical Concerns in: Off-shore Employment (anonymous), Free lancing FIA (roles)

8.39 Information System and Data Processing

Course Contents: Introduction to Information Systems (ISs) and digital firm, Information Systems of a digital firm Business perspective on ISs. Dimensions of ISs; Organizations, Technology, Management, Management Levels in an organization, Major types of ISs from management point of view, Enterprise Applications, Business perspective on ISs, E-commerce and the internet, The Mobile digital platform and mobile e-commerce, Managing Project Risk.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe the role that information systems play in business operations, management, and strategy.	C-2	11
Analyze how common software, hardware, database, and networking applications can be applied to business problems.	C-4	2
Differentiate between traditional computer file systems and current data base management systems	C-4	2
Describe the contemporary approaches to information system and its business function point of view	C-2	1
Analyze business processes and the impact of computer use on society.	C-4	6

Week-Wise Course Plan	
Week	Topic
1	Introduction to Information Systems (ISs) and digital firm New business environment of this age
2	Information Systems of a digital firm Business perspective on ISs. Dimensions of ISs; Organizations, Technology, Management
3	Contemporary approaches to Information Systems Flow of information in a digital firm; Information Architecture
4	Management Levels in an organization Major types of ISs from management point of view
5	Major Business functions Types of Information Systems from business function point of view
6	Business Processes and their importance Enterprise Applications
7	Information Systems of a digital firm Business perspective on ISs
8	E-commerce and the internet E-commerce: Business and Technology
9	The Mobile digital platform and mobile e-commerce Building an e-commerce website
10	Systems Development and Organizational change Business Process Redesign
11	Alternative Systems-Building Approaches Application Development for the Digital Firm

12	The importance of Information Systems Project Management Selecting ISs projects
13	Establishing the business value of Information Systems Managing Project Risk
14	Database approach to data management
15	Databases for improved business performance and decision making Managing Data-Resources
16	Mini Projects Discussion and Evaluation

8.40 Organizational Behaviour

Course Contents: Introduction to organizational behavior, society diversity, ethics, individual personalities and behaviour, Organizational Culture, Motivation in the Workplace, Managing Stress and Emotions, Communication in the Workplace, Managing Stress and Emotions, Communication in the Workplace, Group Dynamics, Managing Groups and Teams, Conflict and Negotiation, Leadership, Organizational Structure

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Describe the general history of management theory and practice and frame how organizational behavior has developed from these into a discrete field	C-2	6
Describe organizational behavior and differentiate between the three levels of influence	C-2	8
Describe contemporary issues and topics in organizational behavior	C-2	12

Week-Wise Course Plan	
Week	Topic
1	Introduction to Organizational Behavior
2	Social Diversity in the Workplace
3	Ethics in Business
4	Individual Personalities and Behaviors
5	Organizational Culture
6	Motivation in the Workplace

7	Managing Stress and Emotions
8	Communication in the Workplace
9	Group Dynamics
10	Managing Groups and Teams
11	Conflict and Negotiation
12	Making Decisions
13	Leadership
14	Organizational Structure
15	Organizational Change
16	Organizational Change

8.41 Marketing and Management

Course Contents: Introduction to Project Management, the Project Management and Information Technology Context, the Project Management Process Groups, Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Project Human Resource Management, Project Communications Management, Project Risk Management, Project Procurement Management, Project Management Tools.

Course Learning Outcome(s) - CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Demonstrate critical thinking and focus on managerial problems in an articulate way to figure out the solution	C-3	6
Identify the significance of the management process and know the contemporary management practice in different applications	C-1	11

Week-wise Course Plan	
Week	Topics
1	Foundation of management. Definition Scope and Function of Management, Different levels, Roles and Skills of Management, Management & Organization
2	Current trends & Issues of Management; workforce diversity, globalization, IT development, Knowledge Management, Innovation and Creativity etc.
3	Management theories and perspectives. Evolution of Management Theories, Scientific Management, Administrative Management, Bureaucratic Management

4	Behavioral theories, Hawthorne Studies, System Approach, Contingency Approach, Organizational culture & environment: Different Views and Sources of Culture.
5	. External & Internal Environmental Factors, Task & Mega Environment, Corporate social responsibility, Views on CSR, value based management
6	Ethics in management, factors affecting ethics and improving ethical behaviors, Decision making: Decision making process of eight steps and its Conditions.
7	Decision Making Errors and Biases, Types of Problems and Respective Decisions., Foundation of planning: Conceptual View of Planning and its Purpose and importance.
8	Challenges and Types of Planning, Types and characteristics of Goals and Plans, Developing Organizational Goals. Traditional Approach and MBO
9	Organizing; Foundation of Organizational Structure and design, Contingency Factors. Types of Organizational Structure, Departmentalization & Chain of Command.
10	Span of Control & Formalization, Centralization and Decentralization, Work division, Mechanistic & Organic Organizations, Traditional & Contemporary Designs.
11	Environmental Uncertainty, Scanning and dynamism effects on Organizational Design. Leadership and management: Differences and Similarities, Who are Leaders? What is Leadership?
12	Early Leadership Theories: Trait & behavioral theories, Different Leadership Styles. Models of Leadership: Fielders Model, Path Goal Theory, Blanchard Situational Theory.
13	Contemporary Theories of Leadership: Transactional, Transformational and LMX Theory. Foundation of Control: Importance of Control, Control Process of different steps.
14	Elements, Approaches and Types of Controlling, Organizational Performance. Measures to Control Organizational Performance. Control Strategies for deviations.

8.42 Information security

Course Contents: Introduction to Information Assurance and security, Information security Principles, Standards of Information Assurance, Terms related to Information Security, Cyber Security, Cyber security threats and measures, Cryptography, Cryptography types, Authentication and Signature Techniques, Typical Network Attacks and Threats from the Internet, Passive Measures to Ward off Network Attacks, Active Measures to Safeguard an Enterprise Network.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain the Information Security Principles	C-2	1
Describe the concepts of cryptology, cyber security, and network concepts.	C-2	1
Analyse case studies for Designing and Auditing a Security System	C-4	2

Week-wise Course Plan	
Week	Topics
1	Introduction to Information Assurance and security
2	Information Security Principles
3	Standards of Information Assurance
4	Terms, Concepts and Tradeoffs Related to Information Security
5	Introduction to Cyber Security
6	Cyber Security Threats and Measures
7	Cyber Security Threats and Measures
8	Introduction to Cryptography
9	Symmetric Cryptography
10	Asymmetric Cryptography
11	Secure Identity, Authentication and Signature Techniques
12	Understanding Basic Network Concepts
13	Typical Network Attacks and Threats from the Internet
14	Passive Measures to Ward off Network Attacks
15	Active Measures to Safeguard an Enterprise Network
16	Case Study for Designing and Auditing a Security System

8.43 Software Re-Engineering

Course Contents: Software Life cycle, Corrective maintenance and its techniques, Preventive maintenance and its techniques, Program Comprehension: familiar code reading, Program Comprehension: unfamiliar code reading, Program Comprehension: Tools for program comprehension, Program slicing, Evolution of Legacy Systems, Program translation, Reengineering requirements, Reengineering software architecture, Data-Oriented Challenges to Evolution.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain the concepts and technique of software reengineering.	C-2	1
Apply reengineering techniques to maintain and modify software systems.	C-3	3
Analyze and understand maintenance related problems associated with object-oriented software systems.	C-4	2

Week-wise Course Plan	
Week	Topics
1	The Real Software Lifecycle
2	Techniques for Corrective Maintenance
3	Techniques for Preventive Maintenance
4	Program Comprehension: familiar code reading
5	Program Comprehension: unfamiliar code reading
6	Program Comprehension: Tools for program comprehension
7	Program slicing
8	Evolution of Legacy Systems
9	Program translation
10	Restructuring programs
11	Reengineering requirements
12	Reengineering software architecture
13	Object oriented software systems
14	Object oriented software systems
15	Data-Oriented Challenges to Evolution
16	Data-Oriented Challenges to Evolution

8.44 Software Construction

Course Contents: Introduction to languages, natural languages Descriptive definition of a language, Recursive Definition of Languages, Regular Expressions, Finite automata, Finite automata Transition Graphs, Kleene's Theorem and proofs, NFA -Formal definition, Language of an NFA, Equivalence of DFAs and NFAs, Context-free Grammars (CFGs), Definition, Relationship between parse trees and derivations, Phases of Compilers, Translation Schemes,

Lexical Analysis (Scanning), Parsing, Introduction to languages, natural languages Descriptive definition of a language.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain the concept of languages in software construction	C-2	1
Design regular expressions, context free grammar and automata	C-3	2
Carryout the compiler phases for real time problems	C-3	3

Week-wise Course Plan	
Week	Topics
1	Introduction to languages, natural languages Descriptive definition of a language
2	Recursive Definition of Languages
3	Regular Expressions
4	Regular Expressions continued
5	Finite automata
6	Finite automata Transition Graphs
7	Kleene's Theorem and proofs
8	Kleene's Theorem and proofs continued
9	NFA -Formal definition, Language of an NFA, Equivalence of DFAs and NFAs,
10	Context-free Grammars (CFGs)
11	Definition, Relationship between parse trees and derivations
12	Phases of Compilers
13	Translation Schemes
14	Lexical Analysis (Scanning)
15	Parsing

8.45 Analysis of Algorithm

Course Contents: Introduction; role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations, Big-O, Big Ω , Big Θ , little-o, little- ω , Sorting Algorithm analysis, Loop invariants, Recursion and recurrence relations, Algorithm Design Techniques, Brute Force Approach, Divide-and-conquer approach, Merge, Quick Sort, Greedy approach, Dynamic programming, Elements of Dynamic Programming, Search trees; Heaps, Hashing;

Graph algorithms, shortest paths, sparse graphs, String matching, Introduction to complexity classes Architecture.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain the basic concepts in algorithmic analysis	C-2	1
Apply algorithmic analysis & design principles to a problem	C-3	3
Analyse sorting algorithms	C-4	4
Explain search trees algorithms and their analysis	C-2	1

Week-wise Course Plan	
Week	Topics
1	Introduction; role of algorithms in computing.
2	Analysis on nature of input and size of input Asymptotic notations
3	Big-O, Big Ω , Big Θ , little-o, little- ω , Sorting Algorithm analysis
4	Loop invariants, Recursion and recurrence relations.
5	Algorithm Design Techniques.
6	Brute Force Approach, Divide-and-conquer approach.
7	Merge, Quick Sort.
8	Greedy approach
9	Dynamic programming.
10	Elements of Dynamic Programming,
11	Search trees; Heaps
12	Hashing; Graph algorithms.
13	shortest paths
14	sparse graphs
15	String matching
16	Introduction to complexity classes Architecture

8.46 Introduction To Information and Communication Technology

Course Contents: Introduction to Computer Systems, Looking inside the computer systems, Interacting with your Computer, How do computers represent data, Binary Arithmetic, Boolean algebra: AND, OR, NOT, Processing in a computer, Factors affecting processing speed,

Algorithms, flowchart, pseudo code, basic programming techniques, Operating system basics, Networking basics LAN, WAN, How to write simple program in C language.

Course Learning Outcome(s) – CLO	Bloom's Taxonomy Level	Program Learning Outcome(s) - PLO
Explain basic computer organization and functions of various computer hardware and software components.	C-2	1
Explain modern computer security risks, digital privacy and basic of computer networks	C-2	1,8
Practice hardware components, operating systems and Office Automation tools	P-3	5

Week-wise Course Plan	
Week	Topics
1	Introduction to Computer Systems: What is computer, Digital and Analog Computers, Computers for individual users and for organizations
2	Looking inside the computer systems: Parts of Computer system, Information processing cycle, Essential computer hardware, Processing devices, Memory devices, Input and output devices, Overview of computer graphics, Storage devices, Computer software, Computer data, Computer users
3	Interacting with your Computer: Input devices, Keyboard, Mouse, Variants of the mouse, Devices for the hand, Optical input devices, Audio/visual input devices
4	How do computers represent data: Number systems, Binary number system, Decimal to binary conversion, Example, Binary to decimal conversion, Example
5	Binary Arithmetic: Binary addition, Binary multiplication, Binary subtraction and their Examples
6	Binary Arithmetic: Binary division, Signed numbers, 1's complement, 2's complement, Subtraction with signed numbers, Octal number system, Hexadecimal number systems
7	Boolean algebra: AND, OR, NOT
8	Processing in a computer: VON Neumann architecture, Machine cycles

9	Processing in a computer: Machine cycles Memory
10	Factors affecting processing speed: Registers, Memory and Computing power, The computer's internal clock, The bus, The system bus, The data bus, The address bus, Cache memory
11	Algorithms, flowchart, pseudo code
12	Basic programming techniques
13	Operating system basics
14	Networking basics LAN, WAN
15	Programming Language introduction
16	How to write simple program in C language

9. Lab-Outline

9.1 Introduction to Computing

S #	CLO Statement	Domain	Taxonomy Level	PL O
1	Demonstrate knowledge about the practical aspects of computer system.	Cognitive	3	1
2	Achieve knowledge of different features of Operating Systems and typing tools to achieve the ability for developing solutions of Engineering problems.	Psychomotor	2	3
3	Adopt efficient time and resource allocation strategy to complete the assigned task	Affective	3	11
4	Assist to report the outcome of an experiment/task in standard format.	Affective	2	10

Week-wise Course Plan	
Week	Topics
1	Identification of Parts of Computer
2	Computer Keyboard Shortcuts and Special Characters
3	Acquaintance with the use of Graphical User Interface on Operating System (Desktop, Start menu , Taskbar and graphical icons)
4	Study of Components of Central Processing Unit
5	Acquaintance with use of Picture Editor
6	Acquaintance with use of Text Editor

7	Electronic mail and E-mail Application
8	Acquaintance with use of web browser and search engine for better use of internet for knowledge
9	Acquaintance with use of Word Processing Editor
10	MS Word and Use of tables in document
11	Acquaintance with use of MS Power Point
12	Using Custom Animation in MS PowerPoint Presentation
13	Acquaintance with use of spreadsheet Editor MS Excel
14	Google Doc, Google Sheet, Google Slides and Office Lens(Pocket Scanner)

9.2 Applied Physics

S #	CLO Statement	Domain	Taxonomy Level	PL O
1	Practice hands on experience on primary electronic lab instruments including DMM, function generator & oscilloscope.	Psychomotor	3	1
2	Use Resources to construct an electronic circuit on bread board and observe its output on oscilloscope by applying practical knowledge acquired in lab using different passive components	Affective	3	4
3	Report the outcome of an experiment/task in standard format.	Affective	2	10
4	Assess knowledge of constructing an electronic circuit for a given set of constraints	Cognitive	6	1
5	Choose an individual or team to solve real world problems.	Affective	3	9

Week-wise Course Plan	
Week	Topics
1	Introduction to Electric Charge, Conductors, Insulators and Induced Charges
2	Coulomb's Law, Electric Field and Electric Forces, Electric-Field Calculations
3	Electric-Field Lines, Electric Dipole
4	Charge and Electric Flux, Calculating Electric Flux
5	Gauss's Law, Applications of Gauss's Law, Charges on Conductors
6	Introduction to Electric Potential Energy, Electric Potential, Calculating Electric Potential
7	Equi-potential Surfaces, Potential Gradient
8	Capacitors and Capacitance, Capacitors in Series and Parallel
9	Energy Storage in Capacitors and Electric-Field Energy, Dielectrics
10	Molecular Model of Induced Charge, Gauss's Law in Dielectrics
11	Current, Resistance and Electromotive force

12	Electromotive Force and Circuits, Energy and Power in Electric Circuits, Theory of Metallic Conduction
13	Magnetism, Magnetic Field, Magnetic Field Lines and Magnetic Flux
14	Motion of Charged Particles in a Magnetic Field, Application of Motion of Charged Particles
15	Magnetic Force on a Current Carrying Conductor, Force and Torque on a Current Loop, Direct Current Motor
16	The Hall Effect

9.3 Programming Fundamental

S #	CLO Statement	Domain	Taxonomy Level	PL O
1	<i>practice</i> various programming concepts to perform logical and computational tasks.	Psychomotor	3	3
2	<i>Use resources</i> and time allocation to complete the assigned task	Affective	3	11
3	<i>Respond</i> the outcome of an experiment/task in standard format.	Affective	2	10
4	<i>Analyze</i> knowledge about the practical aspects of Introduction of Programming Lab Course	Cognitive	2	1
5	<i>Choose</i> as an individual or in team to solve real world problems.	Affective	3	9

Week-wise Course Plan	
Week	Topics
1	Introduction to computers software and hardware. Problem solving and programming.(high level languages vs. low level languages) Compilers vs. interpreters. Phases of a C++ program.
2	Structure of a C++ program, input and output statements. Algorithms, Pseudo code
3	Flow Charts, Data Types , variables, Operators
4	Selection statements (if and if else statement)
5	else if statement, nested if's , and break statement
6	Switch statement , conditional operator, manipulators
7	Iteration statements : While loop , for loop
8	Do-while loop , nested loops
9	Arrays , declaration , initialization , printing .Basic operations : searching , sorting , insertion , removal

10	2D arrays : declaration, initialization , printing Basic operations : searching , insertion , removal
11	Function : declaration , initialization , parameters , return types , return statement , local vs. Global variables
12	Functions parameters passing techniques: pass by value and pass by reference Passing Arrays to function.
13	Introduction to user defined data type Structures: declaration, initialization. Structure operations: copy, comparison.
14	String handling :Basic operations: string length , sorting , copy , concatenation , comparisons
15	Standard template library
16	Practical problem solving

9.4 Object Oriented Programming

S #	CLO Statement	Domain	Taxonomy Level	PL O
1 .	<i>practice</i> problems by applying the concepts of data encapsulation, inheritance and polymorphism.	Psychomotor	3	3
2 .	Use resources and time allocation to complete the assigned task	Affective	3	11
3 .	Respond to the outcome of an experiment/task in standard format.	Affective	2	10
4 .	Analyze knowledge about the practical aspects of Introduction of Programming Lab Course	Cognitive	2	1
5 .	Choose as an individual or in team to solve real world problems.	Affective	3	9

Week-wise Course Plan	
Week	Topics
1	Exploring Dev-C++ IDE
2	Implementation of Classes & objects in C++
3	Class constructor and destructor
4	Constant and non-constant function
5	Static data member and functions
6	Function overloading and Operator overloading
7	Unary & binary Operator Overloading
8	Inheritance
9	Virtual Functions
10	Abstract classes
11	Interfaces
12	Streams and Files

13	Function Templates and Class Templates
14	Exception Handling
15	Open Ended Lab
16	Project Presentation

9.5 Software Requirement Engineering

CLO's with Taxonomy level and Mapping to PLO				
CLO	CLO Statement	Domain	PLO	BLOOM
CLO-1	Understand the Software Requirements Engineering Process and software requirements and undertake the requirements elicitation tasks.	Cognitive	PLO-01	C2
CLO-2	Analyze the client needs by creating models of requirements using a variety of notations and techniques	Cognitive	PLO-5	C3
CLO-3	Create software requirements specifications based on standard and validate them.	Cognitive	PLO-3	C2

Weeks	Week Experiment Detail
Week 01	LAB 01: Introduction to Requirement Engineering <ul style="list-style-type: none"> Introduction to Requirement Engineering. Assignment of projects to groups
Week 02	LAB 02: Introduction to Unified Modeling Language <ul style="list-style-type: none"> UML modelling. Modelling Diagrams Star UML modelling tool
Week 03	LAB 03: Requirement Elicitation Techniques <ul style="list-style-type: none"> Elicitation of Requirements and analysing their effectiveness. Preparing Questionnaires and conducting surveys for system requirements
Week 04	LAB 04: Requirement Elicitation Techniques cont. Prototyping, and Tool for development of Prototypes.
Week 05	LAB 05: Introduction to Use cases. <ul style="list-style-type: none"> Introduction to Use cases Extracting Use Cases for the System Design
Week 06	LAB 06: UseCase Modeling <ul style="list-style-type: none"> Drawing Use Case Diagrams by Problem analysis of Case Study/projects Identification of Stake Holders.
Week 07	LAB 07: Full Dress UseCase <i>Use Case writing in detail</i>
Week 08	MID LAB EXAM

Week 09	LAB 08: Definition of a System Scope Defining the System Scope and Constraints imposed on it.
Week 10	LAB 09: Working with Class Diagram <ul style="list-style-type: none"> Understanding building blocks of a class diagram. Drawing class diagram of system under consideration.
Week 11	LAB 10: Business Modeling /Project Domain Model <ul style="list-style-type: none"> Understanding system domain of a project. Designing Business Domain Model of (SUC) system under consideration
Week 12	LAB 11: Working with Interaction Sequence Diagram <ul style="list-style-type: none"> Understanding the building blocks of a Sequence Diagram. Drawing Sequence Diagram of system under consideration
Week 13	LAB 12: Working with Interaction Collaboration Diagram <ul style="list-style-type: none"> Understanding the building blocks of a Collaboration Diagram Drawing Collaboration Diagram of system under consideration
Week 14	LAB 13: Working with Interaction State-Chart Diagram <ul style="list-style-type: none"> Understanding the building blocks of a State-Chart Diagram Drawing State-Chart Diagram of system under consideration
Week 15	LAB 14: Software Requirement Specification Documents <ul style="list-style-type: none"> SRS writing System Modelling.
Week 16	FINAL LAB EXAM

9.6 Data Structures and Algorithm

S #	CLO Statement	Domain	Taxonomy Level	PLO
1	Demonstrate knowledge about the practical aspects of data structures & algorithms Lab Course	Cognitive	3	1
2	Produce Data structures & Algorithms based solutions that meet specified needs for an engineering problem at hand	Psychomotor	4	3
3	Assist to report an engineering task in the required format	Affective	2	10
4	Care for time and resource allocation to complete the assigned task	Affective	2	11
5	Behave and work effectively as an individual or in team to solve real world problems.	Affective	3	9

Week-wise Course Plan	
Week	Topics
1	Introduction to Data Structures : Built-in Data types & Derived Data Types

2	Arrays: Implementation of Basic operations , Dynamic Array
3	Link List: Node Creation, different insertion operations, display elements in link list
4	Link List: Complete singly link list and circular link list implementation
5	Link List: Doubly link list implementation
6	Stack: Static & dynamic implementation
7	Recursive functions :Implementation of factorial(Iterative and recursive algorithms)
8	Queues: Basic Functions (Enqueue&Dequeue)
9	Implementation of queues with arrays and linked lists Application of queues
10	Circular Queue Implementation
11	Searching Algorithm: Linear search, Binary search
12	Sorting Algorithms: bubble sort, merge sort etc.
13	Trees: Implementation of Binary search tree
14	Graphs & Hashing
15	Project presentation & Viva
16	

9.7 Software Design & Architecture

S #	CLO Statement	Domain	Taxonomy Level	P L O
1	Use resources and time allocation to complete the assigned task	Affective	3	11
2	Demonstrate knowledge about tools and techniques for designing and documenting the software systems.	Psychomotor	4	3
3	Respond to the outcome of an experiment/task in standard format.	Affective	3	10
4	Discuss knowledge about the practical aspects of Software design and architecture lab course.	Cognitive	2	1

Week-wise Course Plan	
Week	Topics
1	Introduction and project definition
2	Software Requirements Specification

3	Introduction to UML and use case diagrams
4	System modeling ER
5	System modeling DFD
6	Flow of events
7	Activity diagram
8	OO analysis: discovering classes
9	Interaction diagrams: sequence diagrams
10	Interaction diagrams: collaboration diagrams showing client server architecture pattern
11	Software Design: software architecture and object- oriented design
12	Draw Model view control (MVC) pattern of any project using UML Diagrams (open ended lab)
13	State Transition Diagram
14	Component diagrams showing component based architecture pattern
15	Deployment diagrams
16	Software testing and documentation

9.8 Introduction to Database Systems

S #	CLO Statement	Domain	Taxonomy Level	PL O
1	Comply with allocated time and resources to complete the assigned task	Affective	2	11
2	Practice the ability for developing solutions that meet specified needs for an engineering problem at hand	Psychomotor	3	3
3	Comply required format while submitting an engineering task	Affective	2	10
4	Demonstrate the learning of the concepts of Database system	Cognitive	3	3
5	solve real world problems effectively as an individual or in a team	Cognitive	3	9

Week-wise Course Plan	
Week	Topics
1	Introduction to MS Visio
2	Entity Relationship Diagram (ERD):Notations for Entities and Attributes
3	Entity Relationship Diagram (ERD):Notation of Relationships
4	Enhanced Entity Relationship Diagram (EERD)
5	Conversion of ERD to relational schema
6	Conversion of EERD to relational schema
7	Conversion of relational schema to physical schema

8	Normalization
9	Midterm Examination
10	Introduction to SQL, Data Definition Language (DDL): Create, Drop, Alter, Truncate etc.
11	Data Manipulation Language (DML) Part I: Insert, Select, Update, Delete.
12	Data Manipulation Language (DML) Part II: Joins: Inner & Outer Joins, Natural Join.
13	Data Manipulation Language (DML) Part III: Aggregate Function, Group by etc.
14	Views and Triggers
15	Sub Queries [Co-related & Non Co-related]
16	Backup and recovery, indexes

9.9 Operating System

S #	CLO Statement	Domain	Taxonomy Level	PLO
1	Practice the implementation of core functions of the operating systems.	Psychomotor	3	3
2	Use time and appropriate resources to complete the assigned task	Affective	3	11
3	Respond to the outcome of an experiment/task in standard format.	Affective	2	10
4	Demonstrate knowledge about the practical aspects of Operating System.	Cognitive	2	1
5	Choose as an individual or in team to solve real world Problems	Affective	3	9

Week-wise Course Plan	
Week	Topics
1	OS Administration-1: Installation of Linux Distribution (Ubuntu)
2	OS Administration-2: Exploring the Linux (Ubuntu) Environment
3	OS Administration-3: Essential Linux Commands
4	OS Administration-4: Process States In OS
5	Process Management-1: Process Creation
6	Process Management-2: Process Exit & Wait System Calls
7	Process Management-3: Creating and Managing Multiple/Orphan Processes
8	Process Scheduling-1: First Come First Serve (FCFS)

9	Process Scheduling-2: Shortest Job First
10	Process Scheduling-3: Round Robin
11	Mutual Exclusion using Semaphores
12	File I/O: Reading & Writing from/to a File
13	Inter-Process Communication Using Pipes
14	Memory Management
15	Memory Management II
16	Project Presentation

9.10 Web Engineering

S #	CLO Statement	Domain	Taxonomy Level	PL O
1	Demonstrate different design/develop solutions that meet specified needs for an engineering problem at hand.	Psychomotor	4	3
2	Comply with allocated time and resources to complete the assigned task	Affective	3	11
3	Follow standard format for submitting the outcome of an experiment/task.	Affective	2	10
4	Describe knowledge about the practical aspects of Web Engineering Lab Course	Cognitive	2	1
5	solve real world problems effectively as an individual or in a team	Cognitive	3	9

Week-wise Course Plan	
Week	Topics
1	HTML Text Formatting Tags, Tables, Forms and Controls, Classes & IDs, HTML5 elements
2	Cascading Style Sheets, selectors, styling borders, margins and padding, floating elements with CSS,
3	JavaScript variables, operators, arrays, loop, functions, objects, events, form validation & debugging
4	BootStrap framework, grid system, typography, tables, form, navbar, dropdown, images
5	Programming constructs in PHP (syntax, variables, arrays, loops, functions)
6	Connectivity with Database Server (database connection, CRUD operation, file upload)
7	Session maintenance in HTTP
8	AJAX (Asynchronous JavaScript & XML)
9	Installation of Laravel PHP Framework, artisan commands
10	Routing, Controllers, Blade templates (views)
11	Middleware, Migrations, Models, exploring Auth Scaffolding, Eloquent ORM and relations, Form
12	File uploading to a web server using FTP

13	Vue framework, Vue instance, data and methods in vue instance, lifecycle hooks, directives, form
14	Angular JavaScript Framework, syntax, module, controllers, expressions, directives, working with
15	Installation of Wordpress, dashboard review,
16	Project

9.11 Digital Image Processing

S #	CLO Statement	Domain	Taxonomy Level	PL O
1	Achieve knowledge of different image processing algorithms	Psychomotor	2	3
2	Adopt efficient algorithm to complete the assigned task	Psychomotor	6	4
3	Perceive basic concepts of programming in MATLAB and explain use of built-in and user defined functions to perform assigned	Psychomotor	1	5
4	Behave and work effectively as an individual or in team to solve real world problems.	Affective	3	9
5	Adopt efficient time and resource allocation strategy to complete the assigned task	Affective	4	11

Week-wise Course Plan	
Week	Topics
1	Introduction to MATLAB TOOL
2	Image Basic Operations
3	Pixel relationship
4	Image interpolation and Arithmetic operation
5	Image transformation I
6	Image Transformation II
7	Basic filter designing
8	Filtering in spatial domain – smoothing filters
9	Filtering in spatial domain – sharpening filters
10	Image Morphology I
11	Image Morphology II
12	Image segmentation basics
13	Image segmentation II
14	Introduction to Neural Networks - basics
15	Multi-layer Neural Network implementation
16	Project

9.12 Advance Databases

S #	CLO Statement	Domain	Taxonomy Level	PLO
1	<i>Practice</i> the skills to design and implement properly structured databases that match the standards based under realistic constraints and conditions.	Psychomotor	3	5
2	<i>Apply</i> different stages of database development using different data models.	Cognitive	3	5
3	<i>Comply with allocated</i> time and resources to complete the assigned task	Affective	3	11
4	<i>Follow</i> standard format for submitting the outcome of an experiment/task.	Affective	2	10
5	<i>solve</i> real world problems effectively as an individual or in a team	Cognitive	3	9

Week-wise Course Plan	
Week	Topics
1	Introduction to the MongoDB Project
2	Install the MongoDB, Configuration
3	MongoDB CRUD Operations
4	Update Documents
5	Indexing and Hashing
6	Create User and Add Role
7	Replication
8	SQL to MongoDB Mapping Chart
9	Map in Big Data
10	Geospatial Queries
11	Data Normalization
12	Microsoft Access vs MongoDB
13	Geo JSON Data
14	Project

9.13 Computer Communication and Networks

S #	CLO Statement	Domain	Taxonomy Level	PLO
1	Practice the skills to configure network systems and troubleshoot common networking issues using appropriate tools.	Psychomotor	3	5
2	Try different networking scenarios for the analysis of protocols.	Psychomotor	3	3
3	Comply with allocated time and resources to complete the assigned task	Affective	3	11
4	Follow standard format for submitting the outcome of an experiment/task.	Affective	2	10
5	solve real world problems effectively as an individual or in a team	Cognitive	3	9
6	Demonstrate knowledge about the practical aspects of Computer Networks and Internet	Cognitive	2	1

Week-wise Course Plan	
Week	Topics
1	Network Basic Commands: TCP/IP Configuration & Troubleshooting
2	Cable construction: Straight and Cross-Over
3	Building a Switched Based Network
4	Introduction to Wireshark- Packet Analyzer
5	Analysis of HTTP using Wireshark
6	Introduction to Socket Programming
7	UDP Socket Programming: Client and Server
8	TCP Socket Programming: Client and Server
9	Analysis of TCP traffic using Wireshark
10	IP Addressing, Sub-netting and DHCP Server Configuration
11	Basic Router Configuration and Password Operations
12	Advanced Router Configuration
13	Configuration of Routing Information Protocol (RIP) and an Internetwork
14	Configuration of Open Shortest Path First (OSPF) Protocol and an Internetwork
15	Design & Analysis of Star Topology Ethernet LAN in Network Simulator (e.g, NS-2/NS-3, Opnet)
16	Project

9.14 Software Testing

S #	CLO Statement	Domain	Taxonomy Level	PLO
1	Demonstrate the Automation Testing Approach.	Cognitive	3	1
2	Produce test suites for software.	Psychomotor	4	3
3	Execute Selenium server and demonstrate it using a script in Java/PHP	Psychomotor	4	5
4	Generate and test a program to login a specific web page.	Cognitive	5	5, 12
5	Generate and test a program to update student records into table into Excel file.	Cognitive	5	5,12
6	Generate and test a program to get the number of list items in a list / combo box.	Cognitive	5	12

Week-wise Course Plan	
Week	Topics
1	Understand The Automation Testing Approach
2	Introduction to Selenium IDE
3	Using Selenium IDE, Write a test suite containing minimum 4 test cases.
4	Conduct a test suite for any two web sites.
5	Install Selenium server and demonstrate it using a script in Java/PHP
6	Write and test a program to login a specific web page.
7	Write and test a program to update 10 student records into table into Excel file
8	Write and test a program to select the number of students who have scored more than 60 in any one subject (or all subjects).
9	Write and test a program to provide total number of objects present.
10	Write and test a program to get the number of list items in a list / combo box.
11	Write and test a program to count number of check boxes on the page checked and unchecked count
12	Take a case study and model it in different views i.e Use case view, logical view, component view.
13	Generate the deployment view, Database design, forward and Reverse Engineering, and Generation of documentation of the case study
14	Project

9.15 Artificial Neural Networks

S #	CLO Statement	Domain	Taxonomy Level	PL O
1	Demonstrate the knowledge about basics of artificial neural networks	Psychomotor	4	4
2	Apply supervised and unsupervised Learning in machine learning using neural networks	Psychomotor	5	5
3	Discuss the knowledge about the practical aspects of machine learning algorithms	Cognitive	2	6
4	Behave and work effectively as an individual or in team to solve real world problems.	Affective	3	9
5	Produce lab reports as an individual or in a team to solve problems	Affective	4	11

Week-wise Course Plan	
Week	Topics
1	Python Input/Output, operators, Methods
2	Python (Iterations, Lists)
3	Python (Tuples, Dictionary, User-defined functions)
4	Python (object oriented)
5	NumPy-I (arrays, indexing, slicing)
6	NumPy-II (arrays join, split, sort, search, filter)
7	NumPy-(Exercise)
8	Pandas –I (Series, DataFrame)
9	Pandas-II (reindexing, iteration, sorting)
10	SciPy-I (basic functions, integration, optimization, Fourier transforms)
11	SciPy-II (multidimensional image processing functions)
12	Intro. To ML with scikit-learn
13	Implementing classification/regression techniques through Tensorflow
14	Building/implementing convolutional neural networks on Tensorflow
15	Deployment of Machine Learning Models
16	Project

9.16 Software Project Management Lab

S #	CLO Statement	Domain	Taxonomy Level	PLO
1	Practice open source tools for creation of tasks, setting the resources, assigning the resources, generating the reports and tracking the project.	Psychomotor	3	5,12
2	Generate function points and COCOMO using tool	Cognitive	5	5,12
3	Make Work Breakdown Structure (WBS) using tool.	Psychomotor	4	5,12
4	Make Gantt chart using tool	Psychomotor	4	5,12

	Week-wise Course Plan
Week	Topic
1	Introduction to MS project
2	Task creation in MS project
3	Setting Up Resources
4	Assigning Resources to the Tasks
5	Formatting & Printing Project Plan
6	Tracking Progress on Tasks, Project Monitoring and Control
7	Generate Dashboard and Reports (Resource, Cost Progress)
8	Mid-Term
9	Compute function points and COCOMO using online tool such as Tiny Calculator and STRS COCOMO calculator.
10	Implement function points computation using any programming language.
11	Creating Work Breakdown Structure (WBS) using ProjectLibre tool.
12	Draw Gantt chart and find critical path using ProjectLibre tool.
13	Draw Gantt chart and find critical path using GanttProject tool
14	Draw Gantt chart using Microsoft Excel.
15	Perform cost-benefit analysis using Microsoft Excel.
16	Project

10. Summary of Courses CLO vs PLO Mapping

[illegible]

Applied Physics (Lab)	√			√					√	√		
Functional English									√	√		√
Calculus & analy Geometry	√	√										
Introduction to Soft Engg	√											
Digital Logical Design	√	√	√	√								
Programming Fundamental	√		√	√								
Programming Fundamental (Lab)	√		√						√	√	√	
Linear Algebra	√				√							
Communication Skills	√							√	√	√		√
Num & Symb Computing	√			√								
Software Requirement and Specification	√	√		√						√		
Software Requirement and Specification (lab)	√		√		√							
Data Structures & Algorithm	√	√	√	√								
Data Structures & Algorithm (Lab)	√		√						√	√	√	
Pakistan Stud & Islamiyat						√	√	√		√		√
Technical Report Writing								√	√	√		√
Operating Systems	√	√		√								
Operating Systems (lab)	√		√						√	√	√	
Software Architecture Design	√		√	√								
Software Architecture Design (lab)	√		√							√	√	
Object Oriented Programming	√		√	√								
Object Oriented Programming (Lab)	√		√						√	√	√	
Intro to Database System	√	√	√	√								
Intro to Database System (lab)			√						√	√	√	
Principles of Management							√		√	√	√	√
Software Verification & Validation	√	√	√	√								
Object Oriented Software Engineering	√	√		√								
Software Engg Economics	√				√							
Probability & Statistics	√			√								
Web Engineering	√		√	√								
Web Engineering (lab)	√		√						√	√	√	

Digital Image Processing	√	√	√	√								
Digital Image Processing (lab)			√	√	√				√		√	
Comptr Comm & Networks	√	√		√								
Comptr Comm & Networks (lab)	√		√		√				√	√	√	
Formal methods in SE	√			√								
Artificial Intelligence	√		√	√								
Software Testing	√		√	√								
Software Testing (lab)	√		√		√							√
Software Project Management	√			√				√			√	√
Software Project Management (lab)					√							√
Human Resource Management						√	√	√	√	√	√	√
Human Comptr Interaction		√	√	√								
Professional Practices						√	√	√		√		√
Mob App & Development	√		√		√	√	√		√		√	
Advance Database Systems		√	√	√								
Advance Database Systems (lab)					√				√	√	√	
Artificial Neural Networks	√	√	√			√	√					
Artificial Neural Networks (lab)				√	√	√			√		√	
Information system and data processing	√	√				√					√	
Organizational Behaviour						√		√				√
Marketing and Management						√					√	
Information Security	√	√										
Software Re-engineering	√	√	√									
Software Construction	√	√	√									
Analysis of Algorithm	√		√	√								
Introduction to Information and Communication Technology	√				√			√				

