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FUTURE UNIVERSITY, BAREILLY

(Established under the Uttar Pradesh Private Universities (Third Amendment) Act, 2024)

COURSE CURRICULUM

AND

EVALUATION SCHEME

B.Tech(CS)

For the Students Admitted in Academic Session 2025-26

Effective From

Academic Session 2025-26

Prepared By

Future University, Bareilly

Approved By

Academic Council

Future University, Bareilly

Published By

Office of the Registrar

Future University, Bareilly

Academic Session: 2025-26



(This Curriculum and Evaluation Scheme shall be applicable to all students admitted to the B.Tech. Programme from the Academic Session 2025-26 onwards and shall remain in force until amended or revised by the Academic Council of Future University, Bareilly.)



FUTURE UNIVERSITY
(Established under Govt. of U. P. Act No. 12, 2024)

Study & Evaluation Scheme Of

Bachelor of Technology

B. TECH. (CS)

[Applicable w.e.f. Academic Session 2025-26]

Approved by Academic Council



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FUTURE UNIVERSITY

18th Milestone, Bareilly-Lucknow Highway NH-24
Near Faridpur, Bareilly, Uttar Pradesh 243503
Website: www.futureuniversity.in



Syllabus Applicable w.e.f. Academic Session 2025-2026

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SUMMARY

Programme	Bachelor of Technology B. Tech. (CS)				
Duration	Four years Full Time (eight semesters)				
Medium	English				
Minimum Required Attendance	75%				
Maximum Credit	170				
Minimum Credit (required for the degree)	160				
Assessment (Theory)	Mid Term	End Term		Total	
	30%	70%		100%	
Assessment (Practical)	Mid Term	End Term		Total	
	50%	50%		100%	
Internal Evaluation (Theory Papers)	Class Test I	Class Test 2	Assignment(s)	Other Activity (including attendance)	Total
	10 marks	10 marks	5 marks	5 marks	30 marks
Internal Evaluation (Practical Papers)	Experiment File Viva	Exam	Attendance	Total	
	10 marks	30 marks	10 marks	50 marks	
Duration of Examination (Theory)	Mid Term		End Term		
	3 hrs.		1 ½ hrs.		
Duration of Examination (Practical)	As per the requirement of the practical paper				

To qualify the course a student is required to secure a minimum of 40% marks in aggregate including the semester end examination and teachers' continuous evaluation. (i.e., both internal and external).

A candidate who secures less than of 40% of marks in a course shall be deemed to have failed in that course. The student should have at least 50% marks in aggregate to clear the semester. In case a student has more than 40% in each course, but less than 50% overall in a semester, he/she shall re-appear in courses where the marks are less than 50% to achieve the required aggregate percentage of 50% in the semester.

Question Paper Structure

1. *The question paper shall consist of six questions. Out of which first question shall be of short answer type (not exceeding 50 words) and will be compulsory. Question No. 1 shall contain 8 parts representing all units of the syllabus and students shall have to answer any five (weight age 4 marks each).*
2. *Out of the rest five questions, students shall be required to attempt all five questions, but there will be an internal choice of A or B. Each question will be from one unit of the syllabus. The weight age of Question No. 2 to 6 shall be 10 marks each.*

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Faculty of Engineering and Technology (Code: 05)

Department of Engineering and Technology

Bachelor of Technology in Computer Science and Engineering

Credit Framework for the B. Tech. (CS) -NEP-2020									Total Credit
Sem.	Major (Core)	Minor Stream	Multidisciplinary	Ability Enhancement Course	Skill Enhancement Course	Value Added Courses Common for All UG	Summer Internship	Research Project/ Dissertation	
1	10	4	5	0	2	2			23
2	10	2	5	0	2	2			21
Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline / Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester									
3	10	6	2	2	2				22
4	14	3		2					19
Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline / Subject provided they secure 4 credits in skill based vocational courses offered during first year or second year summer term.									
5	15	3			2				20
6	13	4						3	20
Students who want to undertake 3-year UG Programme will be awarded UG Degree in the relevant Discipline/ Subject Upon securing 120 credits									
7	11	3						6	20
8	9	4						12	25
Students will be awarded UG Degree (Honours) with Research in the relevant Discipline/ Subject provided they secure 160 credits (As per NEP guidelines)									

Total = 170 Credit

			Future University												
			B. Tech. in Computer Science (Undergraduate Regular)												
			Course Structure/ Degree Award Checklist 2025-2029												
Program Name:		B. Tech. (CS)									Program Code:	07			
			Total Credit of Program: 170									Branch Code:	05		
		Theory				Week			Evaluation Scheme		Total	Credit			
S N	Course Category	Code	Course Title		L	T	P	C A	E E						
Semester –I															
1	Multidisciplinary Course	HSS1101	Engineering Mathematics-1		3	0	0	30	70	100	3				
2	Minor Course	HSS1102	Advanced Engineering Physics		2	0	0	30	70	100	2				
3	Major Core Courses	EEE1103/EEC1103	Essentials of Electrical Engineering / Essentials of Electronics Engineering		3	0	0	30	70	100	3				
4	Major Core Courses	ECS1104/EME1104	Principles of Problem-Solving Using Advance C / Elements of Mechanical		3	0	0	30	70	100	3				
5	Value added course	ECS1105	AI for Everyone		2	1	0	30	70	100	3				
6	Minor Course	ECS1106	MOOC		Self-Paced Learning				100		3				
Practical															
7	Minor Course	HSS1170	Advanced Engineering Physics LAB		0	0	2	50	50	100	1				
	Major Core Courses	ECS1171/EME1171	Programming using advanced C LAB / EME Lab		0	0	2	50	50	100	1				
	Major Core Courses	EEE1172/EEC1172	Essentials of Electrical Engineering LAB / Essentials of Electronics Engineering LAB		0	0	2	50	50	100	1				
	Skill Enhancement Course	EME1173/EME1174	Workshop Practice Lab / Engineering Graphics Lab		0	0	4	50	50	100	2				

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11	Multidisciplinary Course	IKS1101	IKS-1 (Indian Knowledge System-1)	1	0	0	50	50	1
TOTAL				14	1	10	400	550	23

			Theory	Week			Evaluation Scheme		Total	Credit
SN	Course Category	Code	Course Title	L	T	P	CA	EE		
Semester –II										
1	Multidisciplinary Course	HSS1201	Engineering Mathematics – II	3	0	0	30	70	100	3
2	Minor Course	HSS1202	Environmental Science	2	0	0	30	70	100	2
3	Major Core Courses	EEC1203/EEE 1203	Essentials of Electronics Engineering / Essentials of Electrical Engineering	3	0	0	30	70	100	3
4	Major Core Courses	EME1204/EC S1204	Elements of Mechanical Engg. / Principles of Problem Solving Using Advance C	2	1	0	30	70	100	3
5	Value added course	ECS1205	AI for Engineers	2	1	0	30	70	100	3
6	Minor Course	ECS1206	MOOC	Self-Paced Learning					100	3
Practical										
7	Major Core Courses	EME1271/EC S1271	EME Lab/Programming using advanced C LAB	0	0	2	50	50	100	1
8	Major Core Courses	EEC1272/EEE 1272	Essentials of Electronics Engineering LAB / Essentials of Electrical Engineering	0	0	2	50	50	100	1
9	Skill Enhancement Course	EME1273/EM E1274	Engineering Graphics Lab / Workshop Practice Lab	0	0	2	50	50	100	1
10	Skill Enhancement Course	LSM1210	LSM - I (Life Skill & Mentoring I)	0	0	0				1
			TOTAL	14	3	8	300	500	900	21

			Theory	Week			Evaluation Scheme		Total	Credit
S N	Course Category	Code	Course Title	L	T	P	C A	EE		
Semester –III										
1	Multidisciplinary Course	HSS2301	Discrete Mathematics	2	0	0	3 0	70	10 0	2
2	Minor Course	HSS2302	Mathematics-III	2	0	0	3 0	70	10 0	2
3	Major Core Courses	ECS2303	Data Structures	2	1	0	3 0	70	10 0	3
4	Minor Course	ECS2304	MOOC	Self-Paced Learning					10 0	3
5	Major Core Courses	EEE2305	Digital Electronics	2	1	0	3 0	70	10 0	3
6	Skill Enhancement Course	ECS2306	Python Programming	2	1	0	3 0	70	10 0	3
Practical										
1	Major Core Courses	ECS2370	Data Structures Lab	0	0	4	50	50	10 0	2
2	Major Course	EEE2371	Digital Electronics Lab	0	0	4	50	50	10 0	2
3	Major Core Courses	ECS2372	Python Programming Lab	0	0	4	50	50	10 0	2
TOTAL				13	2	8	28 0	520	90 0	22

			Theory	WEEK			Evaluation Scheme			
S N	Course Category	Code	Course Title	L	T	P	C A	E E	Total	Credit
Semester-IV										
1	Major Core Courses	ECS2401	OOP's Concept using Java	3	0	0	30	70	100	3
2	Major Core Courses	ECS2402	Computer Organization & Architecture	3	0	0	30	70	100	3
3	Major Core Courses	ECS2403	Operating Systems	2	0	0	30	70	100	2
5	Minor Course	ECS2404	Recent Advances in Technology	2	0	0	30	70	100	2
6	Minor Course	ECS2405	MOOC	Self-Paced Learning					100	3
Practical										
7	Major Core Courses	ECS2470	OOP's Concept using Java Lab	0	0	4	50	50	100	2
8	Major Core Courses	ECS2471	Computer Organization & Architecture Lab	0	0	4	50	50	100	2
9	Major Core Courses	ECS2472	Operating System Lab	0	0	4	50	50	100	2
			TOTAL	12	0	12	300	500	900	19

			Theory	Week			Evaluation Scheme			
SN	Course Category	Code	Course Title	L	T	P	CA	E E	Total	Credit
Semester –V										
1	Major Core Courses	ECS3501	Design and Analysis of Algorithms	3	0	0	30	70	100	3
2	Major Core Courses	ECS3502	Database Management System	3	0	0	30	70	100	3
3	Major Core Courses	ECS3503	Compiler Design	2	0	0	30	70	100	2
4	Major Core Courses	ECS3504	Elective-1	3	0	0	30	70	100	3
5	Minor Course	ELA3505	Professional Law and Ethics	2	0	0	30	70	100	2
6	Minor Course	ECS3506	MOOC	Self-Pace Learning					100	1
Practical										
8	Major Core Courses	ECS3571	Design and Analysis of Algorithms Lab	0	0	4	50	50	100	2
9	Major Core Courses	ECS3572	Database Management System Lab	0	0	4	50	50	100	2

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10	Skill Enhancement Course	ECS3573	Internship	0	0	4	50	50	100	2
			TOTAL	13	0	12	300	500	900	20

		-	Theory	Week		Evaluation Scheme				
S N	Course Category	Code	Course Title	L	T	P	CA	EE	Total	Credit
Semester-VI										
1	Major Core Courses	ECS3601	Computer Networks	2	0	0	30	70	100	2
2	Major Core Courses	ECS3602	Elective II	3	0	0	30	70	100	3
3	Major Core Courses	ECS3603	Cryptography	2	0	0	30	70	100	2
4	Minor Course	ECS3604	Open Elective-I	3	0	0	30	70	100	3
5	Major Core Courses	ECS3605	Digital Image Processing	2	0	0	30	70	100	2
6	Minor Course	ECS3606	MOOC	Self-Pace Learning				100	1	
Practical										
8	Major Core Courses	ECS3671	Computer Networks Lab	0	0	4	50	50	100	2
9	Major Core Courses	ECS3672	Elective II Lab	0	0	4	50	50	100	2
10	Research Project/ Dissertation	ECS3673	Mini Project	0	0	6	50	50	100	3
			TOTAL	12	0	14	300	500	900	20

S N o	Course Category	CODE	Theory	Week			Evaluation Scheme		Total	Credit
			Course Title	L	T	P	C A	E E		
Semester –VII										
1	Major Core Courses	ECS4701	Elective- III	3	0	0	30	70	100	3
2	Major Core Courses	ECS4702	Elective- IV	3	0	0	30	70	100	3
3	Major Core Courses	ECS4703	Open Elective-II	3	0	0	30	70	100	3

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4	Minor Courses	ECS4704	Engineering Research Methodology	2	0	0	30	70	100	2
5	Minor Courses	ECS4705	MOOC	Self-Pace Learning					100	1
Practical										
6	Research Project/ Dissertation	ECS4771	Project-I	0	0	12	50	100	150	6
7	Major Core Courses	ECS4772	Elective- IV Lab	0	0	4	50	50	100	2
			TOTAL	11	0	16	220	430	750	20

S N	Course Category	Code	Theory Course Title	Week			Evaluation Scheme		Total	Credit
				L	T	P	C A	E E		
Semester-VIII										
1	Major Core Courses	ECS4801	Artificial Intelligence and Expert Systems	3	0	0	30	70	100	3
2	Major Core Courses	ECS4802	Elective-V	3	0	0	30	70	100	3
3	Minor Course	ECS4803	Elective- VI	3	0	0	30	70	100	3
4	Major Core Courses	ECS4804	Data Compression	3	0	0	30	70	100	3
5	Minor Course	ECS4805	MOOC	Self-Pace Learning					100	1
Practical										
6	Research Project/ Dissertation	ECS4871	Project – II	0	0	24	100	300	400	12
			TOTAL	12	0	24	220	580	900	25

SN	Course Category
1	Major (Core)
2	Minor Stream
3	Multidisciplinary
4	Ability Enhancement Course

5	Skill Enhancement Course
6	Value Added Courses Common for All UG
7	Summer Internship
8	Research Project/ Dissertation

SN		B. Tech. CS ELECTIVE-I
1	ECS3504	Fuzzy logic
2	ECS3507	Soft Computing
3	ECS3508	Discrete Mathematics
4	ECS3509	Graph Theory
5	ECS3510	System Programming
SN		B. Tech. CS ELECTIVE-II
1	ECS3602	Software Testing
2	ECS3607	Multimedia Systems
3	ECS3608	Principles of Programming Language
4	ECS3609	Web Development
5	ECS3610	Linux Administration
SN		B. Tech. CS ELECTIVE-III
1	ECS4701	Cyber Security
2	ECS4704	Pattern Recognition
3	ECS4705	Parallel Algorithm
4	ECS4706	Introduction to Machine Learning

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5	ECS4707	Introduction to IOT
SN		
		B. Tech. CS ELECTIVE-IV
1	ECS4702	Embedded and Real Time Systems/Embedded and Real Time Systems Lab
2	ECS4708	Neural Networks/Neural Networks Lab
3	ECS4709	OS for Smart Devices (Android)/ OS for Smart Devices (Android) Lab
4	ECS4710	Client Server Computing/Client Server Computing Lab
5	ECS4711	Cloud Computing/Cloud Computing Lab
SN		
		B. Tech. CS ELECTIVE-V
1	ECS4802	Distributed Databases
2	ECS4806	Entrepreneurship & Technology Management
3	ECS4807	Simulation and Modeling
4	ECS4808	Block Chain
5	ECS4809	Edge & Fog Computing
SN		
		B. Tech. CS ELECTIVE-VI
1	ECS4803	Advanced Computer Networks
2	ECS4810	Data Warehouse and Data Mining
3	ECS4811	Computational Complexity
4	ECS4812	DevOps
5	ECS4813	Autonomous Systems & Robotics
SN		
		CSE OPEN ELECTIVE-I
1	ECS3604	Total Quality Management
2	ECS3608	Human Computer Interaction
3	MBA3650	Entrepreneurship Development
4	HAS3626	Non-Conventional Energy Resource
5	HAS3628	Operational Research
SN		
		CSE OPEN ELECTIVE-II
1	HAS4725	Soft Skills and Interpersonal Communications

2	MBA4751	Human Resource Development and Organizational Behaviour
3	ECS4703	Product Development
4	HAS4727	Queuing Theory and Modelling
5	ECS4707	E-Governance and Digital Transformation



HSS2301	Discrete Mathematics	L T P 2 0 0	2 credits
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Course Objectives:

CO1	Introduce the fundamental concepts and structures of discrete mathematics.
CO2	Develop logical thinking and problem-solving skills.
CO3	Understand and apply principles of logic, set theory, relations, and functions..
CO4	Learn combinatory, graph theory, and trees essential for computer science
CO5	Provide a foundation for formal methods, algorithms, and theoretical computer science.

Unit-I

Logic and Proof Techniques: Propositional Logic and Truth Tables, Logical Connectives, Implications, Equivalences, Predicates and Quantifiers, Methods of Proof: Direct, Indirect, Contradiction, Contrapositive, Mathematical Induction.

Unit-II

Set Theory and Algebraic Structures: Sets, Subsets, Power Sets, Operations on Sets, Venn Diagrams, Set Identities, Cartesian Products, Relations and Their Properties, Functions: Types, Inverse, Composition, Partitions and Equivalence Relations.

Unit-III

Combinatorics and Recurrence: Counting Principles: Addition, Multiplication, Permutations and Combinations, Pigeonhole Principle, Inclusion-Exclusion Principle, Recurrence Relations and Solutions, Generating Functions.

Unit-IV

Graph Theory: Introduction to Graphs: Types and Representations, Graph Terminologies: Degree, Path, Cycle, Subgraphs, Special Graphs: Complete, Bipartite, Regular, Trees, Matrix Representation of Graphs, Graph Traversal: BFS, DFS, Eulerian and Hamiltonian Paths and Circuits, Planar Graphs and Graph Coloring.

Unit-V

Trees and Applications: Definition and Properties of Trees, Binary Trees, Binary Search Trees, Tree Traversals: Preorder, Inorder, Postorder, Spanning Trees, Kruskal's and Prim's Algorithms, Applications of Trees in Expression Parsing, File Structures, etc.



Text books and References:

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1. "Discrete Mathematics and Its Applications" – Kenneth H. Rosen, McGraw-Hill Education
2. "Discrete Mathematical Structures" – Bernard Kolman, Robert C. Busby, Sharon Cutler Ross, Pearson Education
3. "Elements of Discrete Mathematics" – C.L. Liu, D.P. Mohapatra, McGraw-Hill

COURSE OUTCOMES:

CO1	Apply the principles of logic and proof techniques in mathematical reasoning.
CO2	Use set theory, relations, and functions to model and solve problems.
CO3	Analyze and solve problems using combinatorics and recurrence relations.
CO4	Represent and manipulate discrete structures such as graphs and trees.
CO5	Apply graph theory concepts in solving network-related problems.



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HSS2302	Mathematics-III	L 3	T 0	P 0	3 credits
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Course Objectives:

CO1	The idea of partial differentiation and types of partial differential equations.
CO2	The idea of classification of second partial differential equations, wave, heat equation and transmission lines.
CO3	The basic ideas of statistics including measures of central tendency, correlation, regression and their properties.
CO4	The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
CO5	The statistical methods of studying data samples, hypothesis testing and statistical quality control, control charts and their properties.

Unit-I

Partial Differential Equations: Origin of Partial Differential Equations, Linear and Non Linear Partial Equations of first order, Lagrange's Equations, Charpit's method, Cauchy's method of Characteristics, Solution of Linear Partial Differential Equation of Higher order with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients.

Unit-II

Applications of Partial Differential Equations: Classification of linear partial differential equation of second order, Method of separation of variables, Solution of wave and heat conduction equation up to two dimensions, Laplace equation in two dimensions, Equations of Transmission lines.

Unit-III

Statistical Techniques I: Introduction: Measures of central tendency, Moments, Moment generating function (MGF), Skewness, Kurtosis, Curve Fitting, Method of least squares,

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Fitting of straight lines, Fitting of second degree parabola, Exponential curves, Correlation and Rank correlation, Regression Analysis: Regression lines of y on x and x on y, regression coefficients, properties of regressions coefficients and non linear regression.

Unit-IV

Statistical Techniques II: Probability and Distribution: Introduction, Addition and multiplication law of probability, Conditional probability, Baye's theorem, Random variables (Discrete and Continuous Random variable) Probability mass function and Probability density function, Expectation and variance, Discrete and Continuous Probability distribution: Binomial, Poisson and Normal distributions.

Unit-V

Statistical Techniques III: Sampling, Testing of Hypothesis and Statistical Quality Control: Introduction, Sampling Theory (Small and Large), Hypothesis, Null hypothesis, Alternative hypothesis, Testing a Hypothesis, Level of significance, Confidence limits, Test of significance of difference of means, T-test, F-test and Chi-square test, One way Analysis of Variance (ANOVA). Statistical Quality Control (SQC), Control Charts, Control Charts for variables ($\bar{X}$ and R Charts), Control Charts for Variables (p, np and C charts).



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Text books and References:

1. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003(Reprint).
2. S. Ross: A First Course in Probability, 6th Ed., Pearson Education India, 2002.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
4. T. Veerarajan : Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi.

COURSE OUTCOMES:

CO1	Remember the concept of partial differential equation and to solve partial differential equations
CO2	Analyze the concept of partial differential equations to evaluate the problems concerned with partial differential equations
CO3	Understand the concept of correlation, moments, skewness and kurtosis and curve fitting
CO4	Remember the concept of probability to evaluate probability distributions
CO5	Apply the concept of hypothesis testing and statistical quality control to create control charts.

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ECS2303	DATA STRUCTURES	L T P 2 1 0	3 credits
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Course Objectives:

CO1	Introduce the concept of data structures through ADT including List, Stack, Queues
CO2	To understand concepts about searching and sorting techniques.
CO3	To understand basic concepts about stacks, queues, lists, trees and graphs.
CO4	Able to analyze algorithms and determine their time complexity
CO5	To enable them to write algorithms for solving problems with the help of fundamental data structures.

Unit-I

Introduction: Basic Terminology, Elementary Data Organization, Algorithm, Time and space complexity of algorithms. Asymptotic notations, Abstract data types.

Arrays: Representation of arrays, insertion and deletion operations, Single and Multidimensional Arrays, Sparse Matrices and their representations.

Searching : Sequential search, Binary Search, Comparison and Analysis

Unit-II

Stacks: Primitive Stack operations: Push & Pop, Array and Linked Implementation of Stack. Application of stack: Prefix and Postfix Expressions conversion, Evaluation of postfix expression, Iteration and Recursion- Principles of recursion, Problem solving using recursion with examples such as binary search, Fibonacci numbers, and towers of Hanoi.

Queues: Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, Array and linked implementation of queues, Dequeue and Priority Queue.

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Unit-III

Linked List: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. Garbage collection and memory compaction.

Unit-IV

Trees : Basic terminology used with Binary Trees, Binary Tree Representation, Extended Binary Trees, Tree Traversal algorithms: Inorder, Preorder and Postorder, Constructing Binary Tree from given Tree Traversal, Binary Search Tree: Operation of Insertion , Deletion, Searching in Binary Search tree . Threaded Binary trees, Traversing Threaded Binary trees. Concept & Basic Operations of AVL Tree. B Tree: definitions, algorithms and analysis.

Unit-V

Sorting: Bubble sort, Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Two Way Merge Sort, Heap Sort. Performance and Comparison among all the methods. Hashing: Hash Function, Collision Resolution Strategies Graphs: Terminology used with Graph, Data Structure for Graph Representations: Adjacency Matrices, Adjacency List. Graph Traversal: Depth First Search and Breadth First Search, Connected Component, Spanning Trees, Minimum Cost Spanning Trees: Prims and Kruskal algorithm.



Text books and References:

1. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein "Data Structures Using C and C++", PHI
2. Horowitz and Sahani, "Fundamentals of Data Structures", Galgotia Publication
3. Jean Paul Trembley and Paul G. Sorenson, "An Introduction to Data Structures with applications", McGraw Hill
4. R. Kruse et al, "Data Structures and Program Design in C", Pearson Education
5. Lipschutz, "Data Structures" Schaum's Outline Series, TMH
6. G A V Pai, "Data Structures and Algorithms", TMH

COURSE OUTCOMES:

CO1	For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.
CO2	For a given Search problem (Linear Search and Binary Search) student will able to implement it.
CO3	For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.
CO4	Able to analyze algorithms and determine their time complexity
CO5	Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

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EEE2305	DIGITAL ELECTRONICS	L T P 2 1 0	3 credits
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Course Objectives:

CO1	Understand the concepts of various components
CO2	Understand concepts that underpin the disciplines of analog and digital electronic logic circuits.
CO3	Understand various Number systems and Boolean algebra, the Boolean expression using Boolean algebra and design it using logic gates.
CO4	Understand Design and implementation of combinational circuits.
CO5	Understand Design and develop sequential circuits.

Unit-I

Digital system and binary numbers: Signed binary numbers, binary codes, cyclic codes, Error detecting and correcting codes, hamming codes. Floating point representation Gate-level minimization: The map method up to five variable, don't care conditions, POS simplification, NAND and NOR implementation, Quine McClusky method (Tabular method).

Unit-II

Combinational Logic: Combinational circuits, analysis procedure, design procedure, binary addersubtractor, decimal adder, binary multiplier, magnitude comparator, decoders, encoders, multiplexers, Half adder, Full adder, Half subtractor, Full subtractor, Parallel binary adder & subtractor, Multiplexer (MUX) and Demultiplexer (DEMUX), Encoder and Decoder, Parity generator and checker, Comparator.

Unit-III

Synchronous Sequential logic: Sequential circuits, storage elements: latches, flip flops, analysis of clocked sequential circuits, state reduction and assignments, design procedure. Registers and counters: Shift registers, ripple counter, synchronous counter, other counters.

Unit-IV

Memory and programmable logic: RAM ROM, PLA, PAL.

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Design at the register transfer level: ASMs, design example, design with multiplexers.
Asynchronous sequential logic: Analysis procedure, circuit with latches, design procedure, reduction of state and flow table, race Free State assignment, hazards

Unit-V

Logic Families & IC Technology: Introduction to TTL and CMOS logic families,
Characteristics: Speed, Power, Noise margin, Fan-in, Fan-out, Interfacing between TTL and CMOS.



Text books and References:

1. M. Morris Mano and M. D. Ciletti, "Digital Design", 4th Edition, Pearson Education
2. Introduction to Digital Logic Design, JP Hayes, PHI.
3. The Art of Digital Design: An Introduction to Top-Down Design, Franklin P. Prosser, PHI

COURSE OUTCOMES:

CO1	Understand the concepts of various components to design stable analog circuits
CO2	Represent numbers and perform arithmetic operations
CO3	Minimize the Boolean expression using Boolean algebra and design it using logic gates.
CO4	Analyze and design combinational circuit.
CO5	Design and develop sequential circuits.

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ECS2306	Python Programming	L T P 2 1 0	3 credits
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Course Objectives:

CO1	Introduce students to the fundamentals of Python programming language.
CO2	Develop the ability to design and implement algorithms using Python.
CO3	Provide hands-on experience with Python for solving real-world problems.
CO4	Enhance programming skills using Python's data structures and object-oriented features.
CO5	Familiarize students with modules, file handling, and exception handling in Python.

Unit-I

Introduction to Python Programming: History and Features of Python, Python Installation and IDEs (IDLE, Jupyter, etc.), Syntax, Keywords, Identifiers, Variables, Data Types, Input/Output operations, Operators and Expressions, Type Conversion and Type Casting, Basic Python Programs.

Unit-II

Control Flow and Looping: Decision Making: if, if-else, elif, Loops: for, while, Nested Loops, Loop Control Statements: break, continue, pass, range() function and its use in loops

Unit-III

Functions and Modules: Defining and Calling Functions, Function Arguments and Return Values, Recursion, Lambda Functions, Modules and Packages, Built-in Functions and Importing Modules (math, random, datetime, etc.)

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Unit-IV

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Data Structures in Python: Strings and String Operations, Lists and List Comprehension, Tuples and Tuple Operations, Sets and Set Operations, Dictionaries and Dictionary Operations, Iterating through data structures, Understanding *args and **kwargs

Unit-V

Object-Oriented Programming in Python: Classes and Objects, __init__ Constructor Method, Class Variables and Instance Variables, Inheritance and Overriding, Encapsulation and Polymorphism, Exception Handling: try, except, finally, raise



Text books and References:

4. "Learning Python" by Mark Lutz
5. "Python Programming: An Introduction to Computer Science" by John Zelle
6. "Python for Everybody" by Charles R. Severance
7. Online Tutorials: Python.org, W3Schools, GeeksforGeeks, etc.

COURSE OUTCOMES:

CO1	Understand the syntax, semantics, and basic constructs of Python.
CO2	Apply Python data structures such as lists, tuples, sets, and dictionaries for data manipulation.
CO3	Implement functions and modules to structure code logically and efficiently.
CO4	Demonstrate file handling, exception handling, and use of built-in libraries.
CO5	Solve real-world problems using Python through hands-on mini-projects or case studies.



Text books and References:

1. Reussir Le Delf: This book comes with an audio CD and includes transcripts of what's said on the audio
2. Cosmopolite A1.
3. Collins.easy learning Complete French "Grammer + verbs + vocabulary"

COURSE OUTCOMES:

CO1	Engage in simple conversations and introduce themselves confidently. Ask and respond to basic questions in daily life situations (greetings, shopping, ordering food, travel, etc.).
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CO2	Understand and Apply Basic Grammar. Construct simple and grammatically correct sentences, phrases, and dialogues.
CO3	Improve Pronunciation and Listening Skills, Recognize and correctly pronounce commonly used French words and phrases.
CO4	Comprehend short articles, advertisements, and passages in French.
CO5	Gain Cultural Awareness, Gain language skills beneficial for careers in IT, business, tourism, hospitality, and international relations.



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ECS2370	Data Structures Lab	L T P 0 0 4	2 credits
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List of Programs to be Implemented in C language :

1. Implementation of Linear Search
2. Implementation of Binary Search.
3. Implementation of Largest and second largest in array
4. Implementation of Bubble Sort
5. Implementation of Selection Sort
6. Implementation of Insertion sort
7. Implementation of transpose of sparse matrix
8. Implementation of Single Linked List.
9. Implementation of Double Linked List
10. Implementation of Circular Linked List.
11. Implementation of Stack Using Single Linked List.
12. Implementation of Stack Using Array.
13. Implementation of Circular Queue Using Array.
14. Implementation of Queue Using Linked List.
15. Implementation of Tower of Hanoi
16. Implementation of Recursive Binary search
17. Implementation of Merge sort
18. Implementation of Quick Sort
19. Implementation of Heap sort
20. Implementation of Conversion of Infix Expression to Postfix Expression
21. Implementation of Postfix Expression Evaluation

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ECS2372	Python Programming Lab	L 0	T 0	P 4	2 credits
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List of Programs to be Implemented in Python language :

1. Write a Python program to perform basic arithmetic operations (Addition, Subtraction, Multiplication, Division).
2. Write a Python program to swap two numbers (with and without using a third variable).
3. Write a Python program to check whether a number is even or odd.
4. Write a Python program to find the largest of three numbers.
5. Write a Python program to find whether a given year is a leap year or not.
6. Write a Python program to display the multiplication table of a number.
7. Write a Python program to check if a number is prime or not.
8. Write a Python program to print the Fibonacci sequence up to 'n' terms.
9. Write a Python program to calculate the factorial of a number using a loop.
10. Write a Python program to print patterns using nested loops (e.g., stars, numbers, pyramid, etc.).
11. Write a Python program using user-defined functions to find factorial, prime, and palindrome.
12. Write a Python program to demonstrate default, keyword, and variable-length arguments (*args, **kwargs).
13. Write a Python program to demonstrate the use of lambda functions.
14. Write a Python program to import and use built-in modules (math, random, datetime).
15. Write a Python program to perform CRUD operations on a list.
16. Write a Python program to count the frequency of characters in a string.
17. Write a Python program to sort a dictionary by key and by value.
18. Write a Python program to remove duplicates from a list and convert it into a set.
19. Write a Python program to read and write data from/to a text file.
20. Write a Python class with constructor and methods to compute the area of a rectangle and a circle.



EEE2371	Digital Electronics Lab	L 0	T 0	P 4	2 credits
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LIST OF EXPERIMENTS:

1. Study of TTL gates – AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.
2. Design & realize a given function using K-maps and verify its performance.
3. To verify the operation of multiplexer & Demultiplexer
4. To verify the operation of comparator.
5. To verify the truth tables of S-R, J-K, T & D type flip flops.
6. To verify the operation of bi-directional shift register.
7. To design & verify the operation of 3-bit synchronous counter.
8. To design and verify the operation of synchronous UP/DOWN decade counter using J K flip-flops & drive a seven-segment display using the same.
9. To design and verify the operation of asynchronous UP/DOWN decade counter using J K flip-flops & drive a seven-segment display using the same.
10. To design & realize a sequence generator for a given sequence using J-K flip-flops.

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ECS2401	OOP's Concept using Java	L	T	P	3 credits
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Course Objectives:

CO1	Understand the core principles of Object-Oriented Programming, including inheritance, polymorphism, abstraction, and encapsulation.
CO2	Learn to design and implement classes and objects effectively in Java.
CO3	Gain proficiency in Java's features, such as constructors, interfaces, and exception handling.
CO4	Develop skills in using collections, generics, and data structures within Java to solve problems.
CO5	Apply object-oriented design patterns and principles to create maintainable and reusable Java applications.

Unit-I

Introduction to Java : Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, Math class, Arrays in java.

Unit-II

Objects and Classes : Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, Inbuilt classes like String, Character, StringBuffer, File, this reference.

Unit-III

Inheritance and Polymorphism : Inheritance in java, Super and sub class, Overriding, Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, UTIL package. Event and GUI programming : Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing.

Unit-IV

I/O programming : Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files, Introduction to java collections, Overview of java collection framework, commonly used collection classes □ Array List, Vector, Hash table, Stack.

Unit-V

Multithreading in java: Thread life cycle and methods, Runnable interface, Thread synchronization, Exception handling with try-catch-finally, Collections in java, Introduction to JavaBeans and Network Programming.

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Text books and References:

1. Introduction to Java Programming (Comprehensive Version), Daniel Liang, Seventh Edition, Pearson.
2. Programming in Java, Sachin Malhotra & Saurabh Chaudhary, Oxford University Press.
3. Murach's Beginning Java 2, Doug Lowe, Joel Murach and Andrea Steelman, SPD.
4. Core Java Volume-I Fundamentals, Eight Edition, Horstmann & Cornell, Pearson Education.

COURSE OUTCOMES:

CO1	Design and implement Java classes and objects to solve real-world problems using OOP principles.
CO2	Apply inheritance, polymorphism, encapsulation, and abstraction to create modular and maintainable Java programs.
CO3	Develop Java applications that effectively use exception handling and error management.
CO4	Utilize Java libraries and frameworks to build efficient, reusable, and scalable software solutions.
CO5	Demonstrate the ability to implement advanced OOP concepts, such as generics and design patterns, in Java-based projects.

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ECS2402	Computer Organization & Architecture	L	T	P	3 credits
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Course Objectives:

CO1	How Computer Systems work & the basic principles.
CO2	Instruction Level Architecture and Instruction Execution.
CO3	The current state of art in memory system design.
CO4	How I/O devices are accessed and its principles.
CO5	Concepts of advanced pipelining techniques.

Unit-I

Basic Functional units of Computers: Functional units, basic Operational concepts, Bus structures. Software, Performance, Multiprocessors, Multicomputer. Data Representation: Signed number representation, fixed and floating point Representations.

Computer Arithmetic: Addition and subtraction, multiplication Algorithms, Division Algorithms. Error detection and correction codes.

Unit-II

Register Transfer Language and Micro Operations: RTL- Registers, Register transfers, Bus and memory transfers. Micro operations: Arithmetic, Logic, and Shift micro operations, Arithmetic logic shift unit.

Basic Computer Organization and Design: Computer Registers, Computer instructions, Instruction cycle. Instruction codes, Timing and Control, Types of Instructions: Memory Reference Instructions, Input – Output and Interrupt.

Unit-III

Central Processing Unit organization: General Register Organization, Stack organization, Instruction formats, Addressing modes, Data Transfer and Manipulation, Program Control, CISC and RISC processors **Control unit design:** Design approaches, Control memory, Address sequencing, micro program example, design of CU, Micro Programmed Control.

Unit-IV

Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Associative Mapping, Direct Mapping, Set-Associative Mapping, Writing into Cache, Cache Initialization, Virtual Memory.

Unit-V

Input –Output Organization: Peripheral devices, Input-output subsystems, I/O device interface, I/O Processor, I/O transfers–Program controlled, Interrupt driven, and DMA, interrupts and exceptions. I/O device interfaces – SCII, USB

Pipelining and Vector Processing: Basic concepts, Instruction level Parallelism Throughput and Speedup, Pipeline hazards.

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Text books and References:

1. Computer Systems Architecture- M.Moris Mano, IIIrd Edition, Pearson/PHI.
2. Computer Organization – Carl Hamacher, Zvonks Vranesic, SafeaZaky, Vth Edition, McGraw Hill.
3. Computer Architecture and Organization”, 3rd Edition by John P. Hayes.
4. “Computer Organization and Architecture: Designing for Performance”, 10th Edition by William Stallings, Pearson Education.

COURSE OUTCOMES:

CO1	Student will learn the concepts of computer organization for several engineering applications.
CO2	Student will develop the ability and confidence to use the fundamentals of computer organization as a tool in the engineering of digital systems.
CO3	An ability to identify, formulate, and solve hardware and software computer engineering problems using sound computer engineering principle.
CO4	To impart the knowledge on micro programming.
CO5	Comprehend the concepts of advanced pipelining techniques.

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ECS2403	Operating Systems	L	T	P	3 credits
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Course Objectives:

CO1	Learn concepts of operating systems.
CO2	Study of various mechanisms involved in memory management techniques.
CO3	Develop skills in hardware and software integration for embedded systems with resource constraints.
CO4	Gaining knowledge of deadlocks prevention and detection techniques
CO5	The purpose of this course is to understand the mechanisms of the Operating Systems like Process Management, Process Synchronization etc.

Unit-I

Operating System: History, Types: Batch System, Time Sharing System, Real Time System Multiprogramming, Distributed System; Functions; Services; System calls; System programs; Virtual machines.

Process Management: Concept, States, Control Block.

Unit-II

CPU Scheduling: Scheduling Concepts, Performance Criteria, Process States, Process Transition Diagram, Schedulers, Process Control Block (PCB), Process address space, Process identification information, Threads and their management, Scheduling Algorithms, Multiprocessor Scheduling.

Unit-III

Process Synchronization: Critical Section, Race Condition, Synchronization Hardware, Semaphores, Classical Problems of Synchronization.

Deadlocks: Characterization, Avoidance, Detection & Recovery.

Unit-IV

Memory Management: Contiguous Allocation, External and Internal, Fragmentation, Paging & Segmentation.

Virtual Memory: Concept, Demand Paging, Page Replacement Algorithms, Allocation of Frames, Thrashing.

Unit-V

File Management: Directory Structure, Allocation Methods; Contiguous; Linked; Indexed; Free

Space Management: Disk: Structure, Scheduling Algorithms, Disk Management. Linux: Basics of Linux, Introduction to Linux - History, Architecture, Basic commands in Linux, Files and File Structure

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ECS2404	Recent Advances in Technology	L 2	T 0	P 0	2 credits
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Course Objectives:

CO1	Expose students to emerging technologies shaping the modern world
CO2	Provide insights into the latest developments in computing, communication, and intelligent systems.
CO3	Encourage awareness of interdisciplinary technological innovations and their societal impacts.
CO4	Build the ability to critically analyze and explore the future scope of recent technologies.
CO5	Prepare students for industry trends and research-oriented careers..

Unit-I

Introduction to Emerging Technologies: Overview of Technological Evolution, Disruptive Innovation and Industry 4.0, Cyber-Physical Systems, Smart Devices and Embedded Systems, Impact on Business and Society.

Unit-II

Artificial Intelligence and Machine Learning: Fundamentals of AI and ML, Deep Learning and Neural Networks, Natural Language Processing, AI in Healthcare, Education, and Industry, Ethical Issues and AI Governance

Unit-III

Internet of Things (IoT) and Edge Computing: Introduction to IoT Architecture, Sensors, Actuators, and Communication Protocols, Cloud vs Edge vs Fog Computing, IoT Applications in Smart Cities, Agriculture, and Health, Security Challenges in IoT

Unit-IV

Blockchain and Cybersecurity: Basics of Blockchain Technology, Bitcoin, Ethereum, Smart Contracts, Use Cases: Supply Chain, Banking, Identity Management, Cybersecurity Threats and Defenses, Data Privacy and Regulations (e.g., GDPR)

Unit-V

Robotics and Automation: Industrial and Service Robots, Human-Robot Interaction, Autonomous Vehicles and Drones, RPA (Robotic Process Automation), Safety and Ethics in Robotics

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Text books and References:

1. "Emerging Technologies: AI, IoT, and Beyond" – Kevin Desouza
2. "Blockchain Basics" – Daniel Drescher
3. "Artificial Intelligence: A Modern Approach" – Stuart Russell & Peter Norvig
4. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" – Aurélien Géron

COURSE OUTCOMES:

CO1	Understand the foundational concepts of recent and emerging technologies.
CO2	Explain the applications and limitations of AI, IoT, Blockchain, and others.
CO3	Analyze the impact of technologies on industries and society.
CO4	Apply basic knowledge of selected technologies in real-world scenarios.
CO5	Explore career and research opportunities in emerging technology fields.

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ECS2470	OOP's Concept Using Java Lab	L	T	P	2 credits
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List of Programs to be Implemented:

1. WAP to show the concept of various principle of OOP's such as
 - a. Inheritance
 - b. Polymorphism
 - c. Encapsulation
 - d. Abstraction
2. WAP to create a calculator using class & inheritance?
3. WAP to print the matrix?
4. WAP to print the addition of two matrixes?
5. WAP to print the multiplication of two matrixes?
6. WAP to print the default value of instance variable?
7. WAP to demonstrate the scope of variables?
8. WAP to show the concept of up casting & down casting?(implicit & explicit typecasting)?
9. WAP to overload the constructor?(Compile time polymorphism)
10. WAP to calculate the sine series, i.e. create a user defined method of sine series?
11. WAP to overload the method? (Compile time polymorphism)
12. WAP to override the method (sine series method)?(Runtime polymorphism)
13. WAP to show the dynamic method dispatch?(Make all possible combination)
14. Demonstrate the calling of constructor?
15. WAP to Demonstrate concept of Automatic type conversion apply to overloading?
16. WAP to calculate the factorial using static methods?
17. WAP to use command line arguments?
18. WAP to show the use of this keyword of java?
19. WAP to show the two use of super keyword of java?
20. WAP to show the ways to call the static method in java?
21. WAP to demonstrate to handle the exception?
22. WAP to create user defined exception?
23. WAP to read its own java source file & write that file in another java file?
24. WAP to create multiple Threads & show how inter Thread communication is performed?
25. WAP to demonstrate the life cycle of an applet?
26. Draw following shapes on an applet:
 - a) Circle
 - b) Rectangle
 - c) Squaremake sure that all shapes must have different colours.
27. WAP to create calculator GUI in java with proper event handling?
28. Create a notepad in java? (Menu driven)

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ECS2471	Computer Organization & Architecture Lab	L 00	T 4	P	2 credits
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List of Practicals:

1. Implementation of Flip-Flops: SR, JK, D, T, Master Slave
2. Implementation of counters, up and Down Counters
3. Implementation of shift registers SISO, SIPO, PISO, PIPO
4. Implementation of Binary Adder.
5. Implementation of Binary Subtractor
6. Implementation of Seven Segment Display.

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ECS2472	Operating System Lab	L 0	T 0	P 4	2 credits
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List of Programs

1. Write a program in C to implement FCFS cpu scheduling.
2. Write a program in C to implement SJF cpu scheduling.
3. Write a program in C to implement Round robin cpu scheduling.
4. Write a program in C to implement Priority cpu scheduling.
5. Write a program in C to implement FIFO page replacement algorithm.
6. Write a program in C to implement LRU page replacement algorithm.
7. Write a program in C to implement OPTIMAL page replacement algorithm.
8. Simulate Banker's Algorithm for Dead Lock Avoidance.
9. Simulate Banker's Algorithm for Dead Lock Prevention.
10. Write a program in C to simulate FCFS disk scheduling algorithms
11. Write a program in C to simulate SCAN disk scheduling algorithms
12. Write a program in C to simulate C-SCAN disk scheduling algorithms.

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ECS3501	Design and Analysis of Algorithms	L 3	T 0	P 0	3 credits
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Course Objectives:

CO1	To demonstrate performance of algorithms with respect to time and space complexity.
CO2	To explain graph and tree traversals
CO3	To explain the concepts greedy method and dynamic programming. Applying for several applications like knapsack problem, job sequencing with deadlines, and optimal binary search tree, TSP and so on respectively.
CO4	To Illustrate the methods of backtracking and branch bound techniques to solve the problems like n-queens problem, graph colouring and TSP respectively.
CO5	To familiarize the concepts of deterministic and non-deterministic algorithms.

UNIT - I

Introduction : Algorithms, Analyzing Algorithms, Complexity of Algorithms, Growth of Functions, Performance Measurements, Sorting and Order Statistics - Shell Sort, Quick Sort, Merge Sort, Heap Sort, Comparison of Sorting Algorithms, Sorting in Linear Time.

UNIT - II

Advanced Data Structures: Red-Black Trees, B - Trees, Binomial Heaps, Fibonacci Heaps, Tries, Skip List

UNIT - III

Divide and Conquer with Examples Such as Sorting, Matrix Multiplication, Convex Hull and Searching.

Greedy Methods with Examples Such as Optimal Reliability Allocation, Knapsack, Minimum Spanning Trees – Prim's and Kruskal's Algorithms, Single Source Shortest Paths - Dijkstra's and Bellman Ford Algorithms.

UNIT - IV

Dynamic Programming with Examples Such as Knapsack. All Pair Shortest Paths – Warshal's and Floyd's Algorithms, Resource Allocation Problem. Backtracking, Branch and Bound with Examples Such as Travelling Salesman Problem, Graph Coloring, n-Queen Problem, Hamiltonian Cycles and Sum of Subsets.

UNIT - V

NP-Hard AND NP-complete problem: Basic concepts, non-deterministic algorithms, NP-hard and NP-complete classes, Cook's theorem. String Matching, Approximation Algorithms and Randomized Algorithm.

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Text books and References:

1. Ellis Horowitz, Satraj Sahni, Rajasekharam (2007), Fundamentals of Computer Algorithms, 2nd edition, University Press, New Delhi.
2. R. C. T. Lee, S. S. Tseng, R.C. Chang and T. Tsai (2006), Introduction to Design and Analysis of Algorithms A strategic approach, McGraw Hill, India.
3. Allen Weiss (2009), Data structures and Algorithm Analysis in C++, 2nd edition, Pearson education, New Delhi.
4. Aho, Ullman, Hopcroft (2009), Design and Analysis of algorithms, 2nd edition, Pearson education, New Delhi

COURSE OUTCOMES:

CO1	Define various Time and Space complexities of various algorithms
CO2	Understand Tree Traversal method and Greedy Algorithms
CO3	Apply Dynamic Programming concept to solve various problems
CO4	Apply Backtracking, Branch and Bound concept to solve various problems
CO5	Analyze different performance analysis methods for non-deterministic algorithms

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ECS3502	DATA BASE MANAGEMENT SYSTEM	L T P 3 0 0	3 credits
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Course Objectives:

CO1	Introduce fundamental concepts, terminology and application of databases.
CO2	Teach design concepts and creation of relational databases.
CO3	Teach basic and advanced SQL commands..
CO4	Provide overview of database programming and procedural languages.
CO5	Provide overview of transaction management, database recovery and security.

Unit-I

Introduction: Overview, Database System vs File System, Database System Concept and Architecture, Data Model Schema and Instances, Data Independence and Database Language and Interfaces, Data Definitions Language, DML, Overall Database Structure. Data Modeling Using the Entity Relationship Model: ER Model Concepts, Notation for ER Diagram, Mapping Constraints, Keys, Concepts of Super Key, Candidate Key, Primary Key, Generalization, Aggregation, Reduction of an ER Diagrams to Tables, Extended ER Model, Relationship of Higher Degree

Unit-II

Relational data Model and Language: Relational Data Model Concepts, Integrity Constraints, Entity Integrity, Referential Integrity, Keys Constraints, Domain Constraints, Relational Algebra, Relational Calculus, Tuple and Domain Calculus. Introduction on SQL: Characteristics of SQL, Advantage of SQL. SQL Data Type and Literals. Types of SQL Commands. SQL Operators and Their Procedure. Tables, Views and Indexes. Queries and Sub Queries. Aggregate Functions. Insert, Update and Delete Operations, Joins, Unions, Intersection, Minus, Cursors, Triggers, Procedures in SQL/PL SQL

Unit-III

Data Base Design & Normalization: Functional dependencies, normal forms, first, second, 8 third normal forms, BCNF, inclusion dependence, loss less join decompositions, normalization using FD, MVD, and JDs, alternative approaches to database design.

Unit-IV

Transaction Processing Concept: Transaction System, Testing of Serializability, Serializability of Schedules, Conflict & View Serializable Schedule, Recoverability, Recovery from Transaction Failures, Log Based Recovery, Checkpoints, Deadlock Handling. Distributed Database: Distributed Data Storage, Concurrency Control, Directory System.

Unit-V

Concurrency Control Techniques: Concurrency Control, Locking Techniques for Concurrency Control, Time Stamping Protocols for Concurrency Control, Validation Based Protocol, Multiple Granularity, Multi Version Schemes, Recovery with Concurrent Transaction, Case Study of Oracle.

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Text books and References:

5. Korth, H.F.,Silbertz, A., Database Concepts, McGraw Hill.
6. Desai, B.C., An introduction to Database Systems,Galgotia.
- 3 Majumdar, A. K. and Bhattacharya, P., Database Management System, Tata McGraw Hill.
4. Ramakrishnan, R., Gehrke, J., Database Management System, McGraw Hill

COURSE OUTCOMES:

CO1	Define the basics of data base systems, structure and architecture, data
CO2	Understanding different transaction processing concepts and different types of serialization techniques.
CO3	Apply different database recovery like shadow paging, deferred/immediate updates and Concurrency control techniques
CO4	Applying integrity and constraints using SQL and PL/SQL.
CO5	Analyzing the anomalies of database and removal of these anomalies using different normalization techniques.

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ECS3503	Compiler Design	L	T	P	2 credits
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Course Objectives:

CO1	To understand the various phases in the design of a compiler.
CO2	To understand the design of top-down and bottom-up parsers.
CO3	To understand syntax directed translation schemes.
CO4	To introduce LEX and YACC tools.
CO5	To learn to develop algorithms to generate code for a target machine.

Unit-I

Introduction to Compiler: Phases and passes, Bootstrapping, Finite state machines and regular expressions and their applications to lexical analysis, Optimization of DFA-Based Pattern Matchers implementation of lexical analyzers, lexical-analyzer generator, LEX compiler, Formal grammars and their application to syntax analysis, BNF notation, ambiguity, YACC. The syntactic specification of programming languages: Context free grammars, derivation and parse trees, capabilities of CFG

Unit-II

Basic Parsing Techniques: Parsers, Shift reduce parsing, operator precedence parsing, top down parsing, predictive parsers Automatic Construction of efficient Parsers: LR parsers, the canonical Collection of LR(0) items, constructing SLR parsing tables, constructing Canonical LR parsing tables, Constructing LALR parsing tables, using ambiguous grammars, an automatic parser generator, implementation of LR parsing tables.

Unit-III

Syntax-directed Translation: Syntax-directed Translation schemes, Implementation of Syntax directed Translators, Intermediate code, postfix notation, Parse trees & syntax trees, three address code, quadruple & triples, translation of assignment statements, Boolean expressions, statements that alter the flow of control, postfix translation, translation with a top down parser. More about translation: Array references in arithmetic expressions, procedures call, declarations and case statements.

Unit-IV

Symbol Tables: Data structure for symbols tables, representing scope information. Run-Time Administration: Implementation of simple stack allocation scheme, storage allocation in block structured language. Error Detection & Recovery: Lexical Phase errors, syntactic phase errors semantic errors.

Unit-V

Code Generation: Design Issues, the Target Language. Addresses in the Target Code, Basic Blocks and Flow Graphs, Optimization of Basic Blocks, Code Generator. Code optimization: Machine-Independent Optimizations, Loop optimization, DAG representation of basic blocks, value numbers and algebraic laws, Global Data-Flow analysis.

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Text books and References:

- 1 .Aho, Sethi & Ullman, "Compilers: Principles, Techniques and Tools", Pearson Education
- 2 .K. Muneeswaran, Compiler Design, First Edition, Oxford University Press
3. J.P. Bennet, "Introduction to Compiler Techniques", Second Edition, McGraw-Hill, 2003.
- 4 .Henk Alblas and Albert Nymeyer, "Practice and Principles of Compiler Building with C", PHI, 2001.
5. V Raghvan, "Principles of Compiler Design", McGraw-Hill,
6. Kenneth Louden, "Compiler Construction", Cengage Learning.
7. Charles Fischer and Ricard LeBlanc, "Crafting a Compiler with C", Pearson Education

COURSE OUTCOMES:

CO1	Define knowledge of different phases and passes of the compiler and also able to use the compiler tools like LEX, YACC, etc. Students will also be able to design different types of compiler tools to meet the requirements of the realistic constraints of compilers.
CO2	Understand the parser and its types i.e. Top-Down and Bottom-up parsers and construction of LL, SLR, CLR, and LALR parsing table.
CO3	Apply the compiler using syntax-directed translation method and get knowledge about the synthesized and inherited attributes.
CO4	Acquire knowledge about run time data structure like symbol table organization and different
CO5	Analyze the target machine's run time environment, its instruction set for code generation and techniques used for code optimization.

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ELA3505	Professional Law and Ethics	L T P	2 credits
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Course Objectives:

CO1	Students will understand the importance of Values and Ethics in their Personal lives and professional careers
CO2	To understand the design of top-down and bottom-up parsers.
CO3	To understand syntax directed translation schemes.
CO4	To learn profession ethics
CO5	To learn about IPR.

Unit-I

Professional Practice – Respective roles of various stakeholders: Government(constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI, Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction); Clients/ owners (role governed by contracts); Developers (role governed by regulations such as RERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards);Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

Unit-II

Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures.

Unit-III

General Principles of Contracts Management: Indian Contract Act, 1972 and amendments covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and sub-contracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /“ Red Flag”conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations.

Unit-IV

Time extensions & Force Majeure: Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public-Private Partnerships; International Commercial Terms;

Unit-V

Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system: Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996;UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.

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Text books and References:

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
2. The National Building Code, BIS, 2017
3. Dutt (1994), Indian Contract Act, Eastern Law House
4. Anson W.R. (1979), Law of Contract, Oxford University Press.
5. Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
6. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co

COURSE OUTCOMES:

C01	Define the basic purpose of profession, professional ethics and various moral and social issues.
C02	Understand of professional rights and responsibilities of a Engineer, safety and risk benefit analysis of a Engineer
C03	Apply knowledge of various roles of Engineer In applying ethical principles at.
C04	Understand Professional Ethical values and contemporary issues
C05	Analyse excelling in competitive and challenging environment to contribute to industrial growth.

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ECS357 1	Design and Analysis of Algorithms Lab	L T P 0 0 4	2 credits
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List of Programs to be implemented:

1. Program for Quick Sort
2. Program for Merge Sort
3. Program for Heap sort
- 4 Program for Insertion sort
- 5 Program for counting sort
6. Program for Radix sort
- 7 Program for Knapsack Problem
- 8 Program for prims algorithm
- 9 Program for Kruskals Algorithm
- 10 Program for k-th element to find minimum and maximum
11. Program for Warshal's Algorithm
12. Program for Dijkstra's Algorithm

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ECS3572	Database Management System Lab	L	T	P	2 credits
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List of Programs to be Implemented:

1. Data Definition, Table Creation, Constraints,
2. Insert, Select Commands, Update & Delete Commands.
3. Nested Queries & Join Queries
4. Views
5. High level programming language extensions (Control structures, Procedures and Functions).
6. Front end tools
7. Forms
8. Triggers
9. Menu Design
10. Reports.
11. Database Design and implementation (Mini Project).

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ECS3601	COMPUTER NETWORKS	L T P 2 0 0	2 credits
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Course Objectives:

CO1	Build an understanding of the fundamental concepts of computer networking.
CO2	Familiarize the student with the basic taxonomy and terminology of the computer networking area.
CO3	Introduce the student to advanced networking concepts, preparing the student for entry Advanced Courses in computer networking.
CO4	Allow the student to gain expertise in some specific areas of networking such as the design and Maintenance of individual networks.
CO5	To understand about electronic mail, FTP, WWW, HTTP, Multimedia and Network security.

Unit-I

Introduction: Introduction to networks, Internet, Protocols and Standards, The OSI model, Layers in OSI Model, TCP/IP Suite, Addressing, Analog & Digital Signals

Physical Layer: Physical Layer Introduction, Digital Transmission, multiplexing, Transmission media, Circuit switched networks, Datagram networks, Virtual circuit networks, Switch & telephone network

Unit-II

Data link layer: Introduction, Block coding, Cyclic codes, checksum, Framing, Flow and error control, Noiseless & Noisy channels, HDLC, Point to point protocols

Media Access Sub Layer: Random Access, Controlled access, channelization, IEEE Standards.

Unit-III

Ethernet, Fast Ethernet, Giga bit Ethernet, wireless LANS, Connecting LANs, Backbone networks, Virtual LANs, Wireless WANs, SONET, frame relay, ATM.

Unit-IV

Network Layer: Logical addressing, internetworking, tunneling, address mapping, ICMP, IGMP, Forwarding, Unicast routing protocols, multicast routing protocols.

Unit-V

Transport Layer: Process to process delivery, TCP and UDP protocols, SCTP, Data traffic, congestion, Congestion Control, QoS, integrated services, Differentiated services, QoS in Switched networks.

Application Layer: Domain name space, DNS in internet, Electronic Mail, FTP, WWW, HTTP, SNMP, Multi Media, Network Security.

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Text books and References:

1. Data Communications and Networking- Behrouz A Forouzan Fourth Edition TMH,2006.
2. Computer Networks- Andrew S Tanenbaum, 4th Edition, Pearson Education
3. An Engineering approach to computer Networks- S. Keshav, 2nd Edition, Pearson Education
4. Computer and communication Networks- Nader F Mir, Pearson Education
5. Data and Computer Communications, G.S. Hura and M. Singhal, CRC Press, Taylor and Francis Group.
6. Data Communications and Computer Networks, P.C. Gupta, PHI

COURSE OUTCOMES:

CO1	Define good understanding of the OSI Reference Model and in particular have a good knowledge of Layers 1-3.
CO2	Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies
CO3	Understand and identify deficiencies in existing protocols, and then go onto formulate new and better protocols
CO4	Apply an understanding of the issues surrounding Mobile and Wireless Networks.
CO5	Evaluate a working knowledge of datagram and internet socket programming.

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ECS3603	Cryptography	L T P 2 0 0	2 credits
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Course Objectives:

CO1	Explain the importance and application of each of confidentiality, integrity, authentication and availability.
CO2	Understand various cryptographic algorithms and basic categories of threats to computers and networks.
CO3	Describe the enhancements made to IPv4 by IPSec.
CO4	Understand Intrusions, intrusion detection, Web security and Firewalls.

Unit-I

Introduction of Cryptography: Introduction To security: Attacks, Services and Mechanisms, Conventional Encryption: Conventional Encryption Model, Steganography, Block Cipher Principles, DES Standard, DES Strength, Differential and Linear Cryptanalysis, Block Cipher Modes of Operations. Double DES, Triples DES, Blowfish, International Data Encryption Algorithm, Placement of Encryption Function, Key Distribution, Random Number Generation and Traffic confidentiality

Unit-II

Number Theory and Public Key Encryption: Fermat's and Euler's Theorem, Primality Testing, Chinese Remainder Theorem, Public-Key Cryptography: Principles of Public-Key Cryptosystems, RSA Algorithm.

Unit-III

Key Management: Key Management scenario in secret key and public key cryptography, Diffie Hellman Key Exchange algorithm, OAKLEY and ISAKMP key management protocol, Elliptic Curve Cryptography

Unit-IV

Hash Functions: Message Authentication and Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Function Birthday Attacks, Security of Hash Function and MACS, MD5 Message Digest Algorithm, Secure Hash Algorithm (SHA), Digital Signatures, Digital Signature Standard (DSS).

Unit-V

Network and System Security: Authentication Applications: Kerberos, X.509, Electronic Mail Security, Pretty Good Privacy (PGP), S/MIME Security: Architecture, Authentication Header, Encapsulating Security Payloads, Combining Security Associations, Key Management, Web Security: Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction (SET), System Security: Intruders, Viruses, Firewall Design Principles, Trusted Systems.

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Text books and References:

1. Cyber security Essentials, Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short, Sybex, October 2018
2. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press
3. Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, B.B. Gupta, D.P. Agrawal, Haoxiang Wang, CRC Press, 2018

COURSE OUTCOMES:

CO1	Define and Identify the various attacks and its issues.
CO2	Understand the usage of cryptographic algorithms for avoiding basic level threats.
CO3	Analyse the issues involved in Integrity, Authentication and Key Management techniques.
CO4	The importance of user authentication and Kerberos concepts.
CO5	Acquire the knowledge of network and system security domain.

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ECS3605	Digital Image Processing	L T P 2 0 0	2 credits
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Course Objectives:

CO1	To learn the advanced concepts of image processing and its implementation.
CO2	Enhance the visual quality of given grey/color image using well known transformations and filters.
CO3	Distinguish between lossy and lossless image compression prototypes.
CO4	Demonstrate the use of MATLAB to create correlative image processing applications

Unit-I

→ **Introduction and Fundamentals** Motivation and Perspective, Applications, Components of Image Processing System, Element of Visual Perception, A Simple Image Model, Sampling and Quantization. Image Enhancement in Frequency Domain Fourier Transform and the Frequency Domain.

Unit-II

Basis of Filtering in Frequency Domain, Filters – Low-pass, High-pass; Correspondence Between Filtering in Spatial and Frequency Domain; Smoothing Frequency Domain Filters – Gaussian Lowpass Filters; Sharpening Frequency Domain Filters – Gaussian High pass Filters; Homomorphic Filtering.

Unit-III

Image Enhancement in Spatial Domain Introduction; Basic Gray Level Functions – Piecewise-Linear Transformation Functions: Contrast Stretching; Histogram Specification.

Unit-IV

Histogram Equalization; Local Enhancement: Enhancement using Arithmetic/Logic Operations – Image Subtraction, Image Averaging; Basics of Spatial Filtering; Smoothing - Mean filter, Ordered Statistic Filter; Sharpening – The Laplacian.

Unit-V

Image Restoration A Model of Restoration Process: Noise Models, Restoration in the presence of Noise only- Spatial Filtering – Mean Filters: Arithmetic Mean filter, Geometric Mean Filter, Order Statistic Filters – Median Filter, Max and Min filters; Periodic Noise Reduction by Frequency Domain Filtering – Bandpass Filters; Minimum Mean-square Error Restoration.

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Text books and References:

1. Digital Image Processing 2nd Edition, Rafael C. Gonzalvez and Richard E. Woods. Published by: Pearson Education.
2. Digital Image Processing and Computer Vision, R.J. Schalkoff. Published by: John Wiley and Sons, NY.
3. Fundamentals of Digital Image Processing, A.K. Jain. Published by Prentice Hall, Upper Saddle River, NJ. E

COURSE OUTCOMES:

CO1	Define and acquire the knowledge of soft computing and hard computing
CO2	Understand to develop skill in soft computing methodology
CO3	To acquire the knowledge of the fuzzy Neural network and Genetic Language.
CO4	To analyze and optimized the problem of real-life applications
CO5	Acquire and able to explain Max and Min filters

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ECS3671	Computer Networks Lab	L T P 0 0 4	2 credits
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List of Programs to be Implemented:

1. Study of different network devices in detail.
2. Study of different types of network cables and practically implement
3. The cross-wired cable and straight through cable using clamping tool.
4. Study of basic network command and Network configuration commands
5. Study of network IP.
6. Implement the concept of VLAN using Network Simulator.
7. Implement the concept of static routing.
8. Implement the concept of dynamic routing (RIP, OSPF, BGP).
9. Packet capture and header analysis by wire-shark (TCP,UDP,IP)
10. Configure a network topology using packet tracer software.

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ECS4704	Engineering Research Methodology	L	T	P	2 credits
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Course Objectives:

CO1	To understand the fundamental concepts of research methodology and its significance in engineering.
CO2	To familiarize students with various research designs, data collection techniques, and sampling methods..
CO3	To equip students with statistical tools and data analysis techniques required for research.
CO4	To develop skills in technical writing, research ethics, and intellectual property rights, to enable students to prepare research proposals, reports, and publications.
CO5	To introduce emerging trends and technological advancements in research methodology.

Unit-I

Introduction to Research : Definition and Objectives of Research, Types of Research: Basic, Applied, Quantitative, Qualitative, Research Process and its Importance in Engineering, Characteristics of Good Research, Research Ethics and Integrity.

Unit-II

Research Problem Identification: Defining the Research Problem, Literature Review: Sources, Techniques, and Critical Analysis, Research Gap Identification, Formulating Research Objectives and Hypotheses.

Unit-III

Research Design & Methodology: Research Design: Experimental, Descriptive, Case Study, Survey, Data Collection Methods: Primary & Secondary Sources, Sampling Techniques: Probability & Non-Probability Sampling, Measurement and Scaling Techniques

Unit-IV

Data Analysis and Interpretation: Statistical Techniques: Descriptive and Inferential Statistics, Regression, Correlation, and Hypothesis Testing, Introduction to Software Tools (SPSS, R, MATLAB, Python etc.), Experimental Design and Simulation in Research, Data Validation and Interpretation Techniques, Technical Writing and Research Ethics: Research Paper Structure and Writing Techniques, Referencing Styles: APA, IEEE, MLA, and Chicago, Plagiarism: Types, Detection, and Avoidance

Unit-V

Intellectual Property Rights (IPR) and Patents: Research Funding Agencies and Grant Proposal Writing, Ethics in Engineering Research, Research Proposal Preparation, Writing Thesis/Dissertation and Technical Reports, Presentation Skills: Oral and Poster Presentations, Emerging Trends in Research Methodology, Role of Artificial Intelligence & Machine Learning in Research, Big Data and Cloud Computing in Research, Research Collaboration and Funding Opportunities

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Text books and References:

7. **C.R. Kothari & Gaurav Garg** – *Research Methodology: Methods and Techniques*, New Age International Publishers, 4th Edition, 2019.
8. **Panneerselvam R.** – *Research Methodology*, PHI Learning, 2nd Edition, 2014."Focuses on both qualitative and quantitative research methods".
9. **John W. Creswell & J. David Creswell** – *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE Publications, 5th Edition, 2018.A detailed guide on different research approaches and methodologies.
10. **Kumar R.** – *Research Methodology: A Beginner's Guide*, Pearson Education, 4th Edition, 2019.Ideal for students new to research methods and techniques.
11. **Donald R. Cooper & Pamela S. Schindler** – *Business Research Methods*, McGraw Hill, 12th Edition, 2018.Explains research concepts with real-world case studies.

COURSE OUTCOMES:

CO1	Define fundamental research principles, methodologies, and processes in engineering research.
CO2	Apply statistical techniques and data analysis tools for meaningful interpretation of research data.
CO3	Demonstrate proficiency in technical writing, referencing styles, and ethical research practices.
CO4	Analyze and prepare well-structured research proposals, thesis reports, and scholarly publications..
CO5	Utilize modern research tools, artificial intelligence, and big data techniques to enhance research quality.
CO5	Understand the role of theory in the application of conceptual frameworks in the research process.

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ECS4801	Artificial Intelligence and Expert Systems	L 3	T 0	P 0	3 credits
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Course Objectives:

CO1	Introduce the foundational concepts and history of AI..
CO2	Explore problem-solving techniques and algorithm design.
CO3	Examine various logic systems and their applications in AI. Understand the architecture and functioning of expert systems.
CO4	Introduce planning problems and state-space search techniques..
CO5	Introduce various learning paradigms, including supervised, unsupervised, and reinforcement learning..

Unit-I

Introduction to Artificial Intelligence: Foundations of AI: Understanding the history, definitions, and applications of AI, **Problem-Solving Techniques:** Exploring various methods to approach and solve complex problems, **Algorithm Design:** Studying the characteristics and development of efficient algorithms.

Unit-II

Knowledge Representation and Reasoning: Logic Systems: Delving into propositional and predicate logic, including clause form and unification algorithms, **Expert Systems:** Examining the architecture and examples of rule-based and non-monotonic expert systems, **Natural Language Processing (NLP):** Introducing basic tasks and challenges in NLP.

Unit-III

Planning and Decision Making: Planning Problems: Understanding state-space search and partial-order planning, **Planning Graphs:** Utilizing propositional logic in planning and analyzing various approaches, **Hierarchical and Conditional Planning:** Exploring advanced planning techniques, including multi-agent planning.

Unit-IV

Machine Learning: Learning Paradigms: Introduction to supervised, unsupervised, and reinforcement learning, **Algorithm Implementation:** Applying machine learning algorithms to real-world problems, **Deep Learning:** Understanding neural networks and their applications in AI.

Unit-V

Advanced Topics in AI: Robotic Process Automation: Studying the automation of repetitive tasks using AI, **Augmented Reality (AR) and Virtual Reality (VR) Simulation:** Exploring the integration of AI in AR/VR technologies, **Big Data Analytics:** Analysing large datasets to extract meaningful insights using AI tools.

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Text books and References:

1. "Artificial Intelligence: A Modern Approach" by Stuart J. Russell and Peter Norvig
2. "Artificial Intelligence" by Elaine Rich and Kevin Knight
3. "Introduction to AI and Expert Systems" by Dan W. Patterson
4. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
5. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto

COURSE OUTCOMES:

CO1	Understand the evolution and applications of AI. Apply problem-solving methods to complex scenarios.
CO2	Apply propositional and predicate logic to AI problems.
CO3	Formulate and solve planning problems using appropriate methods.
CO4	Analyze the role of AI in automating complex tasks through Robotic Process Automation Develop applications that combine AI with AR and VR technologies.
CO5	Understand the integration of AI in these advanced technologies.

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ECS4804	Data Compression	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce the fundamental concepts of data compression and its importance.
CO2	To understand lossless and lossy compression techniques.
CO3	To explore various data compression algorithms used in text, image, audio, and video compression.
CO4	To study entropy coding, dictionary-based methods, and wavelet-based compression.
CO5	To analyze real-world applications of data compression in storage and communication systems.

Unit □

Introduction to Data Compression: Overview of Data Compression, Need for Compression, Types of Compression (Lossless vs. Lossy), Measures of Compression (Compression Ratio, Redundancy), Run-Length Encoding (RLE), Statistical Modeling for Compression.

Unit □

Entropy Encoding and Dictionary-Based Methods: Shannon-Fano Algorithm, Huffman Coding, Arithmetic Coding, Dictionary-Based Compression (LZ77, LZ78, LZW), Burrows-Wheeler Transform (BWT).

Unit □

Lossy Compression Techniques: Transform Coding (Discrete Cosine Transform, Discrete Wavelet Transform), Quantization Methods, Vector Quantization, Predictive Coding (Delta Modulation, Adaptive Predictive Coding).

Unit □

Image, Audio, and Video Compression: JPEG and JPEG2000 Image Compression, GIF and PNG Compression, MP3 and AAC Audio Compression, MPEG Video Compression (MPEG-1, MPEG-2, MPEG-4, H.264), Introduction to HEVC (H.265).

Unit □

Applications and Future Trends in Data Compression: Data Compression in File Storage, Cloud Computing, Video Streaming, and Networking, Compression in Big Data and IoT, Emerging Trends in Data Compression.

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Text books and References:

1. Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann.
2. David Salomon, "Data Compression: The Complete Reference", Springer.
3. Mark Nelson, "The Data Compression Book", M&T Books.
4. Toby Berger, "Rate Distortion Theory", Wiley.

Course Outcomes:

CO1	Understand the fundamentals of data compression and redundancy reduction.
CO2	Apply lossless and lossy compression techniques for different types of data.
CO3	Analyze entropy coding, dictionary-based, and transform-based compression methods.
CO4	Explain image, audio, and video compression standards.
CO5	Explore real-world applications of data compression in networking, multimedia, and storage.

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Electives:



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ECS3504	Fuzzy Logic	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of fuzzy logic and its applications.
CO2	Understand the mathematical foundations of fuzzy sets and fuzzy relations.
CO3	Explore fuzzy inference systems and fuzzy rule-based systems.
CO4	Apply fuzzy logic techniques in real-world scenarios, including decision-making and control systems.
CO5	Analyze and compare fuzzy systems with traditional binary logic systems.

Unit □

Introduction to Fuzzy Logic: Classical Sets vs. Fuzzy Sets: Definitions and Differences, Properties of Fuzzy Sets: Membership Functions, Basic Operations, Fuzzy Complements, Fuzzy Intersections, and Fuzzy Unions, Fuzzy Relations: Cartesian Product, Composition, and Properties, Applications of Fuzzy Logic in Engineering and AI.

Unit □

Fuzzy Systems and Membership Functions: Membership Functions: Types and Characteristics, Linguistic Variables and Hedges, Fuzzy Logic Operators and Aggregation, Fuzzification and Defuzzification Techniques, Fuzzy Decision Making and Approximate Reasoning

Unit □

Fuzzy Inference Systems: Introduction to Fuzzy Inference Systems (FIS), Mamdani and Sugeno Fuzzy Models, Rule-Based Fuzzy Systems, Fuzzy IF-THEN Rules and Rule Aggregation, Case Studies and Applications in Control Systems

Unit □

Fuzzy Control Systems: Fuzzy Controllers: Design and Implementation, Adaptive Fuzzy Systems, Stability and Performance Analysis of Fuzzy Controllers, Applications in Industrial Automation, Robotics, and Pattern Recognition

Unit □

Advanced Topics and Applications: Hybrid Fuzzy Systems: Neuro-Fuzzy and Genetic Fuzzy Approaches, Fuzzy Clustering and Pattern Recognition, Fuzzy Optimization Techniques, Case Studies in Decision-Making and Expert Systems

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Textbooks & References:

1. J. J. Buckley & E. Eslami, "An Introduction to Fuzzy Logic and Fuzzy Sets," Springer.
2. George J. Klir & Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications," Prentice Hall.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," Wiley.
4. Lotfi A. Zadeh, "Fuzzy Sets and Applications," Wiley.
5. H. J. Zimmermann, "Fuzzy Set Theory and Its Applications," Springer.

Course Outcomes:

C01	Understand the theoretical foundations of fuzzy logic and fuzzy sets.
C02	Implement fuzzy set operations and analyze their properties.
C03	Design and apply fuzzy inference systems for various applications.
C04	Develop fuzzy controllers for decision-making and control processes..
C05	Evaluate the advantages and limitations of fuzzy logic compared to conventional systems.

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ECS3507	Soft Computing	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of soft computing and its applications.
CO2	CO2: Understand the mathematical foundations of fuzzy logic, neural networks, and genetic algorithms.
CO3	Explore various soft computing techniques for problem-solving.
CO4	Apply soft computing techniques in real-world scenarios, including optimization and decision-making.
CO5	Analyze and compare soft computing approaches with traditional computational techniques.

Unit □

Introduction to Soft Computing: Definition and Importance of Soft Computing, Comparison of Soft Computing and Hard Computing, Components of Soft Computing: Fuzzy Logic, Neural Networks, and Genetic Algorithms, Applications of Soft Computing in Engineering and AI

Unit □

Fuzzy Logic and Fuzzy Systems: Classical Sets vs. Fuzzy Sets: Definitions and Differences, Properties of Fuzzy Sets: Membership Functions, Basic Operations, Fuzzy Logic Operators and Aggregation, Fuzzification and Defuzzification Techniques, Fuzzy Decision Making and Approximate Reasoning

Unit □

Artificial Neural Networks (ANN): Introduction to Neural Networks, Biological Neurons vs. Artificial Neurons, Learning Techniques: Supervised, Unsupervised, and Reinforcement Learning, Backpropagation Algorithm, Applications of Neural Networks in Pattern Recognition and Data Analysis

Unit □

Genetic Algorithms and Evolutionary Computing: Fundamentals of Genetic Algorithms, Genetic Operators: Selection, Crossover, and Mutation, Convergence of Genetic Algorithms, Hybrid Soft Computing Techniques: Neuro-Fuzzy and Genetic-Fuzzy Approaches, Applications in Optimization Problems

Unit □

Advanced Topics and Applications: Swarm Intelligence and Evolutionary Strategies, Hybrid Soft Computing Techniques, Case Studies in Machine Learning and Control Systems, Real-world Applications in Decision-Making, Robotics, and Data Mining

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Textbooks & References:

1. J. S. R. Jang, C. T. Sun & E. Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence," Pearson.
2. S. N. Sivanandam & S. N. Deepa, "Principles of Soft Computing," Wiley.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," Wiley.
4. S. Rajasekaran & G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications," PHI Learning.
5. D. E. Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning," Addison-Wesley.

Course Outcomes:

C01	Understand the theoretical foundations of soft computing techniques.
C02	Implement fuzzy set operations, neural networks, and genetic algorithms
C03	Design and apply soft computing methods for various applications.
C04	Develop hybrid soft computing models for optimization and control
C05	Evaluate the advantages and limitations of soft computing compared to traditional approaches.

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ECS3508	Discrete Mathematics	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of discrete mathematics and its applications.
CO2	Understand the mathematical foundations of logic, set theory, relations, and functions.
CO3	Explore graph theory, combinatorics, and recurrence relations.
CO4	Apply discrete mathematical techniques in problem-solving and algorithm design.
CO5	Analyze and compare various discrete mathematical structures in computing.

Unit □

Set Theory and Logic: Fundamentals of Sets, Subsets, Operations, and Properties, Propositional Logic: Statements, Logical Connectives, Truth Tables, Predicate Logic: Quantifiers, Rules of Inference, Mathematical Induction and Proof Techniques

Unit □

Relations and Functions: Relations: Properties, Equivalence Relations, Partial Orders, Functions: Types, Composition, Inverse Function, Pigeonhole Principle and Inclusion-Exclusion Principle, Generating Functions and Recurrence Relations

Unit □

Combinatorics and Counting Techniques: Basics of Counting: Permutations and Combinations, Binomial Theorem and Pascal's Triangle, Principle of Inclusion-Exclusion, Recurrence Relations: Solving Linear Recurrence Relations

Unit □

Graph Theory: Basic Definitions and Terminologies in Graph Theory, Types of Graphs: Simple, Directed, Weighted, Graph Traversal Algorithms: BFS and DFS, Shortest Path Algorithms: Dijkstra's and Floyd-Warshall Algorithm, Eulerian and Hamiltonian Graphs

Unit □

Algebraic Structures and Applications: Groups, Monoids, and Semigroups, Rings, Fields, and Lattices, Boolean Algebra and Logic Gates, Applications in Computer Science and Cryptography.

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Textbooks & References:

1. Kenneth H. Rosen, "Discrete Mathematics and Its Applications," McGraw Hill.
2. C. L. Liu & D. P. Mohapatra, "Elements of Discrete Mathematics," McGraw Hill.
3. Richard Johnsonbaugh, "Discrete Mathematics," Pearson Education.
4. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science," PHI.
5. J. P. Tremblay & R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science," McGraw Hill.

Course Outcomes:

CO1	Understand the theoretical foundations of discrete mathematics.
CO2	Implement set operations, logic principles, and proof techniques.
CO3	Apply combinatorial and counting techniques in problem-solving.
CO4	Develop and analyze graph-based models for computing applications.
CO5	Evaluate and utilize algebraic structures in computing and cryptography.

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ECS3509	Graph Theory	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of graph theory and its applications.
CO2	Understand the mathematical foundations of graphs, trees, and connectivity.
CO3	Explore graph algorithms and their computational complexities
CO4	Apply graph theory techniques in real-world problem-solving and network analysis
CO5	Analyze and compare different graph structures and their properties

Unit-I

Introduction to Graph Theory: Basic Definitions: Graphs, Subgraphs, Degrees, and Isomorphism, Types of Graphs: Simple, Multigraphs, Directed, Weighted, Graph Representation: Adjacency Matrix and Adjacency List, Incidence and Degree, Regular Graphs

Unit-II

Trees and Connectivity: Definition and Properties of Tree, Rooted and Binary Tree, Spanning Trees: Prim's and Kruskal's Algorithm, Connectivity: Vertex and Edge Connectivity, Network Flows and Max-Flow Min-Cut Theorem

Unit-III

Graph Traversal and Paths: Eulerian and Hamiltonian Graphs, Graph Traversal: Breadth-First Search (BFS) and Depth-First Search (DFS), Shortest Path Algorithms: Dijkstra's and Bellman-Ford Algorithm, Applications of Graph Traversal in AI and Networking

Unit-IV

Planarity and Coloring: Planar Graphs and Euler's Formula, Kuratowski's Theorem, Graph Coloring: Chromatic Number and Chromatic Polynomials, Applications of Graph Coloring in Scheduling and Resource Allocation

Unit-V

Advanced Topics and Applications: Matching and Covering in Graphs, Graph Isomorphism and Automorphisms, Spectral Graph Theory, Applications in Social Networks, Computer Science, and Bioinformatics.

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Textbooks and References:

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science," PHI.
2. Douglas B. West, "Introduction to Graph Theory," Pearson Education.
3. Reinhard Diestel, "Graph Theory," Springer.
4. Harary F., "Graph Theory," Narosa Publishing.
5. John Clark & Derek Allan Holton, "A First Look at Graph Theory," World Scientific.

Course Outcomes:

C01	Understand the theoretical foundations of graph theory.
C02	Implement and analyze graph-based algorithms
C03	Apply graph traversal and connectivity concepts in problem-solving.
C04	Develop solutions for real-world applications using graph theory.
C05	Evaluate and compare different graph structures and their computational properties.

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EC83510	System Programming	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of system programming and its role in computer science.
CO2	Understand the design and implementation of system software such as assemblers, linkers, and loaders.
CO3	Explore various system software tools, including compilers, interpreters, and operating systems.
CO4	Apply system programming techniques for process management, memory management, and file systems.
CO5	Analyze system software performance and optimization techniques.

Unit-I

Introduction to System Programming: Overview of System Software and Application Software, System Programming vs. Application Programming, Language Processors: Assemblers, Compilers, and Interpreters, Fundamentals of Machine and Assembly Language.

Unit-II

Assemblers and Loaders: Design of an Assembler: Single-Pass and Multi-Pass Assemblers, Macro Processors and Macro Expansion, Linkers and Loaders: Static and Dynamic Linking, Relocation and Symbol Resolution in Linking.

Unit-III

Compilers and Interpreters: Phases of Compilation: Lexical Analysis, Syntax Analysis, Semantic Analysis, Intermediate Code Generation and Code Optimization, Code Generation and Machine-Dependent Optimization, Interpreters vs. Compilers: Design and Applications.

Unit-IV

Operating System Components and Process Management: Introduction to Operating System Components, Process Management: Process Scheduling and Context Switching, Memory Management: Paging and Segmentation, File Systems and I/O Systems.

Unit-V

Advanced Topics and Applications: Device Drivers and System Calls, Virtual Machines and System Security, Performance Optimization of System Software, Case Studies: Unix/Linux System Programming, Windows System Programming.

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Textbooks and References:

1. Leland L. Beck, "System Software: An Introduction to Systems Programming," Pearson Education.
2. John J. Donovan, "System Programming," McGraw Hill.
3. D. M. Dhamdhere, "Systems Programming and Operating Systems," Tata McGraw Hill.
4. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques, and Tools," Pearson Education.
5. Andrew S. Tanenbaum, "Modern Operating Systems," Pearson Education.

Course Outcomes:

CO1	Understand the role and importance of system programming.
CO2	Develop assemblers, loaders, and linkers for system software development.
CO3	Implement compilers and interpreters for programming language translation.
CO4	Apply system programming techniques for process and memory management.
CO5	Analyze and optimize system software performance.

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ECS3602	Software Testing	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of software testing and quality assurance
CO2	Understand various testing techniques, including functional and non-functional testing.
CO3	Explore test automation tools and strategies for efficient software validation.
CO4	Apply test management techniques to ensure software reliability and maintainability.
CO5	Analyze different software testing methodologies and their applications in real-world scenarios

Unit-I

Introduction to Software Testing: Basics of Software Testing and Quality Assurance, Software Development Life Cycle (SDLC) and Testing Life Cycle, Testing Principles, Types of Testing, and Testing Levels, Static and Dynamic Testing Techniques.

Unit-II

Functional and Structural Testing: Black Box Testing: Equivalence Partitioning, Boundary Value Analysis, White Box Testing: Statement, Branch, and Path Coverage, Unit Testing, Integration Testing, System Testing, Regression Testing and Smoke Testing

Unit-III

Test Automation and Tools: Test Automation vs. Manual Testing, Automation Testing Tools: Selenium, JUnit, TestNG, Writing Test Scripts and Test Case Design, Performance Testing and Load Testing with JMeter

Unit-IV

Test Management and Defect Tracking: Test Planning and Strategy Development, Defect Life Cycle and Bug Tracking Tools (JIRA, Bugzilla), Test Metrics and Reporting, Risk-Based Testing and Cost of Quality.

Unit-V

Advanced Topics and Industry Trends: Security Testing and Penetration Testing, Usability Testing and Accessibility Testing, Agile and DevOps Testing Methodologies, Case Studies on Real-World Software Testing Applications.

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Textbooks and References:

1. Glenford J. Myers, "The Art of Software Testing," Wiley.
2. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach," CRC Press.
3. Aditya P. Mathur, "Foundations of Software Testing," Pearson Education.
4. Cem Kaner, Jack Falk, Hung Quoc Nguyen, "Testing Computer Software," Wiley.
5. Rex Black, "Managing the Testing Process," Wiley.

Course Outcomes:

CO1	Understand software testing principles and methodologies.
CO2	Develop functional and structural test cases for software validation.
CO3	Utilize automation tools to enhance testing efficiency
CO4	Implement defect tracking and test management techniques.
CO5	Analyze and apply modern testing methodologies in software development.

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ECS3607	Multimedia systems	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of multimedia systems and their applications.
CO2	Understand different multimedia components, including text, images, audio, and video.
CO3	Explore multimedia storage, compression techniques, and retrieval methods.
CO4	Apply multimedia tools and techniques for content creation and editing.
CO5	Analyze the impact of multimedia in various domains such as education, entertainment, and business.

Unit-I

Introduction to Multimedia Systems: Definition and Components of Multimedia, Multimedia Applications and Evolution, Hardware and Software Requirements for Multimedia, Multimedia and Hypermedia Concepts.

Unit-II

Multimedia Components and Processing: Text and Image Processing: Formats, Editing, and Storage, Audio: Characteristics, File Formats, and Compression, Video: Formats, Frame Rates, Compression Techniques, Animation Techniques and Tools.

Unit-III

Multimedia Storage and Compression: Data Representation and Multimedia Databases, Image Compression: JPEG, PNG, GIF, Audio Compression: MP3, AAC, WAV, Video Compression: MPEG, H.264, AVI.

Unit-IV

Multimedia Networking and Applications: Multimedia over the Internet, Streaming Protocols and Content Delivery Networks, Virtual Reality and Augmented Reality, Multimedia in E-learning, Gaming, and Digital Marketing.

Unit-V

Advanced Multimedia Technologies: Artificial Intelligence in Multimedia Systems, Cloud-based Multimedia Applications, 3D Modeling and Rendering, Case Studies on Multimedia Applications in Industry.

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Textbooks and References:

1. Ze-Nian Li and Mark S. Drew, "Fundamentals of Multimedia," Springer.
2. Ralf Steinmetz and Klara Nahrstedt, "Multimedia: Computing, Communications, and Applications," Pearson Education.
3. Tay Vaughan, "Multimedia: Making It Work," McGraw Hill.
4. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols, and Standards," Pearson Education.
5. John F. Koegel Buford, "Multimedia Systems," ACM Press.

Course Outcomes:

CO1	Understand the principles and components of multimedia systems.
CO2	Process and manipulate multimedia elements effectively.
CO3	Implement compression and storage techniques for multimedia data.
CO4	Apply multimedia tools for real-world applications.
CO5	Analyze the latest trends and advancements in multimedia technologies.

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ECS3608	Principles of Programming Language	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts and paradigms of programming languages.
CO2	Understand syntax, semantics, and implementation techniques for different languages.
CO3	Explore various programming paradigms, including procedural, object-oriented, functional, and logic programming.
CO4	Analyze language features such as type systems, control flow, and memory management.
CO5	Compare and evaluate different programming languages based on their suitability for various applications

Unit-I

Introduction to Programming Languages: History and Evolution of Programming Languages, Language Classification: Procedural, Object-Oriented, Functional, Logic-based, Syntax and Semantics of Programming Languages, Programming Language Design Principles.

Unit-II

Data Types, Variables, and Expressions: Primitive, Composite, and Abstract Data Types, Type Checking and Type Inference, Variable Binding, Scope, and Lifetime, Expression Evaluation and Control Structures.

Unit-III

Control Flow and Subprograms: Conditional Statements and Loops, Subprograms: Functions, Procedures, and Recursion, Parameter Passing Techniques, Exception Handling and Error Recovery.

Unit-IV

Memory Management and Runtime Environment: Static vs. Dynamic Memory Allocation, Stack-based and Heap-based Memory Management, Garbage Collection Techniques, Runtime Environment and Execution Models.

Unit-V

Programming Paradigms and Case Studies: Procedural vs. Declarative Programming, Object-Oriented Programming Concepts, Functional and Logic Programming, Comparative Study of Languages (C, Java, Python, Lisp, Prolog, etc.)

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Textbooks and References:

1. Robert W. Sebesta, "Concepts of Programming Languages," Pearson Education.
2. John C. Mitchell, "Concepts in Programming Languages," Cambridge University Press.
3. Benjamin C. Pierce, "Types and Programming Languages," MIT Press.
4. Ravi Sethi, "Programming Languages: Concepts and Constructs," Addison-Wesley.
5. Terrence W. Pratt, "Programming Languages: Design and Implementation," Pearson Education.

Course Outcomes:

CO1	Understand the principles, syntax, and semantics of programming languages.
CO2	Implement different programming paradigms in software development.
CO3	Analyze and compare various language constructs and features.
CO4	Develop efficient programs using appropriate language paradigms.
CO5	Evaluate and select suitable programming languages for different applications

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ECS3609	Web Development	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts and technologies of web development.
CO2	Understand front-end and back-end development methodologies.
CO3	Explore web development frameworks, tools, and best practices.
CO4	Implement responsive and interactive web applications.
CO5	Analyze security considerations and performance optimization techniques in web development.

Unit-I

Introduction to Web Development: Basics of the Internet and World Wide Web, Overview of Web Technologies (HTML, CSS, JavaScript), Web Standards and Accessibility, Client-Side vs. Server-Side Scripting.

Unit-II

Front-End Development: HTML: Elements, Forms, Tables, and Multimedia, **CSS:** Styling, Layouts, and Responsive Design (Flexbox, Grid), **JavaScript Basics:** DOM Manipulation, Events, ES6+ Features, **Frameworks:** Bootstrap, Tailwind CSS.

Unit-III

Back-End Development: Server-Side Programming: Introduction to Node.js, PHP, Python (Django/Flask), **Databases:** SQL vs. NoSQL, MySQL, MongoDB, **RESTful APIs** and Web Services, Authentication and Authorization (JWT, OAuth).

Unit-IV

Advanced Web Technologies: Single Page Applications (SPAs) with React/Vue.js, State Management: Redux, Vuex, WebSockets and Real-Time Communication, Progressive Web Apps (PWAs)

Unit-V

Web Security and Performance Optimization: Security Threats: XSS, CSRF, SQL Injection, Clickjacking, Web Performance Optimization Techniques (Lazy Loading, Minification, Caching), DevOps and Deployment Strategies (Docker, CI/CD), Cloud Hosting and Serverless Architecture (AWS, Firebase)

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Textbooks and References:

1. Jon Duckett, "HTML & CSS: Design and Build Websites," Wiley.
2. Jon Duckett, "JavaScript and JQuery: Interactive Front-End Web Development," Wiley.
3. Ethan Brown, "Learning JavaScript Design Patterns," O'Reilly.
4. Kyle Simpson, "You Don't Know JS (book series)," O'Reilly.
5. Robin Nixon, "Learning PHP, MySQL & JavaScript," O'Reilly.

Course Outcomes:

C01	Understand and apply web development technologies
C02	Develop responsive and user-friendly web applications.
C03	Work with databases and server-side programming for dynamic content.
C04	Implement modern web frameworks and security measures.
C05	Optimize and deploy scalable web applications.

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ECS3610	Linux Administration	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of Linux operating system and administration.
CO2	Understand Linux installation, file system structure, and command-line interface.
CO3	Explore user management, process control, and system security in Linux.
CO4	Configure networking, services, and automation using shell scripting.
CO5	Analyze Linux system monitoring, troubleshooting, and performance tuning.

Unit-I

Introduction to Linux and Installation: History and Evolution of Linux, Linux Distributions and Installation Methods, File System Structure and Hierarchy, Basic Linux Commands and Shell Environment.

Unit-II

User and File Management: User and Group Administration, File Permissions and Ownership, Process Management and Job Scheduling, File Archiving and Backup Techniques

Unit-III

System Administration and Security: System Boot Process and Initialization (GRUB, systemd), Package Management (APT, YUM, RPM), Security Essentials: Firewalls, SELinux, iptables, Access Control and Encryption Techniques

Unit-IV

Networking and Services Configuration: Network Configuration and Troubleshooting, DNS, DHCP, and Web Server Setup (Apache, Nginx), FTP, SSH, and Remote Administration Database Server Configuration (MySQL/PostgreSQL).

Unit-V

Automation and Performance Tuning: Shell Scripting and Automation, System Monitoring and Performance Analysis (top, vmstat, iostat), Log Management and Troubleshooting (syslog, journalctl), Virtualization and Cloud Integration with Linux.

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Textbooks and References:

1. Evi Nemeth, Garth Snyder, Trent R. Hein, "UNIX and Linux System Administration Handbook," Pearson.
2. William E. Shotts Jr., "The Linux Command Line: A Complete Introduction," No Starch Press.
3. Mark G. Sobell, "A Practical Guide to Linux Commands, Editors, and Shell Programming," Pearson.
4. Richard Blum, "Linux Command Line and Shell Scripting Bible," Wiley.
5. Christopher Negus, "Linux Bible," Wiley.

Course Outcomes:

CO1	Understand Linux system architecture, installation, and file system management.
CO2	Perform user and file management tasks efficiently.
CO3	Configure security mechanisms and system administration tools.
CO4	Manage Linux networking services and remote administration
CO5	Automate tasks and optimize system performance using advanced Linux tools

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ECS4701	Cyber Security	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce fundamental concepts of cyber security and threat management.
CO2	Understand cryptography, network security, and access control mechanisms
CO3	Explore ethical hacking, malware analysis, and penetration testing techniques.
CO4	Analyze security frameworks, policies, and legal aspects of cyber security.
CO5	Implement security measures for risk management and incident response.

Unit-I

Introduction to Cyber Security: Basics of Cyber Security and Its Importance, Threats, Vulnerabilities, and Attack Vectors, Security Policies and Governance Frameworks, Cyber Ethics and Legal Aspects.

Unit-II

Cryptography and Network Security: Principles of Cryptography: Symmetric vs. Asymmetric Encryption, Hash Functions and Digital Signatures, Network Security Protocols (SSL/TLS, IPsec), Firewalls, IDS, and IPS.

Unit-III

Ethical Hacking and Malware Analysis: Ethical Hacking Fundamentals and Penetration Testing, Phases of Ethical Hacking (Reconnaissance, Exploitation, Post-Exploitation), Malware Types and Attack Techniques (Viruses, Worms, Trojans, Ransomware), Reverse Engineering and Forensics

Unit-IV

Security Policies, Risk Management, and Compliance: Security Audits and Risk Assessment Techniques, Security Standards (ISO 27001, NIST, GDPR), Incident Response and Disaster Recovery Planning, Secure Coding Practices and Vulnerability Assessments.

Unit-V

Advanced Cyber Security Technologies: Cloud Security and Virtualization Threats, IoT Security and Industrial Control System Security, Blockchain for Cyber Security Applications, Artificial Intelligence in Cyber Threat Detection

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Textbooks and References:

1. William Stallings, "Cryptography and Network Security: Principles and Practice," Pearson.
2. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security," Cengage Learning.
3. Charles P. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing," Pearson.
4. Kevin Mitnick, "The Art of Deception: Controlling the Human Element of Security," Wiley.
5. Bruce Schneier, "Applied Cryptography: Protocols, Algorithms, and Source Code in C," Wiley.

Course Outcomes:

CO1	Understand cyber security fundamentals, risks, and legal implications.
CO2	Implement cryptographic and network security measures.
CO3	Apply ethical hacking techniques for vulnerability assessment.
CO4	Develop security policies and risk management strategies.
CO5	Utilize emerging technologies for cyber security threat mitigation.

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ECS4704	Pattern Recognition	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of pattern recognition and machine learning.
CO2	Understand feature extraction, dimensionality reduction, and classification techniques.
CO3	Explore supervised and unsupervised learning approaches for pattern analysis.
CO4	Apply statistical and structural methods for pattern recognition problems.
CO5	Implement real-world applications of pattern recognition in various domains.

Unit-I

Introduction to Pattern Recognition: Basics of Pattern Recognition, Applications of Pattern Recognition in Various Domains, Statistical Decision Theory and Bayes Classifier, Introduction to Machine Learning Concepts.

Unit-II

Feature Extraction and Selection: Feature Extraction Techniques (PCA, LDA, ICA), Feature Selection and Dimensionality Reduction, Data Preprocessing and Normalization, Similarity Measures and Distance Metrics.

Unit-III

Classification and Clustering: Supervised Learning: k-NN, Decision Trees, SVM, Neural Networks, Unsupervised Learning: k-Means, Hierarchical Clustering, DBSCAN, Probabilistic Models: Hidden Markov Models (HMM), Gaussian Mixture Models (GMM), Performance Evaluation: Confusion Matrix, ROC Curve, Precision-Recall.

Unit-IV

Structural and Syntactic Pattern Recognition: Graph-Based Approaches to Pattern Recognition, String Matching and Parsing Techniques, Grammar-Based Methods for Pattern Recognition, Applications in Image Processing and Text Recognition

Unit-V

Advanced Topics and Applications: Deep Learning for Pattern Recognition (CNN, RNN, GANs), Real-Time Applications in Speech and Image Recognition, Biometric Systems and Security Applications, Pattern Recognition in Medical and Financial Data Analysis.

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Textbooks and References:

1. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification," Wiley.
2. C. M. Bishop, "Pattern Recognition and Machine Learning," Springer.
3. Sergios Theodoridis, Konstantinos Koutroumbas, "Pattern Recognition," Academic Press.
4. Robert Schalkoff, "Pattern Recognition: Statistical, Structural, and Neural Approaches," Wiley.
5. S. Haykin, "Neural Networks and Learning Machines," Pearson.

Course Outcomes:

CO1	Understand the fundamental concepts of pattern recognition and its applications in various domains such as image processing, speech recognition, and biometrics.
CO2	Apply statistical and structural techniques to analyze and classify data patterns.
CO3	Implement feature extraction and dimensionality reduction techniques for effective data representation.
CO4	Develop and evaluate pattern recognition systems using tools like MATLAB or Python with real-world datasets.
CO5	Analyze the performance of classification and clustering algorithms using appropriate metrics.

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ECS4705	Parallel Algorithm	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Introduce the fundamental concepts of parallel computing and parallel algorithms.
CO2	Understand parallel architectures, models, and complexity analysis.
CO3	Explore parallel sorting, searching, and graph algorithms.
CO4	Implement parallel programming paradigms and synchronization techniques.
CO5	Analyze real-world applications and performance optimization strategies for parallel algorithms

Unit-I

Introduction to Parallel Computing: Fundamentals of Parallelism and Concurrency, Parallel Computer Models and Architectures, Performance Metrics: Speedup, Efficiency, Scalability, Flynn's Taxonomy (SISD, SIMD, MISD, MIMD)

Unit-II

Parallel Algorithm Design and Analysis: Work, Depth, and Parallel Complexity Models, Parallel Divide-and-Conquer Strategies, Scheduling and Load Balancing Techniques, Communication Costs and Overhead.

Unit-III

Parallel Sorting and Searching Algorithms: Parallel Merge Sort, Quick Sort, and Bitonic Sort, Parallel Searching: Parallel Binary Search, Hashing, PRAM Model and Sorting, Networks, Matrix Operations: Parallel Matrix Multiplication

Unit-IV

Parallel Graph Algorithms: Parallel Breadth-First Search (BFS) and Depth-First Search (DFS), Minimum Spanning Tree (MST) Algorithms (Prim's, Kruskal's), Shortest Path Algorithms (Dijkstra, Floyd-Warshall), Graph Partitioning and Connectivity Algorithms

Unit-V

Parallel Programming and Optimization: Shared Memory vs. Distributed Memory Models, OpenMP, MPI, and CUDA Programming, Synchronization and Deadlocks in Parallel Computing, Performance Optimization Techniques and Case Studies

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Textbooks and References:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, "Introduction to Parallel Computing," Pearson.
2. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP," McGraw Hill.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms," MIT Press.
4. Ian Foster, "Designing and Building Parallel Programs," Addison-Wesley.
5. Kai Hwang, "Advanced Computer Architecture: Parallelism, Scalability, Programmability," McGraw Hill.

Course Outcomes:

CO1	Understand the principles of parallel computing and algorithm design.
CO2	Analyze the efficiency and complexity of parallel algorithms.
CO3	Develop and implement parallel sorting, searching, and graph algorithms
CO4	Utilize parallel programming models and synchronization mechanisms.
CO5	Apply performance optimization techniques in real-world parallel computing applications.

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ECS4706	Introduction to Machine Learning	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Understand the fundamental concepts and applications of machine learning.
CO2	Explore various supervised and unsupervised learning techniques.
CO3	Learn feature selection, model evaluation, and performance metrics.
CO4	Implement machine learning algorithms using modern tools and libraries.
CO5	Analyze real-world case studies and applications of machine learning.

Unit-I

Introduction to Machine Learning: Basics of Machine Learning and AI, Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning, Applications of Machine Learning in Various Domains, Basics of Probability, Statistics, and Linear Algebra for ML

Unit-II

Supervised Learning: Regression Techniques: Linear Regression, Polynomial Regression, Classification Algorithms: Logistic Regression, Decision Trees, Random Forests, Support Vector Machines (SVM), Evaluation Metrics: Accuracy, Precision, Recall, F1-Score, ROC Curve, Overfitting and Underfitting: Bias-Variance Tradeoff.

Unit-III

Unsupervised Learning: Clustering Algorithms: k-Means, Hierarchical Clustering, DBSCAN, Dimensionality Reduction Techniques: PCA, LDA, t-SNE, Association Rule Learning: Apriori, FP-Growth, Applications in Anomaly Detection and Customer Segmentation.

Unit-IV

Neural Networks and Deep Learning: Basics of Artificial Neural Networks (ANN), Activation Functions and Backpropagation, Introduction to Deep Learning and Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM).

Unit-V

Practical Applications and Case Studies: Implementing ML Models Using Python (Scikit-Learn, TensorFlow, Keras), Natural Language Processing (NLP) Applications, Image Processing and Computer Vision, Ethics and Challenges in Machine Learning

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Textbooks and References:

1. Tom Mitchell, "Machine Learning," McGraw Hill.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning," Springer.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning," MIT Press.
4. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning," Springer.
5. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow," O'Reilly.

Course Outcomes:

CO1	Gain a strong foundation in machine learning concepts and techniques.
CO2	Apply supervised and unsupervised learning models to real-world problems.
CO3	Evaluate the performance of machine learning models.
CO4	Develop machine learning solutions using modern programming tools.
CO5	Understand ethical concerns and challenges in the field of machine learning.

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ECS4707	Introduction to IOT	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Understand the fundamental concepts and architecture of the Internet of Things (IoT).
CO2	Explore various IoT communication protocols and network technologies
CO3	Learn about IoT sensors, actuators, and embedded systems.
CO4	Implement IoT applications using cloud computing and data analytics.
CO5	Analyze security challenges and real-world applications of IoT.

Unit-I

Introduction to IoT: Overview of IoT and its Evolution, Characteristics and Benefits of IoT, IoT Architecture and Layers, Applications of IoT in Various Domains (Smart Cities, Healthcare, Agriculture, Industry 4.0)

Unit-II

IoT Communication and Networking: IoT Communication Models and Protocols, Wireless Technologies: Bluetooth, Zigbee, LoRa, 6LoWPAN, Cloud Computing and IoT, Edge and Fog Computing in IoT Systems.

Unit-III

Sensors, Actuators, and Embedded Systems: Types of IoT Sensors and Actuators, Microcontrollers and Microprocessors for IoT (Arduino, Raspberry Pi, ESP8266), Interfacing Sensors with IoT Devices, Power Management and Energy Efficiency in IoT.

Unit-IV

IoT Data Processing and Security: IoT Data Analytics and Machine Learning Applications, IoT Security Threats and Countermeasures, Authentication and Encryption in IoT Networks, Privacy and Ethical Concerns in IoT.

Unit-V

Practical Applications and Case Studies: IoT-Based Smart Home Automation, Industrial IoT (IIoT) Applications, Healthcare and Wearable IoT Technologies, Future Trends and Challenges in IoT.

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Textbooks and References:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach," Universities Press.
2. Raj Kamal, "Internet of Things: Architecture and Design Principles," McGraw Hill.
3. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things," Wiley.
4. Pethuru Raj, Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases," CRC Press.
5. Mohammad Ali Jabraeil Jamali, "Practical Internet of Things with Arduino and Raspberry Pi," Springer.

Course Outcomes:

CO1	Understand the core concepts and architecture of IoT.
CO2	Apply IoT communication protocols and networking techniques.
CO3	Develop IoT applications using sensors, actuators, and embedded systems.
CO4	Implement cloud-based IoT solutions with data analytics.
CO5	Evaluate security challenges and ethical considerations in IoT systems.

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ECS4702	Embedded and Real Time Systems	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Understand the fundamentals of embedded and real-time systems.
CO2	Explore the architecture and components of embedded systems.
CO3	Learn about real-time operating systems (RTOS) and scheduling techniques.
CO4	Develop embedded applications using hardware and software components.
CO5	Analyze performance, security, and power management in embedded systems.

Unit-I

Introduction to Embedded Systems: Overview of Embedded Systems, Characteristics and Design Constraints, Embedded System Architecture, Applications of Embedded Systems in Various Domains

Unit-II

Embedded Hardware and Software: Microcontrollers and Microprocessors, Memory and I/O Interfacing, Embedded System Development Tools, Programming Languages for Embedded Systems (C, Assembly).

Unit-III

Real-Time Systems and Scheduling: Fundamentals of Real-Time Systems, Hard vs. Soft Real-Time Systems, Task Scheduling Algorithms: Rate Monotonic Scheduling (RMS), Earliest Deadline First (EDF), Inter-Process Communication and Synchronization

Unit-IV

Real-Time Operating Systems (RTOS): Introduction to RTOS and Kernel Services, Process Management and Multithreading, RTOS Case Studies: FreeRTOS, VxWorks, RTEMS, Power Management and Energy Efficiency in Embedded Systems

Unit-V

Applications and Future Trends: Embedded Systems in IoT, Automotive, and Healthcare, Security Challenges in Embedded Systems, Case Studies and Practical Implementations, Emerging Trends: Edge Computing, AI in Embedded Systems.

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Textbooks and References:

1. Raj Kamal, "Embedded Systems: Architecture, Programming, and Design," McGraw Hill.
2. Frank Vahid, Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction," Wiley.
3. Jonathan W. Valvano, "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers," CreateSpace.
4. Jane W. S. Liu, "Real-Time Systems," Pearson.
5. Qing Li, "Real-Time Concepts for Embedded Systems," CMP Books.

Course Outcomes:

CO1	Understand the fundamentals of embedded and real-time systems.
CO2	Design and develop embedded hardware and software components
CO3	Implement real-time scheduling techniques and RTOS applications.
CO4	Optimize embedded systems for power, performance, and security.
CO5	Analyze real-world applications and future trends in embedded systems.

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Textbooks and References:

1. Simon Haykin, "Neural Networks and Learning Machines," Pearson.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning," Springer.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning," MIT Press.
4. David Kriesel, "A Brief Introduction to Neural Networks."
5. Satish Kumar, "Neural Networks: A Classroom Approach," McGraw Hill.

Course Outcomes:

CO1	Gain a strong foundation in neural network architectures and learning algorithms.
CO2	Implement artificial neural networks for classification and prediction tasks.
CO3	Optimize and fine-tune neural networks for better performance.
CO4	Develop deep learning models for real-world applications.
CO5	Understand ethical concerns and future advancements in neural networks.

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ECS4709	OS for Smart Devices(Android)	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Understand the fundamentals of mobile operating systems with a focus on Android.
CO2	Explore the architecture and components of the Android OS.
CO3	Learn about application development, UI design, and system services in Android.
CO4	Analyze security, performance, and optimization techniques in Android OS.
CO5	Implement real-world Android applications and explore emerging trends.

Unit-I

Introduction to Smart Device OS: Evolution of Mobile Operating Systems, Features and Challenges of Smart Device OS, Android vs. iOS vs. Other Mobile OS, Application Development Lifecycle in Android.

Unit-II

Android Architecture and Components: Android System Architecture, Linux Kernel and Android Runtime (ART), Application Framework and APIs, Activity, Services, Broadcast Receivers, and Content Providers

Unit-III

User Interface and Development Tools: UI Design and Material Design Principles, Layouts, Views, and Event Handling, Android Studio, Gradle, and ADB, Intents, Fragments, and Navigation Components

Unit-IV

System Services and Security: Location-based Services and Sensors, Data Storage: Shared Preferences, SQLite, and Cloud Integration, Android Security Model: Permissions, Encryption, and Sandboxing, App Optimization and Performance Tuning.

Unit-V

Advanced Topics and Future Trends: Internet of Things (IoT) and Android, AI and Machine Learning in Android Apps, Android Custom ROMs and Open-Source Development, Future Directions: 5G, Foldable Devices, and Edge Computing.

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Textbooks and References:

1. Mark Murphy, "The Busy Coder's Guide to Android Development."
2. Ian F. Darwin, "Android Cookbook: Problems and Solutions for Android Developers," O'Reilly Media.
3. Paul Deitel, Harvey Deitel, "Android How to Program," Pearson.
4. Reto Meier, "Professional Android Development," Wrox.
5. Jeff Friesen, "Android Programming for Beginners," Packt Publishing.

Course Outcomes:

CO1	Gain knowledge of mobile operating systems and their evolution.
CO2	Understand Android OS architecture and key components
CO3	Develop Android applications using modern tools and frameworks.
CO4	Implement security, data management, and performance optimization in Android.
CO5	Explore advanced topics and the future of Android OS in smart devices.

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ECS4710	Client Server Computing	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Understand the fundamentals of client-server architecture and distributed systems.
CO2	Explore the roles and responsibilities of clients and servers in a networked environment.
CO3	Develop basic client-server applications using sockets and remote procedure calls.
CO4	Evaluate the performance and scalability of client-server models.
CO5	Understand issues of concurrency, security, and data management in distributed computing.

Unit-I

Introduction to Client-Server Computing: Definition and basics of client-server computing, Evolution of computing models: mainframe, PC, distributed, and client-server, Components of client-server architecture, Comparison: client-server vs. peer-to-peer, Advantages and challenges of client-server architecture, Examples of client-server applications.

Unit-II

Networking Fundamentals and Protocols: Overview of computer networks, OSI and TCP/IP models, Protocols used in client-server communication: HTTP, FTP, SMTP, POP3, IMAP, IP addressing and DNS basics, Socket programming: concepts and types (TCP vs UDP), Basic client-server communication using sockets (with examples)

Unit-III

Client-Server Architectures: Types of architectures: 2-tier, 3-tier, N-tier, Role of clients and servers in each model, Thin client vs. thick client architecture, Middleware: definition, purpose, and types, Comparison of distributed architectures, Real-world examples (banking, online shopping, etc.)

Unit-IV

Interprocess Communication and Middleware Technologies: Interprocess Communication (IPC) concepts, Remote Procedure Call (RPC) and its implementation, Java RMI (Remote Method Invocation), CORBA (Common Object Request Broker Architecture), Message Oriented Middleware (MOM), Introduction to web services (SOAP, REST)

Unit-V

Server-Side Programming and Databases: Overview of server-side scripting languages (PHP, ASP.NET, Node.js), Building server-side applications, Web servers vs. application servers, Database connectivity: ODBC and JDBC, Basics of server-side database operations (CRUD), Introduction to connection pooling and security practices.

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Textbooks and References:

1. "Client/Server Computing" by *Patrick Smith and Steve Guengerich*, Publisher: Prentice Hall, A foundational book covering client-server models, middleware, networking, and implementation technologies.
2. "Distributed Systems: Principles and Paradigms" by *Andrew S. Tanenbaum and Maarten van Steen*, Pearson, Great for understanding the broader context of distributed computing, which includes client-server models.
3. "Web Technologies: A Computer Science Perspective" by *Jeffrey C. Jackson*, Pearson Education, Includes detailed coverage of server-side scripting and web-based client-server systems.
4. "Computer Networks" by *Andrew S. Tanenbaum and David J. Wetherall*, Pearson, Essential for understanding networking protocols used in client-server systems.

Course Outcomes:

CO1	Explain the principles and components of client-server computing architectures.
CO2	Analyze and compare various client-server models and technologies (e.g., 2-tier, 3-tier, N-tier).
CO3	Develop basic client-server applications using socket programming in languages like Java, C++, or Python.
CO4	Apply communication protocols such as HTTP, TCP/IP, FTP, and SOAP in networked applications.
CO5	Apply communication protocols such as HTTP, TCP/IP, FTP, and SOAP in networked applications.

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ECS4711	Cloud Computing	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To provide students with the fundamentals and essentials of Cloud Computing.
CO2	To provide students a sound foundation of the Cloud computing so that they are able to identify the vendors and assess the risk involved in cloud migration.
CO3	To enable students be aware of the various governance issues in cloud and how to manage the same.
CO4	To provide a comprehensive understanding of the fundamental principles and architecture of cloud computing.
CO5	To enable students to explore various cloud service models (IaaS, PaaS, SaaS) and deployment models (public, private, hybrid).

Unit-I

Fundamentals of Cloud Computing: Cloud Computing Basics – History of Cloud Computing, Characteristics of Cloud Computing, Need for Cloud computing, Advantages and Possible Disadvantages of cloud computing, Cloud Deployment Models – Public, Private, Hybrid, Community, Other deployment Models. Evolving Data Center into Private Cloud, Datacenter Components, Extracting Business value in Cloud Computing – Cloud Security, Cloud Scalability, Time to Market, Distribution over the Internet, Cloud Computing Case Studies.

Unit-II

Cloud Delivery Models: Introduction to Cloud Services, Infrastructure as a Service (IAAS) – Overview, Virtualization, Container, Pricing Models, Service Level Agreements, Migrating to the Cloud, IaaS Networking options, Virtual Private Cloud(VPC), IAAS Storage – File and Object storage, Data Protection, IaaS security, Benefits, Risks and Examples of IaaS. Platform as a Service (PAAS) – Overview, IAAS v/s PAAS, PAAS Examples, benefits and risks. Software as a Service (SAAS) – Introducing SaaS, SaaS Examples – Office 365, Google G Suite, Salesforce.com , Evaluating SaaS – user and vendor perspective, Impact of SaaS, Benefits and risks of SaaS. Other Services on Cloud, Cloud Delivery Models Considerations

Unit-III

Cloud Platforms: Introducing Cloud Platforms, Evaluating cloud platforms, Cloud Platform technologies – Amazon Web Services, Microsoft Azure, Google Cloud Platform, Salesforce.com, and Impact of Cloud platforms. Private Cloud Platforms – Introducing Private clouds – Microsoft Azure stack, Open stack, AWS Greengrass, Impact of Private clouds
Cloud Migration: Delivering Business Processes from the Cloud: Business process examples, Broad Approaches to Migrating into the Cloud, The Seven-Step Model of Migration into a Cloud, Efficient Steps for migrating to cloud., Risks: Measuring and assessment of risks, Company concerns Risk Mitigation methodology for Cloud computing, Case Studies

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Unit-IV

Cloud Computing - Challenges, Risk and Mitigation: Cloud Storage, Application performance, Data Integration, Security, Ensuring Successful Cloud Adoption: Designing a Cloud Proof of Concept, Vendor roles and capabilities, moving to the Cloud. Impact of Cloud on IT Service Management. Risks and Consequences of Cloud Computing – Legal Issues, Compliance Issues, Privacy and Security.

Unit-V

Managing the Cloud: Managing and Securing Cloud Services, Virtualization and the Cloud, Managing Desktops and devices on the cloud, SOA and Cloud computing, Managing the Cloud environment, Planning for the Cloud – Economic Cost Model and Leveraging the Cloud, Cloud computing resources, Cloud Dos and Don'ts.

Textbooks and References:

1. Kirk Hausman, Susan L. Cook, TelmoSampaio, "CLOUD ESSENTIALS CompTIA® Authorized Courseware for Exam CLO-001", John Wiley & Sons Inc., 2013
2. Judith Hurvitz , Robin Bloor , Marcia Kaufman , Fern Halper, "Cloud Computing for Dummies", Wiley Publishing Inc., 2010
3. Erl, "Cloud Computing: Concepts, Technology & Architecture", Pearson Education, 2014
4. Srinivasan, "Cloud Computing: A Practical Approach for Learning and Implementation "Pearson Education, 2014

Course Outcomes:

CO1	Analyze the Cloud computing setup with its vulnerabilities and applications using different architecture
CO2	Analyze the risks involved in migrating the existing infrastructure to cloud.
CO3	Assess various cloud service providers and generate effective cloud infrastructure by optimizing the cost involved..
CO4	Broadly educate to know the impact of engineering on legal and societal issues involved in addressing the security issues of cloud computing.
CO5	Explain the basic concepts, service models, and deployment models of cloud computing, and identify its applications and benefits in real-world scenarios.

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ECS4802	Distributed Databases	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	Enhanced the knowledge in the area of Distributed Database system.
CO2	Comprehend the Distributed query processing
CO3	The subject explores the ideas of Transaction management and concurrency control.
CO4	Know the parallel database system architecture.
CO5	To learn about Distributed Deadlock Detection

Unit-I

Transaction and schedules: Concurrent Execution of transaction, Conflict and View Serializability, Testing for Serializability, Concepts in Recoverable and Cascadeless schedules. Lock based protocols, time stamp based protocols, Multiple Granularity and Multiversion Techniques, Enforcing serializability by Locks, Locking system with multiple lock modes, architecture for Locking scheduler

Unit-II

Distributed Transactions Management: Data Distribution, Fragmentation and Replication Techniques, Distributed Commit, Distributed Locking schemes, Long duration transactions, Moss Concurrency protocol. Issues of Recovery and atomicity in Distributed Databases

Unit-III

Traditional recovery techniques, Logbased recovery, Recovery with Concurrent Transactions, Recovery in Message passing systems, Checkpoints, Algorithms for recovery line, Concepts in Orphan and Inconsistent Messages.

Unit-IV

Distributed Query Processing: Multiway Joins, Semi joins, Cost based query optimization for distributed database, Updating replicated data, protocols for Distributed Deadlock Detection, Eager and Lazy Replication Techniques. Distributed Transactions: Definition and characteristics, ACID properties in distributed environments, Transaction processing monitors, **Commit Protocols:** Two-Phase Commit (2PC), Three-Phase Commit (3PC), Failures and recovery mechanisms in commit protocols.

Unit-V

Concurrency Control in Distributed Databases: Distributed concurrency control techniques, Locking mechanisms (centralized, primary site, distributed), Timestamp ordering, Multiversion concurrency control, **Deadlock Management:** Deadlock prevention, avoidance, and detection, Deadlock resolution techniques in distributed systems, **Reliability and Fault Tolerance:** Reliability issues in distributed systems, Failure classification, Recovery methods and techniques (shadow paging, write-ahead logging)

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Textbooks and References:

1. Silberschatz, orth and Sudershan, Database System Concept', McGraw Hill
2. Ramakrishna and Gehrke,' Database Management System, McGraw Hill
3. Garcia-Molina, Ullman, Widom,' Database System Implementation' Pearson Education
4. Ceci and Pelagatti,'Distributed Database', TMH
5. Singhal and Shivratri, 'Advance Concepts in Operating Systems' MC Graw Hill

Course Outcomes:

CO1	Aware of fundamentals of Distributed Database system
CO2	Use the different techniques of Distributed query processing.
CO3	Set the rules over management of transaction and concurrency control..
CO4	Familiar with parallel database system architecture.
CO5	Understand Distributed Deadlock Detection

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ECS4806	Entrepreneurship & Technology Management	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce students to the concepts of entrepreneurship and the entrepreneurial process.
CO2	To help students understand how to manage technology and innovation in business environments.
CO3	To develop students' ability to identify, evaluate, and implement business opportunities.
CO4	To provide knowledge about institutional support and financing for start-ups and innovation.
CO5	To develop managerial skills for handling risks, scaling, and sustaining technology-based enterprises.

Unit-I

Introduction to Entrepreneurship: Definition, characteristics, and types of entrepreneurs, Entrepreneurial mindset and motivation, Theories of entrepreneurship, Women entrepreneurs and rural entrepreneurship, Role of entrepreneurship in economic development.

Unit-II

Entrepreneurial Process & Business Planning: Idea generation and opportunity evaluation, Feasibility study – technical, financial, market, legal, Business model canvas, Business plan development – components and structure, Risk analysis and market strategy

Unit-III

Technology and Innovation Management: Role of technology in entrepreneurship, Innovation types: product, process, incremental, disruptive, Technology life cycle, R&D management and technology transfer, Intellectual Property Rights (IPR) – patents, copyrights, trademarks

Unit-IV

Institutional Support & Funding Agencies: Entrepreneurship development institutions: MSME, NSIC, SIDBI, NIESBUD, DST, NABARD, Incubators, accelerators, and start-up ecosystems, Sources of funding: angel investors, venture capital, crowdfunding, government grants, Start-up India and Make in India initiatives

Unit-V

Managing Growth and Sustainability: Scaling strategies for start-ups, Strategic partnerships and collaborations, Leadership and team building in start-ups, Exit strategies: IPO, acquisition, mergers, Case studies of successful tech-based start-ups

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Textbooks and References:

1. **Entrepreneurship Development**" by *S.S. Khanka*
Publisher: S. Chand
2. **"Entrepreneurship"** by *Robert D. Hisrich, Michael P. Peters, and Dean A. Shepherd*
Publisher: McGraw Hill
3. **"Innovation and Entrepreneurship"** by *Peter F. Drucker*
Publisher: HarperBusiness
4. **"Technology Management: Activities and Tools"** by *Dilek Cetindamar, Rob Phaal, David Probert*
Publisher: Palgrave Macmillan
5. **"Managing Innovation"** by *Joe Tidd and John Bessant*
Publisher: Wiley
6. **"Entrepreneurship: Successfully Launching New Ventures"** by *Bruce R. Barringer and R. Duane Ireland*, Publisher: Pearson Education

Course Outcomes:

CO1	Demonstrate an understanding of entrepreneurial mindset, innovation, and opportunity identification.
CO2	Develop business models and project plans for start-ups, especially in the tech domain.
CO3	Analyze various strategies for managing technology, R&D, and innovation.
CO4	Evaluate funding options and institutional support for entrepreneurs in India and globally.
CO5	Apply managerial techniques to lead, scale, and sustain entrepreneurial ventures.

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ECS4807	Simulation and Modelling	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce the fundamental concepts of system modeling and simulation.
CO2	To understand the types of simulation and their applications.
CO3	To learn discrete-event simulation and Monte Carlo methods.
CO4	To model real-world systems using simulation tools.
CO5	To analyze simulation outputs and validate simulation models.

Unit-I

Introduction to Modeling and Simulation: Definition and types of models: physical, mathematical, static, dynamic, Importance and applications of simulation., Systems and system environment., Steps in a simulation study., Advantages and disadvantages of simulation.

Unit-II

System Modeling: Model classification: deterministic vs. stochastic, continuous vs. discrete, Concept of entities, attributes, and events, System modeling methodologies, Model building, verification, and validation, Case studies of real-world systems.

Unit-III

Discrete-Event Simulation: Discrete-event system simulation, Components of a simulation model., Event scheduling and time-advance mechanisms, Activity scanning, process interaction, Introduction to simulation languages (e.g., Arena, Simul8, GPSS).

Unit-IV

Random Numbers and Monte Carlo Simulation: Generation of random numbers and testing for randomness, Random variate generation: uniform, exponential, normal, Poisson, Monte Carlo simulation techniques, Applications of Monte Carlo methods, Input modeling: data collection and analysis.

Unit-V

Output Analysis and Model Validation: Types of simulation output data, Estimation of performance measures, Confidence intervals and hypothesis testing, Model calibration and validation techniques, Use of simulation software for performance analysis.

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Textbooks and References:

1. Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, *Discrete-Event System Simulation*, Pearson Education.
2. Averill M. Law, *Simulation Modeling and Analysis*, McGraw-Hill Education.
3. Robert E. Shannon, *Systems Simulation: The Art and Science*, Prentice-Hall.
4. W. David Kelton, Randall P. Sadowski, *Simulation with Arena*, McGraw-Hill.
5. Gordon G., *System Simulation*, Prentice-Hall India.
6. Geoffrey Gordon, *Introduction to Simulation*, McGraw-Hill.

Course Outcomes:

CO1	Explain the importance and applications of simulation and modeling in real-world scenarios.
CO2	Develop mathematical models and simulate them using appropriate techniques
CO3	Apply discrete-event simulation techniques to model and analyze complex systems.
CO4	Use Monte Carlo simulation to estimate outcomes under uncertainty.
CO5	Evaluate and validate simulation models and interpret simulation results effectively.

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ECS4808	Block Chain	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To understand the fundamentals of blockchain and distributed ledger technology.
CO2	To explore the structure and functionality of blockchain systems including consensus mechanisms.
CO3	To analyze smart contracts and their applications in various domains.
CO4	To study cryptocurrency technologies like Bitcoin and Ethereum.
CO5	To examine real-world applications and security issues in blockchain-based systems.

Unit-I

Introduction to Blockchain: Definition and features of blockchain, Types of blockchain: Public, Private, Consortium, History of blockchain and Bitcoin, Benefits and limitations, Use cases overview

Unit-II

Blockchain Architecture and Consensus Mechanisms: Block structure and chain structure, Nodes, transactions, and mining, Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated PoS, Byzantine Fault Tolerance, RAFT, PBFT, Scalability and performance issues

Unit-III

Cryptocurrency and Bitcoin: Introduction to cryptocurrency, Bitcoin architecture, Bitcoin wallets and addresses, Bitcoin mining and security, Forks: Hard and Soft Forks

Unit-IV

Ethereum and Smart Contracts: Ethereum architecture and EVM, Introduction to Solidity programming, Writing, compiling, and deploying smart contracts, Gas fees and transactions, Decentralized Applications (DApps)

Unit-V

Blockchain Applications and Challenges: Blockchain in finance, supply chain, healthcare, voting, Interoperability between block chains, Legal and ethical aspects, Blockchain attacks and security concerns, Future trends and research directions

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Textbooks and References:

1. Arvind Narayanan et al., *Bitcoin and Cryptocurrency Technologies*, Princeton University Press, 2016.
2. Andreas M. Antonopoulos, *Mastering Bitcoin*, O'Reilly Media, 2017.
3. Roger Wattenhofer, *The Science of the Blockchain*, 2016.
4. Imran Bashir, *Mastering Blockchain*, Packt Publishing, 2020 (3rd Edition).

Course Outcomes:

CO1	Understand the principles and architecture of blockchain technology.
CO2	Analyze the various consensus mechanisms used in blockchain.
CO3	Develop and deploy smart contracts using Ethereum and Solidity.
CO4	Evaluate the applications of blockchain in different sectors like finance, healthcare, and supply chain.
CO5	Assess the security, privacy, and legal implications of blockchain systems.

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ECS4809	Edge & Fog Computing	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To understand the limitations of traditional cloud computing and the need for edge and fog computing
CO2	To explore the architecture, components, and applications of edge and fog computing.
CO3	To compare and contrast cloud, edge, and fog computing paradigms.
CO4	To study resource management, security, and privacy challenges in edge and fog environments.
CO5	To analyze real-time use cases and future trends in edge and fog computing.

Unit-I

Introduction to Edge and Fog Computing: Evolution from cloud to edge and fog, Need for low latency computing, Comparison: Cloud vs Edge vs Fog, Edge and fog computing in IoT, smart cities, healthcare.

Unit-II

Architecture and Design Principles: Edge and fog computing architecture, Components: Edge nodes, gateways, fog nodes, Communication protocols and network topology, Resource management and orchestration

Unit-III

Application Scenarios and Use Cases: Smart homes and buildings, Industrial IoT and smart manufacturing, Autonomous vehicles and transportation, Content delivery networks and video surveillance

Unit-IV

Security, Privacy, and Challenges: Security threats and vulnerabilities, Authentication and access control in edge/fog, Privacy preservation techniques, Trust models and data integrity.

Unit-V

Tools, Platforms, and Future Directions: Tools and frameworks: Cisco IOx, EdgeX Foundry, Azure IoT Edge, AWS Greengrass, Fog computing with OpenFog Reference Architecture, Edge AI and machine learning at the edge, Research trends and open challenges.

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Textbooks and References:

1. **Rajkumar Buyya and Satish Narayana Srirama**, *Fog and Edge Computing: Principles and Paradigms*, Wiley, 2019.
2. **Meikang Qiu**, *Edge Computing: Models, Technologies and Applications*, Springer, 2020.
3. **Flavio Bonomi et al.**, *Fog Computing and Its Role in the Internet of Things*, MCC Workshop on Mobile Cloud Computing, 2012.
4. **Wei Zhang**, *Edge Computing: A Primer*, SpringerBriefs in Computer Science, 2021.

Course Outcomes:

CO1	Explain the fundamental concepts and evolution of edge and fog computing.
CO2	Describe the architecture and design principles of edge and fog computing systems.
CO3	Analyze real-world applications and case studies involving edge/fog computing.
CO4	Evaluate security, privacy, and resource management issues.
CO5	Apply edge and fog computing strategies to solve latency-sensitive IoT problems.

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ECS4803	Advanced Computer Networks	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To provide in-depth understanding of network protocols and layered architecture.
CO2	To study advanced concepts in routing, transport, and application layer protocols.
CO3	To explore emerging trends like SDN, MPLS, and data center networking.
CO4	To analyze network performance and quality of service (QoS) techniques.
CO5	To understand network security challenges and modern solutions.

Unit-I

Advanced Network Architecture and Protocols: Review of OSI and TCP/IP models, IPv6 and transition mechanisms, Socket programming and advanced IP addressing, Network simulation tools (e.g., NS2/NS3).

Unit-II

Routing and Traffic Engineering: Interior and Exterior Gateway Protocols: OSPF, BGP, Policy-based routing, Multiprotocol Label Switching (MPLS), Software Defined Networking, (SDN) architecture, Network virtualization.

Unit-III

Transport Layer Protocols and Congestion Control: TCP enhancements (TCP Reno, New Reno, Vegas), UDP and DCCP, Congestion control algorithms, Flow control, fairness, and reliability mechanisms, Real-time transport protocols (RTP/RTCP).

Unit-IV

Quality of Service (QoS) and Multimedia Networking: QoS models: IntServ, DiffServ, Traffic shaping and policing, Resource Reservation Protocol (RSVP), Multimedia transport and streaming protocols, Voice over IP (VoIP), SIP, H.323

Unit-V

Network Security and Emerging Technologies: Network attacks and mitigation: DoS, spoofing, sniffing, Firewalls, IDS/IPS, VPNs and tunneling protocols, IoT networking and challenges, Edge, fog, and 5G networking overview.

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Textbooks and References:

1. Larry L. Peterson and Bruce S. Davie, *Computer Networks: A Systems Approach*, 5th Edition, Morgan Kaufmann, 2012.
2. Behrouz A. Forouzan, *Data Communications and Networking*, 5th Edition, McGraw-Hill, 2013.
3. William Stallings, *High-Speed Networks and Internets: Performance and Quality of Service*, 2nd Edition, Pearson, 2002.
4. Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, 5th Edition, Pearson, 2011.

Course Outcomes:

CO1	Analyze and design complex network architectures and protocols.
CO2	Compare traditional and emerging routing techniques including MPLS and SDN.
CO3	Evaluate transport layer mechanisms and congestion control algorithms.
CO4	Apply techniques for traffic engineering and QoS in IP networks.
CO5	Identify and resolve security issues in computer networks.

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ECS4810	Data Warehouse and Data Mining	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce the concepts of data warehousing and data mining techniques.
CO2	To design and implement a data warehouse for analytical processing.
CO3	To apply data mining algorithms for knowledge discovery from large datasets.
CO4	To evaluate various classifications, clustering, and association rule mining techniques.
CO5	To explore advanced topics like web mining, text mining, and big data analytics.

Unit-I

Introduction to Data Warehousing: Data warehouse architecture, OLTP vs OLAP, Multidimensional data model, Star, Snowflake, and Fact Constellation schemas, ETL process and data cleaning.

Unit-II

Data Warehouse Implementation: Data cube and OLAP operations, Indexing OLAP data, Efficient computation of data cubes, Materialization strategies, Data warehouse design and usage.

Unit-III

Introduction to Data Mining: Data mining concepts and functionalities, Data preprocessing and data integration, Types of data mining: Descriptive vs Predictive, Knowledge discovery in databases (KDD), Issues and challenges in data mining.

Unit-IV

Association Rules and Classification: Association rule mining: Apriori algorithm, FP-Growth, Rule generation and evaluation metrics, Classification: Decision trees, Naïve Bayes, KNN, Evaluation methods: Confusion matrix, ROC curves.

Unit-V

Clustering and Advanced Topics: Clustering techniques: K-means, Hierarchical clustering, DBSCAN, Cluster evaluation methods, Introduction to Web mining, Text mining, and Big Data, Applications in business intelligence and fraud detection.

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Textbooks and References:

1. **Jiawei Han, Micheline Kamber, and Jian Pei**, *Data Mining: Concepts and Techniques*, 3rd Edition, Morgan Kaufmann, 2011.
2. **Ralph Kimball and Margy Ross**, *The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*, 3rd Edition, Wiley, 2013.
3. **Alex Berson and Stephen J. Smith**, *Data Warehousing, Data Mining, and OLAP*, McGraw-Hill, 1997.
4. **Pang-Ning Tan, Michael Steinbach, and Vipin Kumar**, *Introduction to Data Mining*, Pearson, 2019.

Course Outcomes:

CO1	Understand the architecture and components of data warehousing.
CO2	Design and implement data warehouse schemas using dimensional modeling.
CO3	Apply various data mining techniques like classification, clustering, and association.
CO4	Analyze patterns and relationships using data mining tools and algorithms.
CO5	Evaluate and interpret results for business intelligence and decision making.

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ECS4811	Computational Complexity	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce foundational models of computation and complexity classes.
CO2	To understand the concept of algorithmic efficiency and resource-bounded computation.
CO3	To explore complexity classes such as P, NP, NP-complete, and beyond.
CO4	To analyze space complexity, hierarchy theorems, and completeness.
CO5	To introduce advanced topics such as probabilistic computation and approximation algorithms.

Unit-I

Models of Computation and Time Complexity: Turing machines: deterministic and nondeterministic, Decision problems and languages, Time complexity and Big-O notation, Time-constructible functions, Complexity class P.

Unit- Class NP and Polynomial-Time Reductions: Definition of NP and nondeterministic computation, Polynomial-time verifiability and certificates, NP-completeness, Reductions and Cook-Levin theorem, NP-complete problems: SAT, CLIQUE, VERTEX COVER

Unit-III

Space Complexity and Hierarchy Theorems: Space complexity classes: L, NL, PSPACE, NPSPACE, Savitch's Theorem and $NL = co-NL$, Deterministic and nondeterministic space hierarchy theorems, PSPACE-completeness and QBF

Unit-IV

Advanced Complexity Classes: The Polynomial Hierarchy (PH), Randomized classes: RP, BPP, Interactive proofs: $IP = PSPACE$, Oracle machines and relativization, Time-space trade-offs

Unit-V

Approximation and Intractability: Approximation algorithms and performance ratios, APX and PTAS, PCP theorem (overview), Hardness of approximation, Complexity theory in cryptography and beyond.

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Textbooks and References:

1. Sanjeev Arora and Boaz Barak, *Computational Complexity: A Modern Approach*, Cambridge University Press, 2009.
2. Christos H. Papadimitriou, *Computational Complexity*, Addison-Wesley, 1994.
3. Michael Sipser, *Introduction to the Theory of Computation*, 3rd Edition, Cengage Learning, 2012.
4. Dexter Kozen, *Theory of Computation*, Springer, 2006.

Course Outcomes:

C01	Explain models of computation and classify problems based on complexity
C02	Identify and analyze problems in P, NP, and NP-complete classes.
C03	Apply polynomial-time reductions to prove NP-completeness.
C04	Understand space complexity classes and the role of hierarchy theorems.
C05	Explore probabilistic and parallel complexity, and limits of efficient computation.

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ECS4812	DevOps	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To understand the principles, practices, and tools of DevOps.
CO2	To explore continuous integration (CI), continuous delivery (CD), and automated deployment pipelines.
CO3	To learn configuration management, containerization, and orchestration tools.
CO4	To examine monitoring, logging, and incident response systems in DevOps.
CO5	To apply DevOps practices to improve software development lifecycle and business outcomes.

Unit-I

Introduction to DevOps: DevOps overview: History, goals, and benefits, DevOps vs traditional IT, Agile, Lean, and DevOps culture, Software Development Lifecycle (SDLC) and role of DevOps, DevOps pipeline overview.

Unit-II

Version Control and Continuous Integration: Source code management with Git and GitHub/GitLab, Branching strategies and merge workflows, CI tools: Jenkins, GitHub Actions, CI pipeline setup and integration testing, Build automation using Maven/Gradle.

Unit-III

Configuration Management and Deployment: Infrastructure as Code (IaC), Configuration tools: Ansible, Puppet, Chef, Environment provisioning, Continuous Deployment (CD), Artifact repositories: Nexus, JFrog Artifactory.

Unit-IV

Containerization and Orchestration: Introduction to Docker: images, containers, Dockerfile, Docker Compose and multi-container apps, Kubernetes: Pods, ReplicaSets, Deployments, Services, Helm charts and Kubernetes configuration management, Microservices and container orchestration.

Unit-V

Monitoring, Logging, and DevOps Security: Monitoring tools: Prometheus, Grafana, Nagios, Centralized logging: ELK Stack (Elasticsearch, Logstash, Kibana), Fluentd, Alerts and incident response, DevSecOps and secure CI/CD pipelines, Best practices and case studies in DevOps.

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Textbooks and References:

1. Len Bass, Ingo Weber, Liming Zhu, *DevOps: A Software Architect's Perspective*, Addison-Wesley, 2015.
2. Emily Freeman, *DevOps for Dummies*, Wiley, 2019.
3. Gene Kim, Jez Humble, Patrick Debois, John Willis, *The DevOps Handbook*, IT Revolution Press, 2016.
4. Jez Humble and David Farley, *Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation*, Addison-Wesley, 2010.

Course Outcomes:

CO1	Explain the DevOps culture, principles, and the need for automation.
CO2	Implement continuous integration and continuous deployment pipelines.
CO3	Use tools like Git, Jenkins, Docker, Ansible, and Kubernetes in a DevOps workflow.
CO4	Monitor, log, and analyze performance of systems and applications.
CO5	Design scalable and automated DevOps pipelines for real-world projects.

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ECS4813	Autonomous Systems & Robotics	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce the fundamentals of autonomous systems and intelligent robotics.
CO2	To understand kinematics, dynamics, and motion planning for mobile robots.
CO3	To explore sensing, perception, and localization techniques in robotics.
CO4	To study control architectures and decision-making strategies for autonomous behavior.
CO5	To gain insight into real-world applications and ethical implications of autonomous systems.

Unit-I

Introduction to Autonomous Systems and Robotics: Definition and characteristics of autonomous systems, History and evolution of robotics, Components of a robotic system: sensors, actuators, controllers, Types of robots: wheeled, legged, aerial, underwater, Applications in industry, healthcare, military, and service domains.

Unit-II

Robot Kinematics and Dynamics: Forward and inverse kinematics, Degrees of freedom (DoF), coordinate frames, and transformations, Robot dynamics and equations of motion, Mobile robot locomotion: differential drive, skid-steer, omni-wheels, Trajectory generation and path following

Unit-III

Sensing, Perception, and Localization: Robot sensors: LIDAR, sonar, GPS, cameras, IMU, Data fusion and sensor calibration, Environment mapping: occupancy grids, SLAM, Localization techniques: Kalman filter, Particle filter, Vision-based perception and object detection

Unit-IV

Planning and Decision Making: Motion planning: A*, D*, RRT, Behavior-based and deliberative architectures, Finite State Machines (FSM) and Hybrid control, Path planning vs trajectory planning, Real-time decision-making and reactive behaviors.

Unit-V

Autonomous System Design and Applications: Control architectures: centralized vs decentralized, ROS (Robot Operating System) framework, Multi-robot coordination and swarm robotics, Autonomous vehicles and drones, Ethics, safety, and human-robot interaction (HRI).

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Textbooks and References:

1. Siegwart, Roland; Nourbakhsh, Ilah R.; Scaramuzza, Davide, *Introduction to Autonomous Mobile Robots*, 2nd Edition, MIT Press, 2011.
2. Bruno Siciliano and Lorenzo Scialicco, *Robotics: Modelling, Planning and Control*, Springer, 2009.
3. John J. Craig, *Introduction to Robotics: Mechanics and Control*, 4th Edition, Pearson, 2017.
4. George A. Bekey, *Autonomous Robots: From Biological Inspiration to Implementation and Control*, MIT Press, 2005.

Course Outcomes:

CO1	Describe the structure and functioning of autonomous robotic systems.
CO2	Apply principles of kinematics, motion planning, and navigation to mobile robots.
CO3	Utilize various sensors and perception techniques for robot localization and mapping.
CO4	Design control architectures and decision-making algorithms for autonomy.
CO5	Evaluate real-world applications, trends, and ethical considerations in autonomous robotics.

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Open Electives:



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ECS3604	Total Quality Management	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To provide a comprehensive understanding of quality concepts and the importance of TQM in organizations.
CO2	To introduce quality management tools and techniques for continuous improvement.
CO3	To understand the role of leadership and employee involvement in quality improvement.
CO4	To explore various quality standards, certifications, and benchmarking practices.
CO5	To study statistical tools and Six Sigma methodologies for quality control and assurance.

Unit-I

Introduction to Total Quality Management: Definitions and dimensions of quality, Evolution of TQM and its principles, Contributions of quality gurus: Deming, Juran, Crosby, Feigenbaum, Customer focus and satisfaction, Cost of quality.

Unit-II

TQM Tools and Techniques: Seven basic tools: Flowcharts, Check sheets, Histograms, Pareto charts, Cause-and-effect diagrams, Control charts, Scatter diagrams, New management tools: Affinity diagram, Tree diagram, Matrix diagram, PDPC, Continuous improvement (Kaizen), 5S and Poka-Yoke (mistake-proofing).

Unit-III

Quality Management Systems: ISO 9000 series standards, Quality auditing and documentation, Environmental management systems (ISO 14000), Quality certification processes, Benchmarking and Quality Function Deployment (QFD)

Unit-IV

Statistical Quality Control (SQC): Fundamentals of statistics and probability, Control charts for variables and attributes, Process capability analysis (Cp, Cpk), Acceptance sampling and operating characteristic curves, Design of experiments (DOE)

Unit-V

Six Sigma and Leadership in TQM: Introduction to Six Sigma methodology: DMAIC, Roles and responsibilities in Six Sigma (Green Belt, Black Belt, etc.), Leadership and strategic planning for TQM, Employee involvement and teamwork, Organizational culture and change management in TQM.

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Textbooks and References:

1. Dale H. Besterfield, *Total Quality Management*, 3rd Edition, Pearson Education, 2011.
2. Subburaj Ramasamy, *Total Quality Management*, McGraw Hill Education, 2013.
3. Joel E. Ross, *Total Quality Management: Text, Cases and Readings*, 3rd Edition, CRC Press, 1999.
4. James R. Evans and William M. Lindsay, *Managing for Quality and Performance Excellence*, 9th Edition, Cengage Learning, 2016.

Course Outcomes:

CO1	Define and explain core concepts and principles of Total Quality Management.
CO2	Apply quality improvement tools and techniques in real-world scenarios.
CO3	Analyze and interpret quality data using statistical quality control tools.
CO4	Evaluate the role of leadership, teamwork, and culture in TQM.
CO5	Implement quality standards such as ISO and Six Sigma in organizational processes.

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ECS3608	Human Computer Interaction	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To understand the fundamental concepts of Human-Computer Interaction.
CO2	To explore the design and evaluation of user interfaces.
CO3	To study human factors in the context of interaction with digital systems.
CO4	To apply usability principles and HCI design processes in real-world applications.
CO5	To learn modern tools and methods for user-centered design and interaction evaluation.

Unit-I

Introduction to HCI: Definition, importance, and goals of HCI, Human factors in HCI: memory, attention, perception, and cognition, Interaction models and paradigms, HCI in the context of system design, HCI and usability engineering

Unit-II

Design Process and User Requirements: Human-centered design process, User modeling and personas, Task analysis and scenario development, Requirements gathering techniques: interviews, observations, surveys, User interface design guidelines and standards

Unit-III

Interaction Styles and Interface Design: Command-line, menu-based, form-based, graphical, and web interfaces, Direct manipulation and virtual environments, Mobile and ubiquitous computing interfaces, Principles of good design: visibility, feedback, consistency, Navigation, layout, and accessibility

Unit-IV

Usability Evaluation and Prototyping: Usability evaluation methods: heuristic evaluation, cognitive walkthroughs, User testing and usability metrics, Low-fidelity and high-fidelity prototyping, Tools for prototyping: Figma, Adobe XD, Balsamiq, Case studies in usability testing

Unit-V

Advanced Topics in HCI: Affective computing and emotional design, Adaptive and intelligent user interfaces, Multimodal and natural user interfaces (NUIs), Brain-Computer Interfaces (BCIs), Ethics, privacy, and inclusivity in interface design

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Textbooks and References:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, *Human-Computer Interaction*, 3rd Edition, Pearson Education, 2004.
2. Ben Shneiderman, Catherine Plaisant, *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, 6th Edition, Pearson, 2016.
3. Donald A. Norman, *The Design of Everyday Things*, Revised Edition, Basic Books, 2013.
4. Jenny Preece, Yvonne Rogers, Helen Sharp, *Interaction Design: Beyond Human-Computer Interaction*, 5th Edition, Wiley, 2019.

Course Outcomes:

CO1	Understand the principles of human-computer interaction and usability.
CO2	Analyze user needs and design interactive systems that meet those needs.
CO3	Apply cognitive and psychological principles to interface design.
CO4	Evaluate the usability and performance of user interfaces.
CO5	Use modern tools and techniques for prototyping and user interface development.

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MBA3650	Entrepreneurship Development	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce students to the fundamental concepts of entrepreneurship.
CO2	Including the roles and functions of entrepreneurs, as well as the challenges they face the real-world business environment.
CO3	To equip students with the knowledge and skills needed to transform an idea into a viable business opportunity.
CO4	Providing a deep understanding of various funding sources available for startups.
CO5	To learn modern tools and methods for emerging technologies.

Unit-I

Fundamentals of Entrepreneurship: Meaning, definition, and concept of entrepreneurship, Evolution and importance of entrepreneurship in economic development, Characteristics, traits, and competencies of successful entrepreneurs, Difference between entrepreneur and manager, Types of entrepreneurs: innovative, imitative, drone, Fabian, social, and rural, Entrepreneurial mindset and behavior, Functions and roles of entrepreneurs in different sectors, Entrepreneurial decision-making process, Challenges and opportunities for entrepreneurs in emerging technologies.

Unit-II

Entrepreneurial Finance and Government Support: Financial planning for startups, Estimating fund requirements and working capital, Sources of finance: banks, NBFCs, venture capital, angel investors, crowdfunding, Overview of financial institutions: SIDBI, NABARD, NSIC, etc., Role of Central and State Governments in entrepreneurship development, Incentives, subsidies, and grants offered by the government, Export-oriented units: fiscal and tax concessions, Startup India, Make in India, and Digital India initiatives, Overview of MSME policy and its impact on entrepreneurship.

Unit-III

Innovation, Creativity, and Business Design: Meaning and significance of creativity and innovation in entrepreneurship, Types of innovation: product, process, business model, service, design-led, Startups vs. large firm innovation: differences and challenges, Open innovation and co-creation models, Developing an innovation strategy for startups, Role of emerging technologies (AI, ML, IoT) in entrepreneurial innovation, Creating an innovative business culture and environment, Design thinking and improvisation in startups, Intellectual Property Rights (IPR) basics for innovators.

Unit-IV

Idea Generation and Business Planning: Idea generation techniques and classification, Identification of market gaps and opportunity assessment, Individual creativity and ideation tools, Introduction to business model canvas, Process of starting a new venture and startup lifecycle,

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Business planning: elements and structure, Preparation of project report and pitch deck, Feasibility analysis: technical, market, economic, financial

Unit-V

Venture Launch, Legalities and Growth Strategies: Steps to launch a business: planning to execution, Legal structures: proprietorship, partnership, LLP, private/public limited, Registration process and licenses required for startups, Business scaling, growth strategies, and risk management, Marketing strategies for new ventures, Role of technology in scaling businesses, IPOs and exit strategies, Revival and closure of ventures: when and how, Ethical and social responsibilities of entrepreneurs.

Textbooks and References:

1. Khanka, S.S.; Entrepreneurial Development; S. Chand and Co.
2. Mitra, Jay: The Business of Innovation, 2017, SAGE Publishing
3. Entrepreneurship – Rajeev Roy, Oxford University Press
5. Entrepreneurship Development and Small Business Enterprises – Poornima M. Charantimath, Pearson Education
6. Innovation and Entrepreneurship – Peter F. Drucker, Harper Business
7. The Lean Startup – Eric Ries, Crown Publishing
8. Business Model Generation – Alexander Osterwalder & Yves Pigneur, Wiley

Course Outcomes:

CO1	Understand the meaning, definition, and concept of entrepreneurship and its evolution in economic development.
CO2	Understand the meaning, definition, and concept of entrepreneurship and its evolution in economic development
CO3	Differentiate between an entrepreneur and a manager and identify various types of entrepreneurs
CO4	Evaluate the entrepreneurial mindset, behavior, and the decision-making process i process in the entrepreneurial journey.
CO5	Recognize the challenges and opportunities for entrepreneurs, particularly in emerging technologies.

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HAS3626	Non-Conventional Energy Resource	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce the importance and scope of renewable and non-conventional energy resources.
CO2	To provide knowledge of solar, wind, biomass, and other alternative energy technologies.
CO3	To study the design and application of energy systems using renewable sources.
CO4	To create awareness about environmental and economic aspects of non-conventional energy.
CO5	To promote sustainable and energy-efficient practices in engineering and daily life.

Unit-I

Introduction to Energy Resources: Overview of global and Indian energy scenario, Classification of energy sources: conventional vs non-conventional, Need for renewable energy and sustainability, Energy consumption patterns and future trends, Energy economics and environmental impacts

Unit-II

Solar Energy: Solar radiation and measurement, Solar thermal systems: flat plate collectors, concentrating collectors, Solar photovoltaic (PV) systems: working principle, types of PV cells, Applications: solar water heater, solar cooker, solar dryer, solar street lighting, Grid-connected and off-grid solar systems

Unit-III

Wind Energy: Wind characteristics and site selection, Basic components and types of wind turbines, Wind energy conversion systems (WECS), Performance analysis of wind systems, Environmental impact and challenges of wind energy

Unit-IV

Biomass and Bioenergy: Biomass resources: types and availability, Biogas production: anaerobic digestion, plant design, Biofuels: biodiesel, ethanol, Biomass gasification and combustion, Waste-to-energy technologies

Unit-V

Other Renewable Energy Sources: Small hydroelectric power: types and layout, Geothermal energy: sources, types, and utilization, Ocean energy: tidal, wave, and ocean thermal energy conversion (OTEC), Hydrogen energy and fuel cells, Hybrid renewable energy systems

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Textbooks and References:

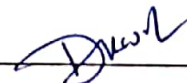
1. G.D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers, 5th Edition, 2011.
2. D.S. Chauhan, *Non-Conventional Energy Resources*, New Age International Publishers, 2010.
3. S.P. Sukhatme and J.K. Nayak, *Solar Energy: Principles of Thermal Collection and Storage*, 3rd Edition, Tata McGraw Hill, 2008.
4. S. Rao and Dr. B.B. Parulekar, *Energy Technology: Non-Conventional, Renewable and Conventional*, Khanna Publishers, 2017.

Course Outcomes:

CO1	Understand the need for and types of non-conventional energy resources..
CO2	Explain the working principles of solar, wind, biomass, and other renewable systems.
CO3	Analyze the performance of various non-conventional energy systems.
CO4	Evaluate the economic and environmental benefits of renewable energy.
CO5	Apply knowledge of renewable energy systems in real-life energy planning and management.


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HAS3628	Operational Research	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce students to the basic concepts and techniques of operations research.
CO2	To develop skills in formulating mathematical models for decision-making problems.
CO3	To provide an understanding of optimization techniques like linear programming and transportation models.
CO4	To enable students to apply analytical methods to solve real-world business and engineering problems
CO5	To foster critical thinking in choosing appropriate tools for decision support.

Unit-I

Introduction and Linear Programming: Introduction to Operational Research (OR) and its applications, Characteristics and phases of OR, Formulation of Linear Programming Problems (LPP), Graphical method and Simplex method, Duality and sensitivity analysis.

Unit-II

Transportation and Assignment Models: Transportation problem: formulation, initial basic feasible solution (North-West Corner Rule, Least Cost, Vogel's Approximation), Optimality test (MODI method), Assignment problem: Hungarian method for optimal assignment, Variants of assignment problem (unbalanced, maximization, restricted)

Unit-III

Decision Theory and Game Theory: Decision-making under uncertainty and risk, Decision trees, Game theory: two-person zero-sum games, Pure and mixed strategies, Saddle point and dominance rules

Unit-IV

Queuing Theory and Inventory Control: Characteristics of a queuing system, Queuing models: M/M/1 and M/M/C (infinite population), Inventory models: deterministic models (EOQ, quantity discount), probabilistic models, Safety stock and reorder point calculation

Unit-V

Network Analysis and Simulation: Project Management: PERT and CPM, Network construction, time estimates, critical path, slack, Crashing of networks and cost optimization, Basics of simulation: Monte Carlo simulation, Applications in inventory and queuing systems.

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HAS4725	Soft Skills and Interpersonal Communications	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To help students understand the significance of soft skills in personal and professional success.
CO2	To enhance communication skills, both verbal and non-verbal, for effective interpersonal interactions.
CO3	To develop teamwork, leadership, and problem-solving skills.
CO4	To improve emotional intelligence and time management for workplace readiness.
CO5	To instill confidence and prepare students for interviews and group discussions.

Unit-I

Introduction to Soft Skills: Definition and importance of soft skills, Categories of soft skills: personal, social, communication-based, and thinking skills, Attributes of a successful professional, Self-awareness and personal development, SWOT analysis and goal setting

Unit-II

Communication Skills: Verbal and non-verbal communication, Barriers to effective communication, Listening skills and feedback mechanisms, Business communication: emails, memos, reports, Oral communication: public speaking, storytelling, voice modulation

Unit-III

Interpersonal and Teamwork Skills: Interpersonal relationships and rapport building, Team dynamics and collaboration, Leadership styles and qualities, Conflict management and negotiation skills, Empathy and emotional intelligence

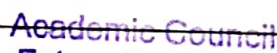
Unit-IV

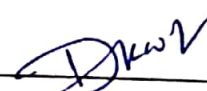
Professional and Workplace Skills: Time management and stress management, Adaptability and resilience, Decision-making and problem-solving techniques, Ethics and professionalism in the workplace, Managing criticism and workplace etiquette

Unit-V

Job Readiness and Presentation Skills: Resume and cover letter writing, Group discussions: structure, preparation, and practice, Interview skills: types of interviews, mock interviews, Presentation skills: planning, organizing, and delivering presentations, Body language and grooming for success


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Textbooks and References:

1. Hamdy A. Taha, *Operations Research: An Introduction*, 10th Edition, Pearson, 2017.
2. P.K. Gupta & D.S. Hira, *Operations Research*, S. Chand & Co., 2014.
3. Kanti Swarup, P.K. Gupta, Man Mohan, *Operations Research*, Sultan Chand & Sons, 2017.
4. J.K. Sharma, *Operations Research: Theory and Applications*, Macmillan India, 5th Edition, 2013.

Course Outcomes:

CO1	Formulate and solve linear programming problems using graphical and simplex methods.
CO2	Apply transportation and assignment models for logistics and resource allocation.
CO3	Use decision theory and game theory for strategic decision-making under uncertainty.
CO4	Solve queuing and inventory problems using standard models.
CO5	Utilize simulation and project management techniques in operational research contexts.


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Textbooks and References:

1. Barun K. Mitra, *Personality Development and Soft Skills*, Oxford University Press, 2016.
2. Meenakshi Raman & Sangeeta Sharma, *Technical Communication: Principles and Practice*, Oxford University Press, 2015.
3. K. Alex, *Soft Skills: Know Yourself and Know the World*, S. Chand Publishing, 2014.
4. Goleman, Daniel, *Emotional Intelligence*, Bantam Books, 2006.

Course Outcomes:

CO1	Demonstrate effective verbal, non-verbal, and written communication in various contexts.
CO2	Exhibit strong interpersonal and teamwork skills in group settings.
CO3	Apply leadership, emotional intelligence, and time management techniques in practical scenarios.
CO4	Identify and use appropriate strategies for conflict resolution and decision-making.
CO5	Prepare and perform successfully in interviews, presentations, and professional discussions.

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MBA4751	Human Resource Development and Organizational Behaviour	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To provide students with a foundational understanding of Human Resource Management, including its scope, functions, and the strategic role of HR professionals in modern organizations.
CO2	To equip students with knowledge of human resource planning, recruitment, selection, training, and development processes essential for effective talent management.
CO3	To develop an understanding of employee performance appraisal, compensation systems, and welfare measures, and their role in organizational effectiveness
CO4	To familiarize students with key concepts of Organizational Behaviour, including individual behavior, perception, personality, learning, group dynamics, and teamwork.
CO5	To enable students to understand the principles of motivation, leadership, stress management, and conflict resolution, and their application in enhancing organizational productivity and employee well-being.

Unit-I

Introduction to Human Resource Management and Planning Concept, Scope, and Importance of HRM, Functions of HRM, Role of HR Manager in Modern Organizations, HRM vs. Personnel Management; HRM vs. HRD, Human Resource Planning: Process and Importance, Job Analysis, Job Description, and Job Specification, Recruitment: Sources and Methods, Selection Process and Techniques.

Unit-II

Training, Development, and Performance Management: Concept and Importance of Training and Development, Methods of Employee Training and Development, Performance Appraisal: Purpose, Process, and Methods, Career Planning and Succession Planning, Components of Compensation, Wage and Salary Administration, Incentives and Fringe Benefits, Employee Welfare and Social Security Measures

Unit-III

Employee Relations, Ethics, and Human Resource Accounting : Industrial Relations, Employee Discipline and Grievance Handling, Ethical Issues in HRM, Human Resource Accounting (HRA): Meaning, Objectives and Scope of HRA

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Unit-IV

Foundations of Organizational Behaviour and Individual Dynamics Organizational Behaviour (OB): Meaning, Features, Nature, and Scope, Challenges and Opportunities for OB, Organizational Goals and Models of OB, Impact of Global and Cultural Diversity on OB, Individual Behaviour: Meaning, Definition, Factors Affecting Individual Behaviour: Personality, Determinants of Personality, Personality Traits and Theories, Perception: Perceptual Process and Factors Affecting Perception, Learning: Concepts and Implications

Unit-V

Group Behaviour, Motivation, Leadership, and Stress Management: Group Dynamics: Meaning, Features, and Types of Group Behaviour, Formal and Informal Group Behaviour, Group Norms and Group Cohesiveness, Teamwork: Types, Teams vs. Groups, , Motivation: Concept, Financial and Non-Financial Motivators, Theories of Motivation: Maslow, Herzberg, McGregor (Theory X and Y), Leadership: Types, Leadership Theories, Leadership Styles, Modern Approaches, Stress Management: Meaning, Types and Causes of Stress, Consequences of Work, Stress and Conflict: Types and Levels, Organisational Development: Meaning, Need, Benefits, and Limitations

Textbooks and References:

1. Aswathappa, K.; *Human Resource Management: Text and Cases*. 9th Edition, McGraw Hill Education, New Delhi, 2020.
 2. Gupta, C. B.; *Human Resource Management*. 1st Edition, Sultan Chand and Sons, New Delhi, 2019.
 3. Aswathappa K., *Human Resource and Personnel Management*, TMH, 5th Edition.
 4. Rao V.S.P., *Human Resource Management: Text and Cases*, Excel Books, 2nd Edition.
 5. Ivansevich, *Human Resource Management*, Tata McGraw Hill, 10th Edition.
- *The latest editions of all the suggested books are recommended.**

Course Outcomes:

CO1	Understand the core concepts, scope, and functions of Human Resource Management, including planning, recruitment, and selection processes.
CO2	Analyze the significance of training, development, performance appraisal, and compensation in enhancing employee effectiveness
CO3	Evaluate employee relations, ethical issues, and the role of Human Resource Accounting in organizational decision-making..
CO4	Demonstrate an understanding of individual behavior, personality, perception, and learning within an organizational context..
CO5	Examine group dynamics, motivation, leadership, and stress management techniques for improving organizational performance.


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ECS4703	Product Development	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To understand the processes and methodologies involved in new product development.
CO2	To equip students with the ability to generate and evaluate product ideas.
CO3	To introduce tools for designing, prototyping, and analyzing product performance.
CO4	To impart knowledge of product lifecycle, innovation, and market strategies.
CO5	To develop skills in cross-functional teamwork and customer-centric design.

Unit-I

Introduction to Product Development: Definition and importance of product development, Types of products: consumer, industrial, software, Product development process and stages, Roles of design, engineering, marketing, and manufacturing, Innovation and technology trends

Unit-II

Product Planning and Concept Development: Identifying customer needs, Market research and opportunity identification, Product specifications and requirement gathering, Idea generation techniques: brainstorming, TRIZ, mind mapping, Concept development and selection

Unit-III

Product Design and Architecture: Product architecture and modularity, Design for manufacturing and assembly (DFMA), Industrial design and aesthetics, Ergonomics and usability considerations, Design review and risk analysis

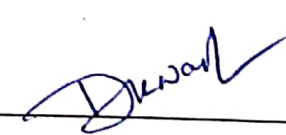
Unit-IV

Prototyping and Testing: Prototyping techniques: virtual, physical, rapid prototyping, Design validation and testing, Failure mode and effects analysis (FMEA), Iterative design and improvement, Case studies of successful product iterations.

Unit-V

Product Launch and Lifecycle Management: Product costing and pricing strategies, Marketing strategies for product launch, Supply chain and production planning, Product lifecycle management (PLM), Post-launch review and continuous improvement.


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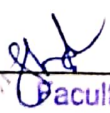


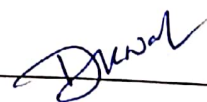
Textbooks and References:

1. Karl T. Ulrich & Steven D. Eppinger, *Product Design and Development*, 6th Edition, McGraw-Hill Education, 2015.
2. Anil Mital, Anoop Desai, Anand Subramanian, *Product Development: A Structured Approach to Consumer Product Development, Design, and Manufacture*, Academic Press, 2014.
3. Tim Jones, *New Product Development: An Introduction to a Multifunctional Process*, Butterworth-Heinemann, 1997.
4. Don Norman, *The Design of Everyday Things*, Basic Books, 2013.
5. Jennifer E. Goodman, *Product Innovation Toolbox*, Wiley, 2012.

Course Outcomes:

CO1	Understand the fundamentals and phases of the product development process.
CO2	Apply techniques for idea generation, concept selection, and product architecture.
CO3	Use tools and strategies for prototyping, testing, and improving product design.
CO4	Analyze the economic and market viability of a product.
CO5	Work in cross-functional teams to plan and manage a product development project.


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Textbooks and References:

1. Donald Gross, John F. Shortle, James M. Thompson, Carl M. Harris, *Fundamentals of Queueing Theory*, 4th Edition, Wiley, 2008.
2. Trivedi, Kishor S., *Probability and Statistics with Reliability, Queueing and Computer Science Applications*, 2nd Edition, Wiley India, 2008.
3. Leonard Kleinrock, *Queueing Systems, Volume 1: Theory*, Wiley-Interscience, 1975.
4. J. Medhi, *Stochastic Models in Queueing Theory*, Academic Press, 2nd Edition, 2002.
5. Robert B. Cooper, *Introduction to Queueing Theory*, North Holland, 1981.

Course Outcomes:

CO1	Understand the structure, notation, and types of queueing systems.
CO2	Analyze and solve basic Markovian (M/M/1, M/M/c) queueing models.
CO3	Evaluate non-Markovian and advanced queueing models (M/G/1, G/M/1).
CO4	Apply queueing models to computer networks, service operations, and manufacturing.
CO5	Use simulation techniques to model and analyze complex queueing scenarios.


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ECS4707	E-Governance and Digital Transformation	L-T-P 3-0-0	Credits: 3
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Course Objectives:

CO1	To introduce the concepts and frameworks of e-Governance and digital transformation.
CO2	To understand the role of ICT in public administration and governance
CO3	To explore various models, policies, and strategies used in implementing e-Governance..
CO4	To analyze digital transformation initiatives in different sectors and countries.
CO5	To evaluate the impact, challenges, and future trends in e-Governance systems.

Unit-I

Introduction to E-Governance: Evolution and scope of e-Governance, Difference between e-Governance and e-Government, Objectives and benefits of e-Governance, Key enablers: ICT, Internet, Mobile, Cloud, and AI, Stakeholders in e-Governance

Unit-II

E-Governance Models and Infrastructure: Government-to-Government (G2G), Government-to-Citizen (G2C), Government-to-Business (G2B), and Government-to-Employee (G2E) models, National e-Governance Plan (NeGP), Digital India, Common Service Centers (CSCs), SWAN, SDC, e-Seva, Role of UIDAI, Aadhar, and DigiLocker, Open Government Data (OGD)

Unit-III

Policies, Legal Framework & Cybersecurity: E-Governance policies and guidelines, IT Act 2000 and amendments, Data privacy and protection in digital governance, Cybersecurity concerns in e-Governance, Ethics and accountability in digital governance

Unit-IV

Digital Transformation in Governance: Digital transformation: definition, scope, and significance, E-Governance maturity models and evaluation, Emerging technologies: AI, Blockchain, IoT in governance, Citizen-centric services and digital inclusion, Smart governance and urban transformation (Smart Cities Mission)

Unit-V

Case Studies and Future Trends: Case studies from India (e.g., e-Choupal, Bhoomi Project, Passport Seva, e-District), Global case studies: Estonia, Singapore, UK, Digital literacy and capacity building, Challenges: digital divide, resistance to change, infrastructure, Future trends in digital governance: GovTech, cloud-first policy, predictive analytics

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Textbooks and References:

1. Pankaj Sharma, *E-Governance: The New Age Governance*, APH Publishing, 2004.
2. Satyanarayana J., *E-Government: The Science of the Possible*, PHI Learning, 2006.
3. Heeks, Richard, *Implementing and Managing E-Government: An International Text*, SAGE Publications, 2006.
4. Shailendra C. Jain Palvia et al., *E-Government and E-Governance: Definitions, Domain Framework and Status around the World*, ICEG 2007.
5. Government of India Reports: *Digital India Initiative*, *NeGP*, *MeitY Guidelines*, etc.

Course Outcomes:

CO1	Understand the evolution, concepts, and frameworks of e-Governance.
CO2	Analyze various models, infrastructure, and applications of e-Governance in public administration.
CO3	Evaluate policies, legal frameworks, and citizen-centric services.
CO4	Explore digital transformation strategies and their role in governance reforms.
CO5	Examine case studies and identify challenges and future trends in digital governance.



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