GOVERNMENT COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to Anna University, Chennai)

BARGUR - 635104

Curriculum for

COMPUTER SCIENCE AND ENGINEERING

MASTER OF ENGINEERING

[Full Time]

I TO IV SEMESTERS

2025

Regulation

For the students admitted

AY 2025-26 onwards

As on 20.01.2026

OFFICE OF CONTROLLER OF EXAMINATIONS

GOVERNMENT COLLEGE OF ENGINEERING BARGUR – 635 104

Website: www.gcebargur.ac.in

Vision of the Department

"To be a center of excellence in Computer Science education and research, producing globally competent, innovative, and socially responsible professionals who contribute to industry, academia, and society."

Mission of the Department

M1: To provide high-quality education in Computer Science aligned with global academic and industry standards. (Quality)

M2: To prepare students for professional careers, entrepreneurship, and higher studies through outcome-based education. (Success)

M3: To promote excellence in teaching and research through modern pedagogical methods and emerging technologies. (Innovation)

M4: To nurture professional ethics, leadership, teamwork, and a sense of social responsibility. (Values)

M5: To provide technical services and outreach activities that address societal and industrial needs.(Community)

Program Educational Objectives (PEOs):

PEO 1: Core Competency

Apply the principles of Computer Science and Engineering to design and develop computing systems and solutions using modern tools and technologies to solve real-world problems.

PEO 2: Professional Excellence

Demonstrate technical competence and leadership in their chosen career path, including industry, academia, entrepreneurship, and research, while adapting to rapid technological changes.

PEO 3: Higher Education and Continuous Up-gradation

Pursue advanced studies and research in computing and interdisciplinary domains and engage in continuous up gradation to stay abreast with evolving technologies.

PEO 4: Ethics and Social Responsibility

Exhibit ethical behavior, teamwork, communication skills, and a commitment to the betterment of society through responsible application of computing technologies.

PROGRAM SPECIFIC OUTCOMES (PSOs):	
PSO1:	**System Design and Development** Designing, developing, and evaluating complex software systems using modern tools and technologies, addressing specific needs across various domains.
PSO2:	**Data Analysis and Decision Making** Apply data analytics and machine learning techniques to extract insights and support decision-making processes in real-world applications.
PSO3:	**Research Competence** Demonstrate the ability to conduct independent research, contributing to scholarly publications and advancements in computer science and engineering.
PSO4:	**Ethical and Social Responsibility** Understand and apply ethical principles and consider societal impacts in the development and deployment of computing solutions.

PROGRAM OUTCOMES (POs)	
PO1:	**Advanced Knowledge** Demonstrate comprehensive knowledge of computer science and engineering, including contemporary research trends, theories, principles, and methodologies.
PO2:	**Problem Analysis and Solution Design** Identify, analyze, and formulate complex engineering problems and design innovative computing solutions using modern tools and techniques.
PO3:	**Research and Development** Apply research methods, including the design of experiments, data analysis, and interpretation, to solve open-ended problems and contribute to the advancement of the field.
PO4:	**Modern Tool Usage** Use advanced tools, software, and programming environments for modeling, simulation, analysis, and development of computing systems.
PO5:	**Multidisciplinary Integration** Integrate knowledge from multiple domains to address challenges in interdisciplinary areas like healthcare, finance, education, agriculture, and smart systems.
PO6:	**Ethics and Professionalism** Apply ethical principles and uphold the professional responsibilities and norms of engineering practice in research, development, and deployment of computing solutions.
PO7:	**Communication** Communicate effectively with the computing community and society at large through well-structured reports, publications, design documentation, and oral presentations.
PO8:	**Project Management and Leadership** Demonstrate leadership, project management, and decision-making skills in collaborative and multidisciplinary environments.
PO9:	**Innovation and Entrepreneurship** Recognize opportunities for innovation and entrepreneurship in the field of computer science, translating technical knowledge into impactful solutions and products.
PO10:	**Societal and Environmental Awareness** Assess the societal, health, safety, legal, and environmental implications of computing technologies and solutions.
PO11:	**Continuous Upgradation** Recognize the need for lifelong learning and engage in continuous education to remain current with technological advancements.

GOVERNMENT COLLEGE OF ENGINEERING, BARGUR (AUTONOMOUS)

M.E - COMPUTER SCIENCE AND ENGINEERING

REGULATION – 2025 CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABI FOR I TO IV SEMESTERS

For the candidates admitted from the Academic Year 2025-2026

SEMESTER – I

S. NO	COURSE CODE	COURSE TITLE	CAT	Contact Period	L	T	P	C
THEORY								
1.	25CSFC01	Mathematics for Computer Science Applications	FC	4	3	1	0	4
2.	25ZMC001	Research Methodology and IPR	MC	3	3	0	0	3
3.	25CSPC02	Advances in Data Structures and Algorithm Analysis	PC	4	4	0	0	4
4.	25CSPC03	Networking Technologies	PC	3	3	0	0	3
5.	25CSPC04	High Performance Computing Architecture	PC	3	3	0	0	3
6.	-	Professional Elective – I	PE	5	3	0	2	4
PRACTICAL								
7.	25CSPC05	Advances in Data Structures and Algorithm Analysis Laboratory	PC	4	0	0	4	2
			TOTAL	**26**	**19**	**1**	**6**	**23**

SEMESTER – II

S.NO	COURSE CODE	COURSE TITLE	CAT	Contact Period	L	T	P	C
THEORY								
1.	25CSPC06	Advances in Operating Systems	PC	4	4	0	0	4
2.	25CSPC07	Compiler Optimization Techniques	PC	3	3	0	0	3
3.	25CSPC08	Database Technologies	PC	3	3	0	0	3
4.	-	Professional Elective - II	PE	5	3	0	2	4
5.	-	Professional Elective - III	PE	5	3	0	2	4

6.	-	Audit Course – I	AC	2	2	0	0	0
PRACTICAL								
7.	25CSPC09	Advanced Operating Systems Laboratory	PC	4	0	0	4	2
8.	25CSEE10	Mini Project with Seminar	EEC	4	0	0	4	2
			TOTAL	**30**	**21**	**0**	**12**	**22**

SEMESTER – III

S.NO	COURSE CODE	COURSE TITLE	CAT	Contact Period	L	T	P	C
THEORY								
1.	-	Professional Elective - IV	PE	5	3	0	2	4
2.	-	Professional Elective –V	PE	5	3	0	2	4
3.	-	Open Elective – I	OE	3	3	0	0	3
4.	-	Audit Course-II	AC	2	2	0	0	0
PRACTICAL								
5.	25CSEE11	Project: Phase–I	EEC	12	0	0	12	6
			TOTAL	**27**	**11**	**0**	**14**	**17**

SEMESTER – IV

S.NO	COURSE CODE	COURSE TITLE	CAT	Contact Period	L	T	P	C
1.	25CSEE12	Project: Phase–II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS: 74

Note:

FC - Foundation Core Course, PC - Professional Core Course,

PE - Professional Elective Course, MC-Mandatory Course,

EEC - Employability Enhancement Course, AC- Audit course, OE - Open Elective Course

	PROFESSIONAL ELECTIVES						
S.NO	**COURSE CODE**	**COURSE TITLE**	**Contact Period**	**L**	**T**	**P**	**C**
Professional Electives – I							
1.	25CSPE01	Artificial Intelligence and Machine Learning	5	3	0	2	4
2.	25CSPE02	Big Data Analytics	5	3	0	2	4
3.	25CSPE03	Wireless Access Technologies	5	3	0	2	4
4.	25CSPE04	Cryptography and Network Security	5	3	0	2	4
Professional Electives – II							
5.	25CSPE05	Natural Language Processing	5	3	0	2	4
6.	25CSPE06	Data Visualization Techniques	5	3	0	2	4
7.	25CSPE07	Software Defined Networks	5	3	0	2	4
8.	25CSPE08	Ethical Hacking and Cyber Forensics	5	3	0	2	4
Professional Elective – III							
9.	25CSPE09	Image Processing and Computer Vision	5	3	0	2	4
10.	25CSPE10	Human Computer Interaction	5	3	0	2	4
11.	25CSPE11	Internet of Things	5	3	0	2	4
12.	25CSPE12	Malware Analysis	5	3	0	2	4
Professional Electives– IV							
13.	25CSPE13	Deep Learning and Generative AI	5	3	0	2	4
14.	25CSPE14	Virtual Reality and Augmented Reality	5	3	0	2	4
15.	25CSPE15	Edge and Fog Computing Networks	5	3	0	2	4
16.	25CSPE16	Biometrics	5	3	0	2	4
Professional Electives– V							
17.	25CSPE17	Multi-Modal Artificial Intelligence	5	3	0	2	4
18.	25CSPE18	Data Ethics, Privacy, and Governance	5	3	0	2	4
19.	25CSPE19	Quantum Computing	5	3	0	2	4
20.	25CSPE20	Blockchain Technology and Applications	5	3	0	2	4

	AUDIT COURSES						
S.NO	**COURSE CODE**	**COURSE TITLE**	**Contact Period**	**L**	**T**	**P**	**C**
	Audit Courses						
1.	25ZAC001	Disaster Management	2	2	0	0	0
2.	25ZAC002	English for Research Paper Writing	2	2	0	0	0
3.	25SAC003	Stress Management	2	2	0	0	0
4.	25SAC004	Pedagogy Studies	2	2	0	0	0
5.	25SAC005	Principles of Management	2	2	0	0	0
6.	25SAC006	Professional Ethics in Engineering	2	2	0	0	0
7.	25SAC007	Engineering Economics and Financial Accounting	2	2	0	0	0
8.	25SAC008	Industrial Automation and Robotics	2	2	0	0	0
	OPEN ELECTIVES						
S.NO	**COURSE CODE**	**COURSE TITLE**	**Contact Period**	**L**	**T**	**P**	**C**
1.	25CSOE01	Python Programming	3	3	0	0	3
2.	25CSOE02	Software Engineering	3	3	0	0	3
3.	25CSOE03	Android Application Development	3	3	0	0	3
4.	25CSOE04	Essentials of Cloud Computing	3	3	0	0	3
5.	25CSOE05	Computer Vision	3	3	0	0	3
6.	25CSOE06	High Performance Computing	3	3	0	0	3

M.E - COMPUTER SCIENCE AND ENGINEERING

(AUTONOMOUS - REGULATIONS – 2025)

For the candidates admitted from the Academic Year 2025-2026

COMPARISON OF CREDITS

SEMESTER	AICTE CREDITS	AUTONOMY CREDITS
SEMESTER - I	18	23
SEMESTER – II	18	22
SEMESTER – III	16	17
SEMESTER – IV	16	12
TOTAL	**68**	**74**

S.NO	CATEGORY	AICTE CREDITS	AUTONOMY CREDITS
1.	Foundation core	0	4
2.	Program Core (PC)	16	24
3.	Program Elective (PE)	19	20
4.	Open Electives (OE)	3	3
5.	Mandatory Courses(MC)	2	3
6.	Audit Course (AC)	0	0
7.	Employability Enhancement Course (EEC)	28	20
	TOTAL CREDITS	**68**	**74**

CREDIT SUMMARY

S.No	Subject Area	Credits Per Semester				Credits Total	% of Total Credits	AICTE Suggested Breakup of Credits
		1	2	3	4			
1	FC	4				**4**	**5**	**-**
2	PC	12	12			**24**	**33**	**22**
3	PE	4	8	8		**20**	**27**	**15**
4	OE			3		**3**	**4**	**3**
5	EEC		2	6	12	**20**	**27**	**26**
6	AC		0	0		**0**	**-**	**-**
7	MC	3				**3**	**4**	**2**
	Total	**23**	**22**	**17**	**12**	**74**	**100**	**68**

Total Credits: 74

SEMESTER I

Subject Code	25CSFC01	**Subject Title**	MATHEMATICS FOR COMPUTER SCIENCE APPLICATIONS
Category	Foundation Core	**L-T-P-C**	3-1-0-4
Regulation	2025	**Semester**	I
Prerequisites	Basic knowledge of calculus, linear algebra, probability concepts, and matrix operations.		

Course Objectives:

1. Understand Toeplitz matrices and explore their use in computational algorithms and signal processing
2. Develop the ability to determine basis, rank, and the independence of vectors.
3. Explore backpropagation and automatic differentiation as used in machine learning
4. Develop understanding of various probability distributions and their applications.
5. Learn the principles of PCA and apply it for data reduction and feature extraction.

Course Content:

[MATRIX THEORY] (9+3 Hours)

Some important matrix factorizations - The Cholesky decomposition - QR factorization - Least squares method - Singular value decomposition - Toeplitz matrices and some applications.

[LINEAR ALGEBRA] (9+3 Hours)

Vector spaces - Linear independence and linear dependence - Basis and Rank - Linear mappings.

[VECTOR CALCULUS] (9+3 Hours)

Gradients of Vector valued functions - Gradients of Matrices - Useful Identities for Computing Gradients - Back Propagation and Automatic Differentiation - Higher order Derivatives - Linearization and Multivariate Taylor series.

[PROBABILITY AND RANDOM VARIABLES] (9+3 Hours)

Probability - Axioms of probability - Conditional probability - Random variables - probability function - Moments - Moment generating functions - Binomial, Poisson, Uniform, Exponential and Normal distributions - Two Dimensional random Variables - Joint distributions - Marginal and conditional distributions - Regression curve - Correlation.

[MULTIVARIATE ANALYSIS] (9+3 Hours)

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components - Population principal components - Principal components from standardized variables

Total Hours: 60

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Apply matrix factorization techniques to solve systems of linear equations and understand their applications in data analysis.	L3	PO1, PO2, PO3, PO4, PO5, PO11
CO2	Understand and apply the concepts of vector spaces,	L2,3	PO1, PO2, PO3, PO4,

	linear transformations, and basis in linear algebra.		PO7, PO11
CO3	Compute and analyze gradients and higher-order derivatives of scalar and vector-valued functions, useful in optimization and machine learning.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO10, PO11
CO4	Analyze random variables and probability distributions to model real-world uncertain systems.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO10, PO11
CO5	Perform multivariate statistical analysis, including principal component analysis, for dimensionality reduction and data interpretation.	L4,3	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO10, PO11

Reference Books:

1. Devore J.L., “Probality and statistics for engineering and the sciences”, 9th Edition, Cengage learning, 2016.
2. Dallas E.Johnson, “Applied multivariate methos for data analysis”,Thomson and Duxbury press,1998.
3. Gupta S.C,and Kapoor V.K., “Fundamentals of mathematical statistics”,11 Edition,Sultan and Sons,Newdelhi, 2014.
4. Johnson,R.A.,Miller, I and Freund J.,”Miller and Freund’s probability and statistics for engineers”,8th Edition,Pearson Education Asia, 2015.
5. Richard A.Johnson and Dean W.Wichern, “Applied multivariate statistician analysis”,6th Edition, Pearson Education Asia, 2007.
6. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning.

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	1	2	1	–	–	–	–	–	1	2	3	2	–
CO2	3	1	1	1	-	–	1	–	–	–	1	2	2	2	–
CO3	2	2	3	2	2	1	1	–	1	1	2	2	3	2	–
CO4	2	1	3	1	1	1	1	–	1	2	3	1	3	2	–
CO5	2	2	3	2	3	1	2	1	2	3	3	2	3	2	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

Subject Code	25ZMC001	**Subject Title**	RESEARCH METHODOLOGY AND IPR
Category	Mandatory Course	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	I
Prerequisites	Basic understanding of scientific inquiry and technical writing skills.		

Course Objectives:

1. To identify the problems and solutions for research in various areas
2. To prepare literature survey and write thesis report
3. To prepare research proposal in various agencies like DST, AICTE etc.,
4. To understand the Intellectual property rights and patenting
5. To understand the patent rights and its developments

Course Content:

[RESEARCH PROBLEM AND SOLUTION] (9 Hours)

Meaning of research problem - Sources of research problem - Motivation - Research process, Methods and Methodology - Criteria Characteristics of a good research problem - Errors in selecting a research problem - Scope and objectives of research problem - Approaches of investigation of solutions for research problem - Data collection - analysis - interpretation - Necessary Instrumentations.

[LITERATURE SURVEY AND WRITING] (9 Hours)

Selecting and studying literature - Extracting information from the selected literature - Effective literature studies approaches - Analysis - Terminology - Plagiarism and Self-Plagiarism - Research ethics - Effective Technical Writing(Outline, Summary, Draft and Final).

[RESEARCH PROPOSAL] (9 Hours)

How to write report and Paper Developing a Research Proposal - Format of research proposal - Starting the Proposal Process, Research Proposal Writing, Revisions and Proofreading, Skills Required for a Research Proposal, Common Mistakes to Avoid in Proposal Writing - Examples of Research Proposals - Presentation and assessment by a review committee.

[NATURE OF INTELLECTUAL PROPERTY] (9 Hours)

Patents - Designs - Trade and Copyright - Process of Patenting and Development: technological research - innovation - patenting - development - International Scenario: International cooperation on Intellectual Property - Procedure for grants of patents - Patenting under PCT.

[PATENT RIGHTS AND NEW DEVELOPMENTS] (9 Hours)

Scope of Patent Rights - Licensing and transfer of technology - Patent information and databases - Geographical Indications - Administration of Patent System - IPR of Biological Systems - Computer Software etc - Traditional knowledge - Case Studies: IPR and IITs.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain core concepts of research processes, literature survey, proposal preparation, and Intellectual Property Rights (IPR) including patents.	L2	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO10, PO11

CO2	Apply methods for identifying research problems, conducting literature reviews without plagiarism, drafting proposals, and navigating patent procedures.	L3	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO10, PO11
CO3	Analyze research ethics, gaps in literature, proposal structures, and IPR components such as patent scopes and licensing.	L4	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO10, PO11
CO4	Evaluate research proposals, technical writings, patent grants under PCT, and IPR protections for innovations.	L5	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO10, PO11
CO5	Develop original research proposals or IPR documentation integrating methodology with patent strategies.	L6	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”, Juta and Company, 2004
2. Ranjit Kumar, 5th Edition, “Research Methodology: A Step by Step Guide for beginners”, SAGE Publications Ltd., 2018
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
5. Mayall , “Industrial Design”, McGraw Hill, 1992.
6. Niebel , “Product Design”, McGraw Hill, 1974.
7. Asimov, “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	2	2	3	1	–	2	2	1	–	1	2	–	–	3	2
CO2	2	2	3	1	–	2	2	1	–	1	2	–	1	3	2
CO3	2	2	3	1	–	3	2	1	–	2	2	–	1	3	3
CO4	2	2	3	1	–	3	2	1	–	2	2	–	1	3	3
CO5	2	2	3	1	–	3	3	2	1	2	2	1	1	3	3
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By **BOS Approval**

Name & Designation Date:

Subject Code	25CSPC02	**Subject Title**	ADVANCES IN DATA STRUCTURES AND ALGORITHM ANALYSIS
Category	Professional Core	**L-T-P-C**	4-0-0-4
Regulation	2025	**Semester**	I
Prerequisites	Knowledge of fundamental data structures, algorithms, and programming skills.		

Course Objectives:

1. To understand the usage of algorithms in computing.
2. To learn and use hierarchical data structures and its operations.
3. To learn the usage of graphs and its applications.
4. To select and design data structures and algorithms that is appropriate for problems.
5. To study about NP Completeness of problems.

Course Content:

[ROLE OF ALGORITHMS IN COMPUTING] (12 Hours)

Algorithms – Algorithms as a Technology - Insertion Sort – Analyzing Algorithms – Designing Algorithms- Growth of Functions: Asymptotic Notation – Standard Notations and Common FunctionsRecurrences: The Substitution Method – The Recursion-Tree Method.

[HIERARCHICAL DATA STRUCTURES] (12 Hours)

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red-Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of Btrees – Basic operations on B-Trees – Deleting a key from a B-Tree- Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

[GRAPHS] (12 Hours)

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single Source Shortest paths in Directed Acyclic Graphs – Dijkstra‘s Algorithm; All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm;

[ALGORITHM DESIGN TECHNIQUES] (12 Hours)

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy- Huffman Codes.

[NP COMPLETE AND NP HARD] (12 Hours)

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

Total Hours: 60 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain asymptotic notations, hierarchical structures like red-black trees and B-trees, graph algorithms, design techniques, and NP-completeness concepts.	L2	PO1, PO2, PO3, PO4, PO11
CO2	Apply sorting, searching, shortest paths, dynamic	L3	PO1, PO2, PO3,

	programming, greedy methods, and reductions to solve computational problems.		PO4, PO11
CO3	Analyze time complexities, recurrences, heap operations, minimum spanning trees, and NP-complete proofs for efficiency.	L4	PO1, PO2, PO3, PO4, PO11
CO4	Evaluate algorithm designs, data structure choices like Fibonacci heaps, and strategies for problems like longest common subsequence.	L5	PO1, PO2, PO3, PO4, PO9, PO11
CO5	Develop custom algorithms using divide-and-conquer, backtracking, or branch-and-bound for advanced data structure implementations.	L6	PO1, PO2, PO3, PO4, PO8, PO9, PO11

Reference Books:

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, — “Data Structures and Algorithms”, Pearson Education, Reprint 2006.
2. Robert Sedgewick and Kevin Wayne, — “ALGORITHMS”, Fourth Edition, Pearson Education.
3. S.Sridhar, “Design and Analysis of Algorithms”, First Edition, Oxford University Press. 2014.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, — “Introduction to Algorithms”, Third Edition, Prentice-Hall, 2011.
5. Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, “Fundamentals of Computer Algorithms”, Galgotia Publications Pvt. Ltd., 2008.
6. Michael R. Garey, D. S. Johnson, “Computers and Intractability: A Guide to the Theory of NP-Completeness”.

Course Articulation matrix:

PROGRAM OUTCOMES												**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	2	2	–	–	–	–	–	–	1	3	2	2	–
CO2	3	3	2	2	–	–	–	–	–	–	1	3	2	2	–
CO3	3	3	2	2	–	–	–	–	–	–	1	3	2	3	–
CO4	3	3	2	2	–	–	–	–	1	–	1	3	2	3	–
CO5	3	3	2	2	–	–	–	1	2	–	1	3	2	3	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

Subject Code	25CSPC03	Subject Title	NETWORKING TECHNOLOGIES
Category	Professional Core	L-T-P-C	3-0-0-3
Regulation	2025	Semester	I
Prerequisites	Basic computer organization, data communication concepts, and programming fundamentals.		

Course Objectives:

1. To provide a comprehensive understanding of network architectures, protocols, and standards across all OSI layers.
2. To enable the design, analysis, and evaluation of scalable and secure network systems.
3. To expose students to modern networking technologies such as SDN, cloud networking, IoT networks, and network virtualization.

Course Content:

[ADVANCED NETWORK ARCHITECTURE AND PROTOCOLS] (9 Hours)

Review of OSI and TCP/IP models - Protocol layering and encapsulation - Internetworking concepts: IP, ARP, ICMP - IPv4 vs IPv6 transition - Routing principles: distance-vector, link-state - Congestion control mechanisms - End-to-end communication and multiplexing

[ROUTING AND SWITCHING TECHNOLOGIES] (9 Hours)

Interior and exterior routing protocols: RIP, OSPF, BGP - Switch architectures and VLANs - Spanning Tree Protocol - MPLS and label switching - Route redistribution and filtering - SDN fundamentals and OpenFlow.

[NETWORK SECURITY AND MANAGEMENT] (9 Hours)

Network security fundamentals - Cryptographic techniques in networks - Secure protocols: IPsec, SSL/TLS, HTTPS - Firewalls and IDS/IPS - Network monitoring and SNMP - Authentication protocols and access control - Network policy enforcement.

[WIRELESS AND MOBILE NETWORKS] (9 Hours)

Wireless LANs, Bluetooth, ZigBee - Cellular networks: GSM, LTE, 5G overview - Mobile IP and handoff strategies - Ad-hoc and sensor networks - MANET and VANET basics - QoS in wireless environments - Energy-efficient protocols in mobile networks.

[EMERGING NETWORKING TECHNOLOGIES] (9 Hours)

Software Defined Networking (SDN) - Network Function Virtualization (NFV) - Cloud networking and data center architectures - Internet of Things (IoT) networks - Edge and fog computing - Network slicing in 5G - Intent-based networking and automation.

Total Hours: 45 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain OSI/TCP-IP models, routing protocols, security mechanisms, wireless standards, and emerging technologies like SDN and 5G.	L2	PO1, PO2, PO3, PO4, PO5, PO6, PO10, PO11
CO2	Apply IP addressing, switching configurations,	L3	PO1, PO2, PO3,

	cryptographic protocols, mobile IP handoffs, and SDN controllers to network design problems.		PO4, PO5, PO6, PO10, PO11
CO3	Analyze congestion control, routing table convergence, firewall rules, QoS metrics, and network slicing performance in diverse scenarios.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO10, PO11
CO4	Evaluate protocol selections for scalability, security posture of IDS/IPS deployments, wireless energy efficiency, and NFV suitability for cloud networks.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO10, PO11
CO5	Develop network topologies integrating VLANs, IPsec tunnels, MANET routing, and IoT edge computing solutions across layers.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO8, PO9, PO10, PO11

Reference Books:

1. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 8th Edition, Pearson, 2021.

2. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, 5th Edition, Morgan Kaufmann, 2011.

3. William Stallings, Data and Computer Communications, 10th Edition, Pearson, 2013.

4. Olivier Bonaventure, Computer Networking: Principles, Protocols and Practice, Open Source Text, 2021.

5. Feamster, Rexford, Zegura, The Road to SDN: An Intellectual History of Programmable Networks, ACM SIGCOMM, 2013

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	2	2	1	1	–	–	–	1	1	3	1	2	1
CO2	3	3	2	2	1	1	–	–	–	1	1	3	2	2	1
CO3	3	3	2	2	1	1	–	–	–	1	1	3	2	3	1
CO4	3	3	2	2	1	2	–	–	–	1	1	3	2	3	2
CO5	3	3	2	2	1	1	–	1	1	1	1	3	2	3	1
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

Subject Code	25CSPC04	**Subject Title**	HIGH PERFORMANCE COMPUTING ARCHITECTURE
Category	Professional Core	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	I
Prerequisites	Fundamentals of computer architecture, operating systems, and parallel programming concepts.		

Course Objectives:

1. Understand the architectural principles of modern high-performance computing systems.
2. Analyze and design parallel algorithms for various computing architectures including multicore and GPU systems.
3. Explore contemporary trends and technologies in scalable and heterogeneous computing environments.

Course Content:

[INTRODUCTION TO HIGH PERFORMANCE COMPUTING] (9 Hours)

Fundamentals of HPC: Definitions and Needs - Performance Metrics: Speedup, Efficiency, Amdahl's Law, Gustafson's Law - Flynn's Taxonomy - Overview of Parallel Architectures: SMP, MPP, Clusters, GPUs, and Accelerators - Interconnection Networks: Topologies and Characteristics

[MEMORY AND COMMUNICATION ARCHITECTURES] (9 Hours)

Memory Hierarchy Design: Caches, Shared and Distributed Memory - NUMA, Cache Coherence, and Consistency Models - Communication Models: Message Passing, Shared Memory - MPI Basics and Use Cases - Network Performance and Scalability.

[PARALLEL PROGRAMMING MODELS AND TOOLS] (9 Hours)

Parallel Programming Models: Threading, OpenMP, MPI - GPU Programming: CUDA Architecture and Programming - Hybrid Programming (MPI+OpenMP) - Compiler Optimizations and Profiling Tools - Scheduling and Load Balancing Techniques.

[MULTICORE, MANYCORE, AND GPU ARCHITECTURES] (9 Hours)

Multicore Architectures: Trends, Challenges - Manycore Processors and Massively Parallel Systems - GPU Architecture (NVIDIA/AMD) - Case Studies: NVIDIA Volta, AMD ROCm - Heterogeneous Computing Systems.

[EMERGING TRENDS IN HPC] (9 Hours)

Exascale Computing and Energy Efficiency - High Performance Cloud and Edge Computing - Quantum and Neuromorphic Computing Overview - Applications of HPC in AI, Weather Forecasting, Genomics, CFD - Benchmarking and Real-World HPC Systems (Top500).

Total Hours: 45 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain HPC metrics, Flynn's taxonomy, memory hierarchies, parallel models, GPU architectures, and exascale trends.	L2	PO1, PO2, PO3, PO4, PO5, PO11

CO2	Apply Amdahl's/Gustafson's laws, MPI/OpenMP/CUDA programming, cache coherence, and load balancing to parallel systems.	L3	PO1, PO2, PO3, PO4, PO5, PO11
CO3	Analyze interconnection topologies, NUMA effects, hybrid programming performance, and manycore scalability challenges.	L4	PO1, PO2, PO3, PO4, PO5, PO11
CO4	Evaluate speedup/efficiency trade-offs, compiler optimizations, heterogeneous computing suitability, and Top500 benchmarks.	L5	PO1, PO2, PO3, PO4, PO5, PO9, PO11
CO5	Develop parallel algorithms integrating MPI+OpenMP+CUDA for multicore/GPU clusters solving computational problems.	L6	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO11

Reference Books:

1. Kai Hwang, "Advanced Computer Architecture and Parallel Processing", McGraw-Hill, 2022.
2. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, "Introduction to Parallel Computing", 2nd Edition, Pearson, 2020.
3. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands-on Approach", 3rd Edition, Morgan Kaufmann, 2021.
4. Shirley V. Scott, John R. Rice, "High Performance Computing: Modern Systems and Practices", Morgan Kaufmann, 2023.
5. Thomas Sterling, "High Performance Computing: Modern Systems and Practices", MIT Press, 2020.

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	2	2	1	–	–	–	–	–	1	3	1	2	–
CO2	3	3	2	3	1	–	–	–	–	–	1	3	2	2	–
CO3	3	3	2	3	1	–	–	–	–	–	1	3	2	3	–
CO4	3	3	2	3	1	–	–	–	1	–	1	3	2	3	–
CO5	3	3	2	3	1	–	–	1	1	–	1	3	2	3	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

Subject Code	25CSPC05	**Subject Title**	ADVANCES IN DATA STRUCTURES AND ALGORITHM ANALYSIS LABORATORY
Category	Professional Core	**L-T-P-C**	0-0-4-2
Regulation	2025	**Semester**	I
Prerequisites	Basic programming knowledge and foundational understanding of data structures and algorithm concepts.		

Course Objectives:

1. Design of algorithms using Divide and Conquer, Dynamic programming approach.
2. Design of algorithms using Greedy and Back Tracking Techniques.
3. Implementation of Graph algorithms and Matrix operations.

Course Content:

LIST OF EXPERIMENTS

1. Implement operations of red black tree, splay tree, b tree, b+ tree and hashing techniques.
2. Implement operations of AVL trees, 2-3 trees, tries.
3. Implement an algorithm that combines k sorted lists in time O (n log k) where n is the total number of elements.
4. Implement an algorithm to solve Matrix Multiplication problem and maximum value contiguous subsequence using dynamic programming approach.
5. Implement an algorithm based on greedy approach to solve knapsack problem and Activity Selection Problem.
6. Implement Merge Sort algorithm using Divide and Conquer approach.
7. Implement stack operations and calculate the amortized cost.
8. Implement Graph Traversal algorithms.
9. Implement algorithms to construct Minimum Spanning Trees.
10. Implement shortest path and Maximum Flow algorithms.
11. Implement String Matching Algorithms.
12. Implement Computational Geometry algorithms.

Total Hours: 60 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain implementations of advanced trees, hashing, dynamic programming, greedy algorithms, graph traversals, and string matching techniques.	L2	PO1, PO2, PO3, PO4, PO11
CO2	Implement red-black trees, AVL trees, merge sort, matrix multiplication, knapsack problems, MST, shortest paths, and geometry algorithms.	L3	PO1, PO2, PO3, PO4, PO11

CO3	Analyze time complexities, amortized costs, and performance of divide-and-conquer, backtracking, and graph algorithms in laboratory settings.	L4	PO1, PO2, PO3, PO4, PO11
CO4	Evaluate efficiency of B-trees vs splay trees, greedy vs dynamic programming solutions, and flow algorithms for optimization problems.	L5	PO1, PO2, PO3, PO4, PO11
CO5	Develop hybrid algorithms combining multiple techniques like k-way merges, maximum subsequences, and computational geometry primitives.	L6	PO1, PO2, PO3, PO4, PO8, PO9, PO11

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	1	2	–	–	–	–	–	–	1	3	2	2	–
CO2	3	3	1	3	–	–	–	–	–	–	1	3	2	2	–
CO3	3	3	2	2	–	–	–	–	–	–	1	3	2	3	–
CO4	3	3	2	2	–	–	–	–	–	–	1	3	2	3	–
CO5	3	3	2	3	–	–	–	1	1	–	1	3	2	3	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

SEMESTER II

Subject Code	25CSPC06	**Subject Title**	ADVANCES IN OPERATING SYSTEMS
Category	Professional Core	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	II
Prerequisites	Fundamental knowledge of operating systems and computer architecture.		

Course Objectives:

1. To explore the design and implementation aspects of modern and distributed operating systems.
2. To analyze advanced concepts such as multiprocessing, memory management, and resource scheduling.
3. To investigate contemporary OS trends including virtualization, security, and real-time OS.

Course Content:

[OPERATING SYSTEM FUNDAMENTALS REVIEW] (9 Hours)

OS architecture: monolithic, layered, microkernel, hybrid - Process model, thread management - CPU scheduling algorithms - Synchronization mechanisms: semaphores, monitors - Deadlock: detection, prevention, avoidance

[MEMORY AND STORAGE MANAGEMENT] (9 Hours)

Paging, segmentation, virtual memory - Page replacement algorithms - Cache memory and TLB - File systems: journaling, distributed file systems - Disk scheduling and I/O systems

[MULTIPROCESSING AND DISTRIBUTED OS] (9 Hours)

Multiprocessor systems and OS support - Process coordination in multiprocessor systems - Distributed OS architectures and transparency - Communication and synchronization in distributed systems - Load balancing and fault tolerance

[VIRTUALIZATION AND SECURITY] (9 Hours)

Virtual machines and hypervisors - Hardware-assisted virtualization (Intel VT-x, AMD-V) - Containers (Docker, Kubernetes) vs. Hypervisors - OS-level security, access control models - Secure kernel and system call interface

[REAL-TIME AND MOBILE OS] (9 Hours)

Characteristics of real-time operating systems (RTOS) - Scheduling in RTOS: EDF, RMS - Embedded OS design issues - Mobile OS (Android, iOS) architecture and security - Energy-aware OS and green computing trends.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain OS architectures, memory management, multiprocessing, virtualization technologies, and real-time scheduling principles.	L2	PO1
CO2	Apply CPU scheduling, page replacement, synchronization primitives, container orchestration, and RTOS task management techniques.	L3	PO1, PO2, PO3

CO3	Analyze deadlock scenarios, distributed system transparency, hypervisor performance overheads, and mobile OS security models.	L4	PO1, PO2, PO4
CO4	Evaluate microkernel vs monolithic designs, journaling file systems, load balancing strategies, and energy-aware OS policies.	L5	PO1, PO2, PO3, PO4
CO5	Develop system configurations integrating multiprocessor coordination, virtual machine deployments, and fault-tolerant distributed services.	L6	PO1, PO2, PO3, PO4, PO5

Reference Books:

1. Andrew S. Tanenbaum, Herbert Bos, "Modern Operating Systems", 5th Edition, Pearson, 2023.
2. William Stallings, "Operating Systems: Internals and Design Principles", 9th Edition, Pearson, 2022
3. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson, 2021
4. Daniel P. Bovet, Marco Cesati, "Understanding the Linux Kernel", O'Reilly, 2020
5. Silberschatz, Galvin, Gagne, "Operating System Concepts", 10th Edition, Wiley, 2021

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	3	3	2	–	–	–	–	–	–	–	–	3	2	3	–
CO3	3	3	–	2	–	–	–	–	–	–	–	3	2	3	–
CO4	3	3	3	2	–	–	–	–	–	–	–	3	2	3	–
CO5	3	3	3	3	2	–	–	–	–	–	–	3	2	3	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPC07	**Subject Title**	COMPILER OPTIMIZATION TECHNIQUES
Category	Professional Core	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	II
Prerequisites	Understanding of compiler design, programming languages, and computer architecture.		

Course Objectives:

1. Intermediate Representations and Control and Data flow analysis
2. Early and loop Optimization and Procedure optimization and scheduling
3. Interprocedural analysis and memory hierarchy optimization.

Course Content:

[INTERMEDIATE REPRESENTATIONS] (9 Hours)
Introduction to compiler technologies - Review of compiler Structure - Intermediate Representations - Run Time Support: Data representations and Instructions - Register Usage - The local stack frame - Run time Stack - Parameter Passing - Procedure Prologues, Epilogues, Calls and Returns - Code sharing and position independent code -- Producing Code Generators Automatically.

[FLOW ANALYSIS] (9 Hours)
Control Flow Analysis – Data-Flow Analysis: Iterative data flow analysis, Lattices of flow functions, Control-Tree-based Data-Flow Analysis, Structural analysis, Interval analysis - Dependence Analysis and Dependence Graphs - Alias Analysis.

[EARLY OPTIMIZATIONS AND LOOP OPTIMIZATIONS] (9 Hours)
Introduction to optimization: Importance of Individual optimizations, Order and repetition of optimizations - Early Optimization: Constant folding, Scalar replacement of aggregates, Algebraic simplifications and Reassociation, Value Numbering, Copy and Constant Propagation - Redundancy Elimination - Loop Optimizations.

[PROCEDURE OPTIMIZATIONS AND SCHEDULING] (9 Hours)
Procedure Optimizations - Register Allocation - Code Scheduling – Control-Flow and Low- Level Optimizations: Unreachable-code elimination, Straightening, If and Loop simplification, Loop inversion, Unswitching, Branch Optimizations, Tail merging, Conditional moves, Dead-code elimination, Branch prediction.

[INTERPROCEDURAL ANALYSIS AND MEMORY HIERARCHY OPTIMIZATION] (9 Hours)
Inter Procedural Analysis and Optimizations: Interprocedural Control-Flow Analysis, Interprocedural Data-Flow Analysis, Interprocedural Alias Analysis, Interprocedural Constant Propagation, Interprocedural Optmization, Interprocedural Register allocation – Optimization for the Memory Hierarchy: Impact of data and Instruction Caches, Instruction-Cache Optimizations.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain intermediate representations, data-flow analysis, optimization techniques, register allocation, and interprocedural analyses.	L2	PO1
CO2	Apply control-flow analysis, constant folding, loop	L3	PO1, PO2, PO4

	optimizations, code scheduling, and cache-aware transformations to compiler passes.		
CO3	Analyze lattices, dependence graphs, aliasing effects, redundancy elimination, and instruction cache performance impacts.	L4	PO1, PO2, PO3
CO4	Evaluate optimization order effectiveness, register allocation strategies, branch prediction schemes, and memory hierarchy trade-offs.	L5	PO1, PO2, PO3, PO5
CO5	Develop custom optimization passes integrating interprocedural analysis with procedure scheduling and loop transformations.	L6	PO1, PO2, PO3, PO4, PO5, PO9

Reference Books:

1. Steven Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kaufman Publishers, 1997.
2. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques, and Tools", Addison Wesley, Second Edition, 2014.
3. Andrew W. Appel, Jens Palsberg, "Modern Compiler Implementation in Java", Cambridge University Press, Second Edition, 2002.
4. Keith Cooper, Linda Torczon, "Engineering a Compiler", Morgan Kaufmann, Second Edition, 2012.
5. Randy Allen and Ken Kennedy, “Optimizing Compilers for Modern Architectures: A Dependence based Approach”, Morgan Kaufman, 2001.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	P010	PO11	PSO 1	PSO 2	PSO 3	PS O4
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	3	3	2	2	–	–	–	–	–	–	–	3	2	3	–
CO3	3	3	3	2	–	–	–	–	–	–	–	3	2	3	–
CO4	3	3	3	–	2	–	–	–	–	–	–	3	2	3	–
CO5	3	3	3	3	2	–	–	–	2	–	–	3	2	3	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPC08	**Subject Title**	DATABASE TECHNOLOGIES
Category	Professional Core	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	II
Prerequisites	Basic understanding of database concepts, SQL, and data modeling.		

Course Objectives:

1. To provide a strong foundation in advanced relational database concepts and query optimization.
2. To expose learners to distributed, NoSQL, and cloud-based database technologies.
3. To enable students to design and develop scalable database applications with security and performance considerations.

Course Content:

[ADVANCED RELATIONAL DATABASES] (9 Hours)

Review of relational model and SQL - Query optimization: heuristics, cost-based optimization - Indexing techniques and join algorithms - Triggers, stored procedures, views - Transaction management and concurrency control

[DISTRIBUTED DATABASES] (9 Hours)

Architecture of distributed databases - Data fragmentation, replication, and allocation - Distributed query processing and optimization - Distributed transaction management - CAP theorem and consistency models

[NoSQL AND NEW DATA MODELS] (9 Hours)

Introduction to NoSQL: need and characteristics - Key-Value, Column-family, Document, and Graph databases - MongoDB, Cassandra, Neo4j – features and use cases - Query languages: CQL, Cypher - Comparison with RDBMS

[BIG DATA AND CLOUD DATABASES] (9 Hours)

Hadoop and HDFS architecture - MapReduce programming model - Hive and Pig – querying large datasets - Cloud databases: Google BigQuery, Amazon RDS, Azure SQL - Data warehouse vs. Data lake

[DATABASE SECURITY AND TRENDS] (9 Hours)

Database security requirements - Access control and encryption techniques - SQL injection and countermeasures - Privacy-preserving data publishing - Trends: multimodel databases, NewSQL, DBaaS, time-series databases.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain relational query optimization, distributed architectures, NoSQL models, big data systems, and database security principles.	L2	PO1
CO2	Apply indexing strategies, distributed transaction protocols, NoSQL query languages, MapReduce processing, and access control mechanisms.	L3	PO1,PO2, PO4

CO3	Analyze CAP theorem trade-offs, data fragmentation schemes, multimodel database performance, and SQL injection vulnerabilities.	L4	PO1,PO2, PO3
CO4	Evaluate NewSQL vs NoSQL suitability, cloud database scalability, data lake architectures, and encryption technique effectiveness.	L5	PO1, PO2, PO3, PO5
CO5	Develop hybrid database solutions integrating sharding, graph queries, Hive analytics, and privacy-preserving data pipelines.	L6	PO1, PO2, PO3, PO4, PO5, PO9

Reference Books:

1. Raghu Ramakrishnan, Johannes Gehrke, “Database Management Systems”, 4th Edition, McGraw Hill, 2023.
2. C. J. Date, “An Introduction to Database Systems”, 8th Edition, Pearson, 2022
3. Shashank Tiwari, “Professional NoSQL”, Wiley, 2021
4. Sherif Sakr, Mohamed Gaber, “Large Scale and Big Data: Processing and Management”, CRC Press, 2020
5. Paul Zikopoulos et al., “Understanding Big Data”, McGraw Hill, 2021

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO1	**PO 2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P010**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	-
CO2	3	3	2	2	–	–	–	–	–	–	–	3	2	3	-
CO3	3	3	3	–	–	–	–	–	–	–	–	3	2	3	-
CO4	3	3	3	–	2	–	–	–	–	–	–	3	2	3	-
CO5	3	3	3	3	2	–	–	–	2	–	–	3	2	3	-
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPC05	**Subject Title**	ADVANCES IN OPERATING SYSTEMS LABORATORY
Category	Professional Core	**L-T-P-C**	0-0-4-2
Regulation	2025	**Semester**	II
Prerequisites	Fundamental knowledge of operating systems and computer architecture.		

Course Objectives:

1. To explore the design and implementation aspects of modern and distributed operating systems.
2. To analyze advanced concepts such as multiprocessing, memory management, and resource scheduling.
3. To investigate contemporary OS trends including virtualization, security, and real-time OS.

Course Content:

LIST OF EXPERIMENTS

1. Study and compare OS architectures: monolithic, layered, microkernel, hybrid.
2. Implement thread management and synchronization using semaphores.
3. Simulate CPU scheduling algorithms (FCFS, SJF, Priority, Round Robin).
4. Demonstrate deadlock detection, prevention, and avoidance algorithms.
5. Implement paging and segmentation memory management techniques.
6. Develop and compare page replacement algorithms (FIFO, LRU, Optimal).
7. Study file system journaling and distributed file systems.
8. Evaluate disk scheduling algorithms (FCFS, SSTF, SCAN, C-SCAN).
9. Experiment with multiprocessor OS support for process coordination.
10. Simulate communication and synchronization mechanisms in distributed OS.
11. Setup and analyze virtual machines and hypervisors (e.g., VMware, VirtualBox).
12. Compare containers (Docker) vs hypervisors from an OS perspective.
13. Implement and evaluate OS-level security models (access control, secure kernel).
14. Study real-time OS schedulers: EDF, RMS via simulation.
15. Analyze mobile OS architectures (Android/iOS) focusing on security and energy-aware computing.

Total Hours: 60 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain OS architectures, thread synchronization,	L2	PO1

	scheduling algorithms, memory management, virtualization, and real-time OS principles through lab demonstrations.		
CO2	Implement semaphores, deadlock algorithms, page replacement, disk scheduling, multiprocessor coordination, and container setups in laboratory environments.	L3	PO1, PO2, PO3, PO4, PO5
CO3	Analyze CPU scheduling performance, paging vs segmentation efficiency, hypervisor overheads, and distributed synchronization mechanisms experimentally.	L4	PO1, PO2, PO3, PO4
CO4	Evaluate journaling file systems, security models, RTOS schedulers (EDF/RMS), and mobile OS energy policies through comparative lab studies.	L5	PO1, PO2, PO3, PO5
CO5	Develop integrated OS simulations combining multiprocessing, virtualization, and fault-tolerant distributed system components.	L6	PO1, PO2, PO3, PO4, PO5, PO9

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	3	3	3	3	2	–	–	–	–	–	–	3	2	3	–
CO3	3	3	3	3	–	–	–	–	–	–	–	3	2	3	–
CO4	3	3	3	–	2	–	–	–	–	–	–	3	2	3	–
CO5	3	3	3	3	2	–	–	–	2	–	–	3	2	3	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

Subject Code	25CSEE10	**Subject Title**	Mini Project with Seminar
Category	EEC	**L-T-P-C**	0-0-4-2
Regulation	2025	**Semester**	II
Prerequisites	Basic programming knowledge and foundational understanding of data structures and algorithm concepts.		

Course Objectives:

1. Usage of mathematical, computational and natural sciences gained by study, experience
2. Practice with judgment to develop effective use of matter, energy and information to the benefit of mankind.
3. Plan, execute, manage and document a project

Upon successful completion of this course, students will be able to:

CO	**Course Outcome**	**Bloom's Level**	**PO's Mapped**
CO1	Explain mathematical, computational, and scientific principles relevant to the selected mini project domain and objectives.	L2	PO1
CO2	Apply engineering judgment to develop effective solutions using matter, energy, and information for societal benefit.	L3	PO1, PO2, PO4
CO3	Analyze project requirements, constraints, and stakeholder needs through literature survey and feasibility studies.	L4	PO1, PO2, PO3, PO4
CO4	Evaluate design alternatives, implementation risks, and performance metrics during project development phases.	L5	PO1, PO2, PO3, PO4, PO5
CO5	Design, implement, test, and document complete mini projects integrating domain knowledge and modern tools.	L6	PO1, PO2, PO3, PO4, PO5, PO9, PO10, PO11

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	3	3	–	2	–	–	–	–	–	–	–	3	2	3	2
CO3	3	3	3	2	–	–	–	–	–	–	–	3	2	3	1
CO4	3	3	3	3	2	–	–	–	–	–	–	3	2	3	1
CO5	3	3	3	3	3	–	–	–	3	3	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

SEMESTER III

Subject Code	25CSEE11	**Subject Title**	Project: Phase–I
Category	EEC	**L-T-P-C**	0-0-12-6
Regulation	2025	**Semester**	III
Prerequisites	Knowledge of research methodology, software development life cycle, and domain-specific technologies.		

Course Objectives:

1. To identify, formulate, and analyze research or design problems relevant to computer science.
2. To design and implement innovative solutions or prototypes using appropriate tools and technologies.
3. To develop technical documentation and present progress effectively.

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO'S Mapped
CO1	Understand and analyze research problem statements, literature, and requirements.	L2	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO10, PO11
CO2	Apply suitable algorithms, frameworks, or methodologies to design project solutions.	L3	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO3	Evaluate the effectiveness of proposed solutions through simulations, experiments, or case studies.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO4	Create functional prototypes or software implementations with proper documentation.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO5	Communicate project findings through presentations, reports, and technical demonstrations.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	3	2	2	1	2	2	–	–	1	2	2	–	3	2
CO2	2	3	2	3	2	1	1	2	2	1	2	3	2	2	1
CO3	2	3	3	3	2	1	1	2	2	2	2	3	2	3	1
CO4	2	3	2	3	2	1	2	3	2	1	2	3	2	2	1
CO5	1	1	1	1	1	2	3	2	1	1	2	1	1	1	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

SEMESTER IV

Subject Code	25CSEE12	**Subject Title**	Project: Phase–II
Category	EEC	**L-T-P-C**	0-0-24-12
Regulation	2025	**Semester**	IV
Prerequisites	Knowledge of research methodology, SDLC, advanced programming, and domain-specific tools.		

Course Objectives:

1. Identify and analyze research or design problems relevant to computer science.
2. Design innovative solutions or prototypes using appropriate tools and technologies.
3. Document and present project ideas and progress effectively.

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO'S Mapped
CO1	Implement project solution using advanced tools and techniques.	L2	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO2	Evaluate, analyze, and optimize results for correctness and performance.	L3	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO3	Document project in technical reports, publications, or presentations.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO4	Demonstrate leadership in completing milestones and managing team contributions.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO5	Disseminate findings through presentations, publications, or demonstrations.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	2	3	2	3	2	1	1	2	2	1	2	3	2	2	1
CO2	2	3	3	3	2	1	1	2	2	2	2	3	2	3	1
CO3	1	1	2	1	1	2	3	2	1	1	2	1	1	2	2
CO4	1	2	2	2	2	2	2	3	2	1	2	2	2	2	2
CO5	1	1	2	1	1	2	3	2	2	1	2	1	1	2	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

Name & Designation

BOS Approval

Date:

PROFESSIONAL ELECTIVES - I

Subject Code	25CSPE01	Subject Title	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
Category	Professional Elective	L-T-P-C	3-0-2-4
Regulation	2025	Semester	I
Prerequisites	Strong foundation in mathematics (linear algebra, calculus, probability, and statistics), programming skills (preferably Python), and basic knowledge of data analysis and algorithms.		

Course Objectives:

1. Introduce the foundations of Artificial Intelligence and its problem-solving paradigms.
2. Explore core concepts and algorithms in supervised and unsupervised Machine Learning.
3. Develop the ability to apply AI/ML techniques to real-world problems using modern tools.

Course Content:

[INTRODUCTION TO ARTIFICIAL INTELLIGENCE] (9 Hours)

History and Evolution of AI - Intelligent Agents and Environments - Problem Solving using Search: BFS, DFS, A*, Hill Climbing - Constraint Satisfaction Problems (CSPs) - Knowledge Representation: Logic, Ontologies, Semantic Networks

[SUPERVISED LEARNING] (9 Hours)

Learning Paradigms and Taxonomy - Linear Regression, Logistic Regression - Decision Trees, Random Forests - Support Vector Machines - Model Evaluation: Precision, Recall, F1, ROC

[UNSUPERVISED LEARNING AND DIMENSIONALITY REDUCTION] (9 Hours)

Clustering: K-Means, Hierarchical Clustering, DBSCAN - Association Rules and Market Basket Analysis - Dimensionality Reduction: PCA, t-SNE - Feature Selection and Engineering Techniques

[NEURAL NETWORKS AND DEEP LEARNING] (9 Hours)

Biological Neurons and ANN Basics - Feedforward Neural Networks, Backpropagation - Convolutional Neural Networks (CNN) - Recurrent Neural Networks (RNN), LSTM - Deep Learning Frameworks (TensorFlow/PyTorch Introduction)

[APPLICATIONS AND RECENT TRENDS IN AI/ML] (9 Hours)

Natural Language Processing: Text Classification, Chatbots - Reinforcement Learning Fundamentals - AI in Robotics and Autonomous Systems - Ethical Issues in AI/ML Case Studies: Healthcare, Finance, Smart Cities.

Total Hours: 45

LIST OF EXPERIMENTS

1. Implement Breadth-First Search (BFS) and Depth-First Search (DFS) for graph-based problems.
2. Solve the 8-puzzle problem using A* search algorithm.
3. Implement Hill Climbing and Simulated Annealing for function optimization.
4. Develop a solution to the N-Queens problem using backtracking.
5. Perform Constraint Satisfaction (Sudoku or Map coloring) using backtracking and inference.

6. Apply Linear and Polynomial Regression to predict continuous variables (e.g., housing prices).
7. Implement Logistic Regression for binary classification tasks (e.g., disease prediction).
8. Build and compare Decision Tree and Random Forest Classifiers.
9. Implement K-Nearest Neighbors (KNN) classifier on benchmark datasets.
10. Apply Naive Bayes Classifier to perform text classification (e.g., spam filtering).
11. Perform K-Means and Hierarchical Clustering on unlabeled datasets.
12. Implement Principal Component Analysis (PCA) for dimensionality reduction.
13. Use Association Rule Mining (e.g., Apriori or FP-Growth) for market basket analysis.
14. Apply SVM for classification and tune kernel parameters.
15. Evaluate models using Confusion Matrix, ROC Curve, and Cross-Validation techniques.

Total Hours: 30 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain the fundamental concepts of Artificial Intelligence, intelligent agents, search techniques, CSPs, and knowledge representation methods.	L2	PO1, PO2
CO2	Apply supervised learning algorithms such as linear regression, logistic regression, decision trees, random forests, and SVM to solve classification and regression problems.	L3	PO1, PO2, PO5
CO3	Analyze unsupervised learning techniques including clustering, association rules, dimensionality reduction, and feature engineering for data analysis.	L4	PO1, PO2, PO4, PO5
CO4	Design and implement neural network and deep learning models using CNN, RNN, LSTM, and frameworks like Tensor Flow/Py Torch.	L6	PO1, PO5, PO9, PO10, PO11
CO5	Evaluate machine learning models using performance metrics and assess ethical and societal implications of AI applications.	L5	PO1, PO2, PO3, PO5, PO9

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", 4th Edition, MIT Press, 2021.
2. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th Edition, Pearson, 2021.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.
4. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow", 3rd Edition, O'Reilly, 2022.

5. Tom M. Mitchell, "Machine Learning", McGraw-Hill, 1997.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2	–
CO2	3	3	-	-	1	-	-	-	-	-	-	3	2	3	–
CO3	2	3	-	2	1	-	-	-	-	-	-	3	2	3	–
CO4	1	-	-	-	1	-	-	-	2	3	1	3	2	3	–
CO5	2	2	3	-	2	-	-	-	1	-	-	2	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE02	Subject Title	BIG DATA ANALYTICS
Category	Professional Elective	L-T-P-C	3-0-2-4
Regulation	2025	Semester	I
Prerequisites	Good understanding of statistics, probability, database management, programming skills (Python/Java), and basic knowledge of data processing frameworks like Hadoop or Spark		

Course Objectives:

1. To understand the concepts, tools, and techniques of big data and its applications.
2. To explore big data frameworks like Hadoop and Spark for storage and processing
3. To enable students to perform data analytics using real-time tools and scalable techniques.

Course Content:

[INTRODUCTION TO BIG DATA] (9 Hours)

Big Data: Characteristics, Challenges, and Applications - Types of Digital Data and Sources - Traditional vs. Big Data Computing - Big Data Architecture and Lifecycle - Overview of Data Storage, Processing, and Analysis

[HADOOP ECOSYSTEM AND HDFS] (9 Hours)

Introduction to Hadoop Framework - Hadoop Distributed File System (HDFS) Architecture - YARN and MapReduce Programming Model - HDFS I/O Operations and File Formats - Introduction to Hive, Pig, and HBase

[APACHE SPARK AND DATA PROCESSING] (9 Hours)

Apache Spark Architecture and Components - RDD, DataFrames, and DataSets - Transformations and Actions in Spark - Spark SQL and Machine Learning with MLlib - Real-Time Data Processing with Spark Streaming

[DATA ANALYTICS AND VISUALIZATION] (9 Hours)

Exploratory Data Analysis Techniques - Data Cleaning and Preprocessing - Statistical Analysis and Pattern Discovery - Data Visualization using Python (Matplotlib, Seaborn) - Dashboards and BI Tools (Tableau/Power BI overview)

[ADVANCED TOPICS AND CASE STUDIES] (9 Hours)

NoSQL Databases (MongoDB, Cassandra) - Introduction to Graph Processing (Neo4j) - Big Data in Cloud (AWS EMR, Google BigQuery, Azure HDInsight) - Applications in Healthcare, Social Media, IoT, and E-commerce - Security, Privacy, and Ethical Issues in Big Data.

Total Hours: 45

LIST OF EXPERIMENTS

1. Data Cleaning and Handling Missing Values using Pandas/Numpy in Python.
2. Exploratory Data Analysis (EDA) using summary statistics, box plots, histograms, and correlation matrix.
3. Outlier Detection and Feature Scaling (Z-score, IQR, normalization, standardization).
4. Feature Engineering: Encoding categorical data (Label, One-hot), Binning, Interaction features.
5. Perform Linear and Multiple Linear Regression on real-world datasets (e.g., housing prices).

6. Apply Logistic Regression for binary classification tasks (e.g., loan default prediction).
7. Perform Hypothesis Testing (t-test, ANOVA, chi-square) on a sample dataset using SciPy or R.
8. Time Series Analysis using decomposition, smoothing, trend detection (Air passenger dataset or similar).
9. Apply K-Means and Hierarchical Clustering on customer segmentation or IRIS dataset.
10. Implement Principal Component Analysis (PCA) to reduce dataset dimensions and visualize.
11. Market Basket Analysis using Association Rule Mining (Apriori or FP-Growth algorithm).
12. Data Visualization using Matplotlib, Seaborn, or Plotly (bar, heatmap, violin, pairplot).
13. Implement a Spark application using PySpark for data transformation and aggregation.
14. Connect and Query NoSQL Databases (MongoDB/Cassandra) for data retrieval and analytics.
15. Develop Interactive Dashboards using Tableau/Power BI or Streamlit for insights delivery.

Total Hours: 30 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Describe the characteristics, challenges, applications, architecture, and lifecycle of Big Data, and differentiate between traditional data computing and Big Data computing approaches.	L1	PO1, PO2
CO2	Explain the Hadoop framework, HDFS architecture, YARN, MapReduce programming model, and illustrate the usage of Hive, Pig, and HBase in Big Data processing.	L2	PO1,PO2, PO3
CO3	Apply Apache Spark concepts such as RDDs, DataFrames, DataSets, transformations, actions, and Spark SQL for large-scale data processing and analytics.	L3	PO1,PO3, PO5
CO4	Analyze datasets using exploratory data analysis, data cleaning, statistical methods, and create meaningful visualizations and dashboards using Python and BI tools.	L4	PO2,PO3, PO4,PO5
CO5	Evaluate NoSQL databases, graph processing techniques, cloud-based Big Data platforms, and assess real-world applications with respect to security, privacy, and ethical issues.	L5	PO2,PO6,PO7, PO8

Reference Books:

1. V. K. Jain, "Big Data and Hadoop", Khanna Publishing, 2023.
2. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly, 2021

3. Jules S. Damji et al., "Learning Spark: Lightning-Fast Data Analytics", 2nd Edition, O'Reilly, 2022

4. M. Zikopoulos et al., "Understanding Big Data", McGraw-Hill, 2020

5. Anand Rajaraman, Jeffrey Ullman, "Mining of Massive Datasets", Cambridge University Press, 2021

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2	–
CO2	3	2	2	-	-	-	-	-	-	-	-	3	2	2	–
CO3	3	-	3	-	3	-	-	-	-	-	-	3	2	3	–
CO4	-	3	3	2	3	-	-	-	-	-	-	3	2	3	–
CO5	-	3	-	-	-	2	2	3	-	-	-	2	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE03	Subject Title	WIRELESS ACCESS TECHNOLOGIES
Category	Professional Elective	L-T-P-C	3-0-2-4
Regulation	2025	Semester	I
Prerequisites	Basic knowledge of wireless communication principles, networking fundamentals, signal processing, and digital communication systems.		

Course Objectives:

1. To understand the fundamentals and evolution of wireless access technologies and communication systems.
2. To explore various wireless standards and protocols across cellular, WLAN, WPAN, and emerging systems.
3. To evaluate and apply wireless technologies for next-generation communication and network solutions.

Course Content:

[FUNDAMENTALS OF WIRELESS COMMUNICATION] (9 Hours)

Wireless communication principles and spectrum allocation - Antennas, propagation, fading, and path loss models - Modulation techniques: ASK, FSK, PSK, QAM - Multiple access schemes: FDMA, TDMA, CDMA, OFDMA - Overview of wireless standards: IEEE, ITU, 3GPP

[WIRELESS LAN AND PAN TECHNOLOGIES] (9 Hours)

IEEE 802.11 a/b/g/n/ac/ax standards (Wi-Fi evolution) - WLAN architecture, MAC layer operations - Security in WLAN: WPA2/WPA3 - Wireless Personal Area Networks (WPANs): Bluetooth, ZigBee, Z-Wave - Wi-Fi 6 and IoT-focused WPANs

[CELLULAR NETWORKS AND EVOLUTION] (9 Hours)

GSM Architecture and Concepts - GPRS and EDGE enhancements - 3G UMTS Architecture - LTE and LTE-Advanced: EPC, VoLTE, CA - 5G NR architecture, spectrum bands, and services

[WIRELESS BROADBAND AND EMERGING TECHNOLOGIES] (9 Hours)

WiMAX (IEEE 802.16), architecture and services - Satellite Communication basics and VSAT - mmWave communication, Massive MIMO - Spectrum sharing and Cognitive Radio - IoT connectivity technologies: LoRa, Sigfox, NB-IoT

[PERFORMANCE, SECURITY, AND APPLICATIONS] (9 Hours)

QoS in wireless networks (delay, jitter, throughput, reliability) - Handoff strategies and mobility management - Wireless network security threats and countermeasures - Case studies: Smart Cities, Healthcare, Rural Access - Wireless technology in 6G and beyond.

Total Hours: 45

LIST OF EXPERIMENTS

1. Simulation of Wireless Signal Propagation Models (Free space, Two-ray ground) using NS2/NS3.
2. Analysis of Access Mechanisms (FDMA, TDMA, CDMA, OFDMA) using MATLAB or Scilab simulation.
3. Simulation of Modulation Techniques (ASK, FSK, PSK, QAM) and path loss analysis using MATLAB.

4. Configuration and Performance Evaluation of IEEE 802.11 (Wi-Fi) networks using Cisco Packet Tracer or GNS3.
5. WLAN Security Configuration and Testing (WEP, WPA2, WPA3) using Wireshark and Router OS tools.
6. Bluetooth/ZigBee Communication Setup using Arduino/Raspberry Pi (or simulation using Cooja/Contiki OS).
7. Simulation of Cellular Networks (GSM, LTE) with open-source tools like OpenAirInterface or GNS3.
8. Study and Simulation of 5G Architecture and Network Slicing using Mininet5G or ONOS SDN controller.
9. Handoff and Mobility Simulation in Wireless Networks (Mobile IP, LTE) using NS2/NS3 or OMNeT++.
10. Simulate IoT Communication Protocols (LoRa/NB-IoT) using NS3 or Arduino with LoRa boards.
11. Implementation of Cognitive Radio Simulation using GNU Radio or MATLAB.
12. WiMAX (IEEE 802.16) Network Simulation and performance analysis using NS3.
13. QoS Measurement in Wi-Fi or LTE Networks (Latency, Throughput, Packet loss) using iPerf or Wireshark.
14. Simulate Ad-Hoc and Sensor Networks (MANET/VANET) with routing protocols (DSDV, AODV) using NS2.
15. Design and Simulation of Wireless Mesh Network using NS3 with mobility and routing protocols.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Describe the fundamental principles of wireless communication, spectrum allocation, antenna characteristics, propagation models, fading effects, and modulation techniques.	L1	PO1, PO2
CO2	Explain multiple access techniques and wireless standards, and analyze WLAN and WPAN technologies including Wi-Fi, Bluetooth, ZigBee, and their security mechanisms.	L2	PO1, PO2, PO3
CO3	Apply concepts of cellular network architectures and evolution from GSM to 5G NR to analyze system components, services, and performance enhancements.	L3	PO1, PO3, PO5
CO4	Analyze emerging wireless broadband technologies such as WiMAX, satellite communication, mmWave, Massive MIMO, cognitive radio, and IoT connectivity solutions.	L4	PO2, PO3, PO4, PO5

CO5	Evaluate wireless network performance, security challenges, mobility management techniques, and assess real-world applications and future wireless technologies beyond 5G.	L5	PO2, PO6, PO7, PO8

Reference Books:

1. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson, 2021.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2021.
3. William Stallings, "Wireless Communications and Networks", 2nd Edition, Pearson, 2020.
4. Sundeep Mishra, "Wireless Access Technologies", Wiley India, 2022.
5. Kaveh Pahlavan, Prashant Krishnamurthy, "Principles of Wireless Networks", Pearson, 2023.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	P010	PO11	PSO 1	PSO 2	PSO 3	PS O4
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2	–
CO2	3	2	2	-	-	-	-	-	-	-	-	3	2	2	–
CO3	3	-	3	-	3	-	-	-	-	-	-	3	2	3	–
CO4	-	3	3	2	3	-	-	-	-	-	-	3	2	3	–
CO5	-	3	-	-	-	2	2	3	-	-	-	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval
Date:

Subject Code	25CSPE04	**Subject Title**	Cryptography and Network Security
Category	Professional elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	I
Prerequisites	Fundamental understanding of discrete mathematics, computer networks, operating systems, and basic programming skills.		

Course Objectives:

1. To understand fundamental principles and mathematical foundations of cryptographic systems.
2. To explore various encryption techniques, security protocols, and their real-world applications.
3. To analyze network security threats and implement protection mechanisms.

Course Content:

[INTRODUCTION TO CRYPTOGRAPHY] (9 Hours)

Security goals and services - Classical cryptosystems: Caesar, Vigenère, Playfair ciphers - Modern symmetric encryption: block vs. stream ciphers - Substitution–permutation networks - Cryptanalysis techniques and attacks

[SYMMETRIC AND ASYMMETRIC ENCRYPTION] (9 Hours)

DES, Triple DES, and AES - Block cipher modes of operation (ECB, CBC, CFB, OFB, CTR) - Public key cryptography principles - RSA, Diffie–Hellman key exchange - Elliptic Curve Cryptography (ECC)

[HASHING AND AUTHENTICATION] (9 Hours)

Cryptographic hash functions: MD5, SHA families - Message authentication codes (MAC), HMAC - Digital signatures and certificate authorities - Authentication protocols: Kerberos, CHAP - PKI infrastructure and digital certificates

[NETWORK SECURITY PROTOCOLS] (9 Hours)

Secure email: PGP, S/MIME - IP security: IPsec architecture and modes - SSL/TLS protocols and HTTPS - Network layer security: Firewalls, VPNs - Transport and application layer protections

[SYSTEM AND WIRELESS SECURITY] (9 Hours)

Intrusion detection systems (IDS/IPS) - Malware types and protection (virus, worms, ransomware) - Secure system design principles - Wireless network security (WPA3, EAP) - Case studies: DNS security, Web app attacks (SQL injection, XSS), and zero-day threats

Total Hours: 45

LIST OF EXPERIMENTS

1. Implement Classical Ciphers: Caesar, Playfair, Vigenère, Hill Cipher.
2. Demonstrate Block Cipher Modes of Operation: ECB, CBC, CFB, OFB using AES.
3. Simulate Feistel Cipher Structure with chosen round functions.
4. Implement DES and AES Algorithms: Perform encryption and decryption using standard libraries and manual logic.
5. Implement RSA Algorithm for secure key generation, encryption, and decryption.

6. Simulate Diffie–Hellman Key Exchange Protocol and verify session key derivation.
7. Implement Hash Algorithms: MD5, SHA-1/SHA-256 and analyze the avalanche effect.
8. Implement MAC and HMAC mechanisms for integrity verification.
9. Simulate Digital Signature Scheme using RSA and SHA.
10. Simulate SSL/TLS Handshake using Wireshark or OpenSSL; analyze certificates.
11. Configure IPsec Tunnel between two machines using Linux or simulation.
12. Implement a Secure Email System using PGP or S/MIME setup.
13. Configure and Analyze VPN Communication using OpenVPN.
14. Simulate Firewall Configuration (iptables or UFW) and test network traffic control.
15. Setup IDS/IPS using Snort or Suricata and simulate a DoS attack for detection.

Total Hours: 30 Hours

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain security goals and services, classical and modern cryptographic techniques, substitution–permutation networks, and basic cryptanalysis concepts.	L2	PO1,PO2
CO2	Explain symmetric and asymmetric encryption algorithms, block cipher modes, RSA, Diffie–Hellman, and Elliptic Curve Cryptography (ECC).	L2	PO1,PO2,PO3
CO3	Apply cryptographic hash functions, message authentication codes, digital signatures, and authentication protocols to ensure data integrity and authenticity.	L3	PO1,PO3,PO5
CO4	Analyze network security protocols such as IPsec, SSL/TLS, secure email systems, firewalls, and VPNs for protecting network communications.	L4	PO2,PO3,PO4, PO5
CO5	Evaluate system and wireless security mechanisms, intrusion detection systems, malware threats, and real-world security attacks to design secure computing environments.	L5	PO2,PO6,PO7, PO8

Reference Books:

1. William Stallings, "Cryptography and Network Security: Principles and Practice", 8th Edition, Pearson, 2023.
2. Behrouz A. Forouzan, "Cryptography and Network Security", 3rd Edition, McGraw Hill, 2022
3. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security: Private Communication in a Public World", 3rd Edition, Pearson, 2021
4. Douglas R. Stinson, "Cryptography: Theory and Practice", 4th Edition, CRC Press, 2022

5. Wade Trappe, Lawrence C. Washington, "Introduction to Cryptography with Coding Theory", 3rd Edition, Pearson, 2020.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2	–
CO2	3	2	2	-	-	-	-	-	-	-	-	3	2	2	–
CO3	3	-	3	-	3	-	-	-	-	-	-	3	2	3	–
CO4	-	3	3	2	3	-	-	-	-	-	-	3	2	3	–
CO5	-	3	-	-	-	2	2	3	-	-	-	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

PROFESSIONAL ELECTIVES - II

Subject Code	25CSPE05	**Subject Title**	NATURAL LANGUAGE PROCESSING
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	II
Prerequisites	Understanding the math behind NLP algorithms is essential. A strong grasp of ML is a must for modern NLP		

Course Objectives:

1. To introduce the fundamental concepts and methods for processing natural language data.
2. To explore linguistic structures, syntax, semantics, and statistical models used in NLP.
3. To apply machine learning and deep learning techniques in real-world NLP applications such as text mining, summarization, and question answering.

Course Content:

[INTRODUCTION AND TEXT PREPROCESSING] (9 Hours)

Basics of NLP: goals and challenges - Linguistic essentials: morphology, syntax, semantics - Text normalization: stemming, lemmatization - Tokenization and sentence segmentation - POS tagging and chunking

[STATISTICAL AND PROBABILISTIC MODELS] (9 Hours)

N-gram language models - Smoothing techniques (Laplace, Good-Turing) - Hidden Markov Models (HMM) - Named Entity Recognition (NER) - Part-of-Speech tagging using HMM/CRF

[SYNTAX, PARSING AND SEMANTICS] (9 Hours)

Context-Free Grammar (CFG) - Top-down and bottom-up parsing - Dependency parsing - Semantic analysis: Word Sense Disambiguation - Ambiguity resolution and semantic role labeling

[NLP USING MACHINE LEARNING AND DEEP LEARNING] (9 Hours)

Word embeddings: Word2Vec, GloVe - Text classification with Naive Bayes, SVM - Sequence models: RNN, LSTM, Bi-LSTM - Transformer models and BERT - Attention mechanisms in NLP

[APPLICATIONS AND RECENT TRENDS] (9 Hours)

Machine translation - Text summarization – Chat bots and dialogue systems - Sentiment analysis and opinion mining - Question answering and ethical concerns in NLP

Total Hours: 45

List of Experiments:

1. Text tokenization, sentence segmentation, stopwords removal using NLTK (Brown corpus).
2. Stemming (Porter/Snowball) and lemmatization using NLTK/spaCy on Gutenberg texts.
3. POS tagging and NER using NLTK's averaged_perceptron_tagger and ne_chunk().
4. N-gram models (unigram/bigram/trigram) with Laplace smoothing using NLTK's NgramAssocMeasures.
5. Viterbi algorithm for HMM POS tagging using NLTK's hmm.py on Brown corpus.
6. CRF for NER using sklearn-crfsuite (pip installable) on CoNLL-2003 dataset.

7. CFG parsing using NLTK's ChartParser (top-down) and ShiftReduceParser (bottom-up).
8. Dependency parsing using spaCy's open source en_core_web_sm model; visualize with displacy.
9. Word Sense Disambiguation using NLTK's lesk() algorithm on SemCor corpus.
10. Word2Vec/GloVe embeddings using Gensim on Google News corpus; cosine similarity analysis.
11. Text classification using scikit-learn's MultinomialNB/SVC on 20 Newsgroups dataset.
12. LSTM for sequence labeling using Keras/TensorFlow on ATIS dataset (POS/NER).
13. Neural machine translation using Keras seq2seq with attention (English-French WMT dataset).
14. Text summarization using Gensim's TextRank4Keyword and ROUGE evaluation.
15. BERT Question Answering using Hugging Face transformers on SQuAD 1.1 dataset.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand linguistic and statistical foundations of NLP systems.	L2	PO1
CO2	Implement probabilistic models for basic language processing tasks.	L3	PO1, PO2, PO5
CO3	Apply parsing and semantic analysis techniques to interpret natural language.	L4	PO1, PO2, PO3, PO4
CO4	Utilize machine learning and deep learning approaches for NLP applications.	L5	PO1, PO2, PO3, PO5
CO5	Develop and evaluate real-world NLP solutions using modern tools and frameworks.	L6	PO1, PO2, PO3, PO4, PO5

Reference Books:

1. Jacob Eisenstein, “Natural Language Processing”, MIT Press, 2022.

2. Daniel Jurafsky and James H. Martin, “Speech and Language Processing”, 3rd Ed. (Draft), Pearson, 2023

3. Yoav Goldberg, “Neural Network Methods for Natural Language Processing”, Morgan & Claypool, 2021

4. Steven Bird, Ewan Klein, Edward Loper, “Natural Language Processing with Python”, O’Reilly, 2020

5. Delip Rao and Brian McMahan, “Natural Language Processing with PyTorch”, O’Reilly, 2019

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	3	3	–	–	2	–	–	–	–	–	–	3	2	3	–
CO3	3	3	3	2	–	–	–	–	–	–	–	3	2	3	–
CO4	3	3	3	–	3	–	–	–	–	–	–	3	2	3	–
CO5	3	3	3	3	3	–	–	–	–	–	–	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE06	**Subject Title**	DATA VISUALIZATION TECHNIQUES
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	II
Prerequisites	Understanding basic math and statistics helps you interpret and present data effectively. Programming Skills helps automate visualization and handle large datasets.		

Course Objectives:

1. To understand the principles and methodologies of data visualization for effective communication.
2. To apply statistical and graphical methods for visual exploration of complex datasets.
3. To use modern tools and libraries to design interactive and insightful visualizations for real-world decision-making.

Course Content:

[INTRODUCTION TO DATA VISUALIZATION] (9 Hours)

Definition and importance of data visualization - Visual perception and cognition - Types of data: categorical, numerical, temporal, spatial - Design principles: clarity, accuracy, efficiency - Introduction to tools: Tableau, Power BI, D3.js, Python (Matplotlib, Seaborn)

[VISUAL ENCODING AND BASIC PLOTS] (9 Hours)

Marks and channels: position, size, shape, color - Data-to-ink ratio, Gestalt principles - Bar charts, line charts, histograms, pie charts, box plots - Scatter plots and bubble charts - Choosing the right visualization for the data type

[MULTIVARIATE AND STATISTICAL DATA VISUALIZATION] (9 Hours)

Visualizing multivariate data: parallel coordinates, radar charts - Heatmaps, correlation matrices - Visualizing distributions: KDE plots, violin plots - Statistical graphs: confidence intervals, error bars - Dashboard components and layout design

[TIME SERIES, GEO, AND NETWORK VISUALIZATION] (9 Hours)

Time series visualization: line charts, moving averages - Geospatial visualization: maps, choropleths, heatmaps - Graph and network visualization: nodes, edges, force-directed layouts - Hierarchical data: treemaps, sunburst charts - Real-time data visualization techniques

[INTERACTIVE VISUALIZATION AND VISUAL ANALYTICS] (9 Hours)

Principles of interactivity: filtering, zooming, brushing, linking - Dashboards with Tableau and Power BI - Web-based visualization with Plotly, Dash, and D3.js - Case studies: business, health, social networks, IoT - Ethics and pitfalls: misleading graphs, bias, accessibility

Total Hours: 45

List of Experiments:

1. Create basic bar charts and pie charts using Matplotlib on categorical datasets.
2. Design line charts and histograms for numerical and temporal data in Matplotlib.
3. Implement scatter plots and bubble charts to visualize relationships among variables.
4. Use Seaborn to construct box plots and violin plots to explore distributions.
5. Generate bubble charts and pie charts highlighting visual encoding principles.
6. Create heatmaps and correlation matrices with Seaborn annotating values.

7. Visualize multivariate data using parallel coordinates and radar charts in Matplotlib.
8. Plot KDE (Kernel Density Estimate) and statistical confidence intervals using Seaborn.
9. Develop dashboards with multiple interactive plots using Jupyter widgets and Matplotlib.
10. Plot time series data with moving averages and seasonal decomposition using Pandas/Matplotlib.
11. Create geospatial maps and choropleth heatmaps using Folium and GeoPandas.
12. Visualize network graphs with NetworkX and Matplotlib's force-directed layouts.
13. Build interactive dashboards with Plotly Dash showcasing filtering and zooming.
14. Visualize real-time streaming data using Bokeh with brushing and linking features.
15. Design ethical data visualizations considering accessibility and bias—detect misleading graphs

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the theoretical foundations of data visualization and visual perception.	L2	PO1
CO2	Apply appropriate visualization techniques to different types of datasets.	L3	PO1, PO2, PO3
CO3	Interpret multivariate, temporal, and geospatial data through effective visuals.	L4	PO1, PO2, PO4
CO4	Use interactive visualization tools to build dynamic dashboards and visual stories	L5	PO1, PO3, PO5
CO5	Evaluate the effectiveness, accuracy, and ethics of data visualizations	L3	PO1, PO2, PO4, PO8

Reference Books:

1. Tamara Munzner, "Visualization Analysis and Design", CRC Press, 2nd Edition, 2023.
2. Nathan Yau, "Data Points: Visualization That Means Something", Wiley, 2021
3. Alberto Cairo, "The Truthful Art: Data, Charts, and Maps for Communication", New Riders, 2021
4. Cole Nussbaumer Knaflic, "Storytelling with Data", Wiley, 2022
5. Kirk Andy, "Data Visualisation: A Handbook for Data Driven Design", Sage Publications, 2020
6. Rohan Alexander, "Telling Stories with Data: With Applications in R", CRC Press, 2021

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	3	3	2	–	–	–	–	–	–	–	–	3	2	3	–
CO3	3	3	–	2	–	–	–	–	–	–	–	3	2	3	–
CO4	3	–	3	–	3	–	–	–	–	–	–	3	2	3	–
CO5	3	2	–	3	–	–	–	2	–	–	–	2	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE07	**Subject Title**	SOFTWARE DEFINED NETWORKS
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	II
Prerequisites	Before learning SDN, you must have a solid foundation in traditional networking concepts.		

Course Objectives:

1. To understand the architecture, principles, and evolution of Software Defined Networking.
2. To design, implement, and manage programmable networks using SDN controllers and protocols.
3. To explore applications of SDN in data centers, cloud networking, and security systems.

Course Content:

[INTRODUCTION AND SDN ARCHITECTURE] (9 Hours)

Traditional networking vs SDN - Evolution of SDN - SDN architecture: control, data, and application planes - Southbound APIs: OpenFlow basics - Advantages and challenges of SDN

[CONTROL PLANE AND SDN CONTROLLERS] (9 Hours)

Centralized and distributed control - SDN controllers: POX, Ryu, ONOS, OpenDaylight - Controller placement problem - Controller communication interfaces - Northbound APIs and programmability

[DATA PLANE AND OPENFLOW PROTOCOL] (9 Hours)

Data plane behavior in SDN - OpenFlow protocol: flow table structure, actions, match fields - Flow installation and modification - Packet-in and Packet-out mechanisms - Switch behavior and datapath architecture

[SDN APPLICATIONS] (9 Hours)

Traffic engineering and load balancing - QoS and bandwidth management - Network function virtualization (NFV) - SDN in data centers and cloud networking - SDN for network monitoring and security

[ADVANCED TOPICS AND TRENDS IN SDN] (9 Hours)

Intent-based networking - SD-WAN and edge computing - Integration with machine learning and AI - Open-source SDN tools and simulators (Mininet, Floodlight) - Security challenges and solutions in SDN

Total Hours: 45

List of Experiments:

1. Setup Virtual SDN Lab Environment using Mininet on VirtualBox.
2. Create Simple Network Topology in Mininet controlled by OpenFlow Controller.
3. Capture and Analyze OpenFlow Messages (FLOW_MOD, PACKET_IN) using Wireshark.
4. Configure and Test POX/Ryu SDN Controllers for Basic Network Control.
5. Implement Controller Placement and Failover Scenarios with ONOS or OpenDaylight.
6. Develop Custom Northbound API Application on Ryu Controller for Network Monitoring.
7. Experiment with Flow Table Modifications: Manual Flow Installation and Packet Handling.
8. Analyze Packet-in and Packet-out Mechanisms in OpenFlow Switch using Mininet.

9. Simulate Packet Forwarding Behavior and Flow Timeouts in Open vSwitch.
10. Implement Traffic Engineering and Load Balancing with OpenFlow Rules.
11. QoS Enforcement and Bandwidth Management using SDN Controller.
12. Simulation of Network Function Virtualization (NFV) with Service Chaining.
13. Explore Intent-Based Networking with OpenDaylight or ONOS Framework.
14. Setup and Configure SD-WAN Testbed Emulation using Mininet and Floodlight Controller.
15. Apply Security Policies and Intrusion Detection in SDN Environment.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain the architecture, components, and evolution of SDN.	L2	PO1, PO2
CO2	Design and manage SDN using controllers and programmable interfaces.	L3	PO1, PO2, PO3, PO4, PO5
CO3	Configure and troubleshoot OpenFlow-based data plane operations.	L4	PO1, PO2, PO3, PO4, PO5
CO4	Develop SDN solutions for cloud, data center, and security applications.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO5	Analyze trends and research directions in SDN and related technologies.	L3	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Paul Goransson, Chuck Black, Timothy Culver, "Software Defined Networks: A Comprehensive Approach", 2nd Ed., Morgan Kaufmann, 2022.
2. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks", O'Reilly, 2021
3. Fei Hu, "Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, 2021
4. William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud", Pearson, 2020
5. Nick Feamster et al., "SDN Deep Dive" (Online Resources and MOOC content)

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	2	3	3	2	3	–	–	–	–	–	–	3	2	3	–
CO3	2	3	2	3	3	–	–	–	–	–	–	3	2	3	–
CO4	2	3	3	3	3	2	2	2	2	2	1	3	2	3	–
CO5	2	2	3	3	2	2	2	1	2	2	3	3	2	3	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE08	**Subject Title**	ETHICAL HACKING AND CYBER FORENSICS
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	II
Prerequisites	Before learning either Ethical Hacking or Cyber Forensics, you must have a strong base in computer science and IT concepts.		

Course Objectives:

1. To understand hacking tools, techniques, and countermeasures with an ethical perspective.
2. To explore digital forensics methodologies and tools for incident investigation.
3. To apply practical skills in ethical hacking and forensic analysis for securing and auditing IT infrastructure.

Course Content:

[INTRODUCTION TO ETHICAL HACKING AND SECURITY] (9 Hours)

Basics of ethical hacking and penetration testing - Legal implications and cyber laws - Types of hackers and attacks (DoS, DDoS, phishing, social engineering) - Phases of hacking: Reconnaissance, scanning, gaining access, maintaining access, covering tracks - Security models and threat landscapes

[SYSTEM AND NETWORK HACKING TECHNIQUES] (9 Hours)

Footprinting and reconnaissance tools - Scanning networks: Nmap, Wireshark - System hacking: password cracking, privilege escalation - Trojans, backdoors, rootkits - Session hijacking, sniffing, and spoofing techniques

[WEB APPLICATION AND WIRELESS ATTACKS] (9 Hours)

SQL Injection, XSS, CSRF - Directory traversal and file inclusion - Burp Suite and OWASP top 10 - Wireless hacking: WEP, WPA/WPA2 cracking - Rogue access points, evil twin attacks

[DIGITAL FORENSICS AND INCIDENT RESPONSE] (9 Hours)

Introduction to cyber forensics and investigation process - Evidence collection, chain of custody - File systems forensics (FAT, NTFS) - Memory and registry analysis - Forensics tools: Autopsy, FTK Imager, Volatility

[ADVANCED TOPICS AND CASE STUDIES] (9 Hours)

Mobile device forensics - Cloud forensics and challenges - Anti-forensics and counter forensics techniques - Real-world forensic case studies - Ethics, laws (IT Act 2000), and professional responsibility in hacking and forensics

Total Hours: 45

List of Experiments:

1. Reconnaissance and Footprinting using whois, dig, theHarvester, Maltego CE on target domains.
2. Network Scanning with Nmap (SYN, UDP, version detection) and vulnerability scanning with OpenVAS.
3. DoS Attack Simulation using hping3, Slowloris against Metasploitable VM; analyze with Wireshark.
4. Password Cracking using John the Ripper, Hashcat on captured hashes from Linux/Windows.

5. Privilege Escalation exploiting kernel vulnerabilities (Dirty COW) on Metasploitable 2 VM.
6. Session Hijacking using Ettercap ARP spoofing and Wireshark packet capture analysis.
7. SQL Injection and XSS attacks on DVWA using sqlmap, manual payloads; exploit mitigation.
8. Burp Suite Community for web vulnerability scanning, intercepting, and fuzzing OWASP Top 10.
9. Wireless Security Testing using aircrack-ng suite for WEP/WPA2 cracking on test AP.
10. Disk Image Forensics using Autopsy on forensic images (FAT/NTFS); recover deleted files.
11. Memory Forensics with Volatility on RAM dumps; detect rootkits, malware processes.
12. Network Forensics using Wireshark/tcpdump; reconstruct files, analyze attack timelines.
13. Mobile Forensics using ADB and autopsy-mobile on Android backup images.
14. Anti-Forensics Analysis detecting file wiping, timestamp manipulation with Sleuth Kit.
15. Incident Response Simulation using TheHive/CTI; timeline reconstruction from case study.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the phases of hacking and demonstrate knowledge of common attack techniques.	L2	PO1, PO2, PO6, PO10
CO2	Apply ethical hacking tools for system and network vulnerability assessment.	L3	PO1, PO2, PO3, PO4, PO5, PO6, PO10
CO3	Analyze and exploit web and wireless networks to identify security flaws.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO10
CO4	Conduct digital forensic investigations and preserve evidence for legal procedures.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO10, PO11
CO5	Evaluate ethical, legal, and societal implications of hacking and forensic practices.	L3	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO10, PO11

Reference Books:

1. Michael T. Simpson, Nicholas Antill, "Hands-On Ethical Hacking and Network Defense", Cengage, 4th Edition, 2022.

2. Nelson, Phillips, Enfinger, Steuart, "Guide to Computer Forensics and Investigations", Cengage,

6th Ed., 2022

3. William Stallings, “Computer Security: Principles and Practice”, Pearson, 2021

4. Kevin Beaver, “Hacking for Dummies”, Wiley, 7th Edition, 2022

5. Georgia Weidman, “Penetration Testing: A Hands-On Introduction to Hacking”, No Starch Press, 2019

6. Darren R. Hayes, “A Practical Guide to Digital Forensics”, Pearson, 2020

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	–	–	–	2	–	–	–	2	–	2	2	2	–
CO2	2	3	2	3	3	2	–	–	–	2	–	3	2	3	–
CO3	2	3	3	3	3	2	–	–	–	3	–	3	2	3	–
CO4	2	3	3	3	3	3	2	1	–	3	1	3	2	3	–
CO5	2	2	2	2	–	3	3	2	–	3	2	2	2	2	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

PROFESSIONAL ELECTIVE - III

Subject Code	25CSPE09	**Subject Title**	IMAGE PROCESSING AND COMPUTER VISION
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	II
Prerequisites	Fundamental knowledge of digital image processing, linear algebra, probability and statistics, programming skills in Python or MATLAB, and basic machine learning concepts.		

Course Objectives:

1. To introduce fundamental concepts and mathematical foundations of digital image processing and computer vision.
2. To equip students with skills for image analysis, filtering, segmentation, and object detection.
3. To explore advanced vision tasks using machine learning and deep learning techniques.

Course Content:

[FUNDAMENTALS OF DIGITAL IMAGE PROCESSING] (9 Hours)

Image representation and properties - Sampling and quantization - Color models and transformations - Histogram equalization and contrast enhancement - Image arithmetic and logical operations

[IMAGE FILTERING AND EDGE DETECTION] (9 Hours)

Spatial and frequency domain filtering - Convolution and correlation - Gaussian, median, and bilateral filters - Edge detection: Sobel, Prewitt, Canny - Hough transform for line and circle detection

[IMAGE SEGMENTATION AND MORPHOLOGY] (9 Hours)

Thresholding techniques: global, local, adaptive - Region-based segmentation: region growing, splitting & merging - Clustering-based segmentation: K-means, Mean shift - Morphological operations: dilation, erosion, opening, closing - Watershed segmentation

[FEATURES AND OBJECT RECOGNITION] (9 Hours)

Feature detection: corners (Harris), blobs (LoG, DoG) - Feature descriptors: SIFT, SURF, ORB - Template matching and object tracking - Bag of Visual Words and BoW model - Object classification using machine learning (SVM, k-NN)

[DEEP LEARNING FOR COMPUTER VISION] (9 Hours)

Introduction to CNNs: architecture, convolution, pooling - Transfer learning and fine-tuning - Face recognition and detection - Semantic segmentation (U-Net, Mask R-CNN) - Applications: autonomous driving, medical imaging, surveillance

Total Hours: 45

List of Experiments:

1. Image loading, color space conversion (RGB→HSV→Grayscale) and histogram equalization using OpenCV.
2. Image arithmetic operations (addition, subtraction, bitwise AND/OR/XOR) and blending using NumPy/OpenCV.
3. Sampling/quantization effects and contrast enhancement (gamma correction, log transform) visualization.
4. Spatial filtering: Gaussian, median, bilateral filters; compare noise reduction effects on Lena image.

5. Edge detection: Implement Sobel, Prewitt, Canny operators; analyze threshold effects.
6. Hough Transform: Line and circle detection on synthetic/real images (canny edges → HoughLinesP).
7. Thresholding: Global, adaptive, Otsu methods; compare on noisy grayscale images.
8. Morphological operations: Dilation, erosion, opening, closing on binary shapes using cv2.morphologyEx.
9. Watershed segmentation on colored markers; region growing implementation from seeds.
10. Feature detection: Harris corners, SIFT keypoints/descriptors extraction and matching.
11. ORB feature matching between reference/query images; homography estimation.
12. Bag of Visual Words: K-means clustering on SIFT descriptors for image classification.
13. CNN implementation using Keras/TensorFlow: MNIST digit classification from scratch.
14. Transfer learning: Fine-tune VGG16/MobileNet on CIFAR-10 for object classification.
15. Object detection: YOLOv5 implementation (Ultralytics) on COCO subset; face detection demo.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain the mathematical foundations of image sampling, quantization, color models, and enhancement techniques, and apply them to process digital images using Python/OpenCV	L2	PO1, PO2, PO3, PO4, PO5, PO10, PO11
CO2	Implement and analyze spatial/frequency domain filters, edge detectors and Hough transforms to enhance and extract features from images	L3	PO1, PO2, PO3, PO4, PO5, PO10, PO11
CO3	Apply segmentation methods and evaluate their performance on diverse image datasets	L4	PO1, PO2, PO3, PO4, PO5, PO10, PO11
CO4	Design and implement feature extraction, descriptor matching, and recognition systems using machine learning models like SVM for object classification	L5	PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PO10, PO11
CO5	Develop deep learning models for advanced vision tasks such as object detection, semantic segmentation, and face recognition in real-world applications	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 4th Edition, Pearson, 2022.
2. Szeliski, Richard, "Computer Vision: Algorithms and Applications", Springer, 2022.
3. Adrian Rosebrock, "Deep Learning for Computer Vision with Python", PyImageSearch, 2021.

4. Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2021.

5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	1	2	2	–	–	–	–	1	2	3	2	3	–
CO2	3	3	2	3	2	–	–	–	–	1	2	3	2	3	–
CO3	3	3	2	3	2	–	–	–	–	2	2	3	2	3	–
CO4	3	3	3	3	3	–	1	1	1	2	2	3	2	3	–
CO5	3	3	3	3	3	1	2	2	2	3	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE10	Subject Title	HUMAN COMPUTER INTERACTION
Category	Professional Elective	L-T-P-C	3-0-2-4
Regulation	2025	Semester	II
Prerequisites	Basic understanding of computer systems, cognitive psychology principles, user interface design fundamentals, and programming skills for prototyping interactive systems.		

Course Objectives:

1. To introduce fundamental concepts, models, and frameworks of human-computer interaction.
2. To develop user-centric thinking and design interactive systems that are usable and accessible.
3. To evaluate interactive systems using usability metrics and empirical methods.

Course Content:

[FOUNDATIONS OF HCI] (9 Hours)

Introduction to HCI and its importance - Human-centered design principles - Models of interaction: Norman's model, Abowd & Beale - Cognitive psychology foundations: perception, memory, mental models - Interaction styles: command-line, GUI, direct manipulation, virtual/augmented reality

[USER INTERFACE DESIGN] (9 Hours)

Design principles: consistency, feedback, affordance - Interface design process - Usability and user experience (UX) goals - Prototyping techniques: low-fidelity and high-fidelity - Interaction design tools (Figma, Adobe XD)

[ACCESSIBILITY AND UNIVERSAL DESIGN] (9 Hours)

Accessibility principles and standards (WCAG) - Designing for diverse users (age, ability, language) - Assistive technologies and inclusive design - Multimodal and adaptive interfaces - Case studies in accessibility (web, mobile)

[EVALUATION AND USABILITY TESTING] (9 Hours)

Evaluation techniques: heuristic, cognitive walkthrough, think-aloud - Quantitative and qualitative methods - Usability metrics and analytics - A/B testing and eye-tracking - Field studies and remote usability testing

[EMERGING TRENDS IN HCI] (9 Hours)

Affective computing and emotion-aware interfaces - Conversational agents and chatbots - Brain-computer interfaces - HCI for IoT, wearables, and ubiquitous computing - Ethical issues in HCI: privacy, bias, sustainability

Total Hours: 45

List of Experiments:

1. Map user interactions on CLI vs GUI apps (terminal vs Firefox); document gulf of execution/evaluation.
2. Use Python Tkinter to create dual-task interfaces; measure reaction time with pygame keypress logging.
3. Prototype command-line, menu-driven, direct manipulation interfaces for file manager using Python console/Tkinter.
4. Design wireframes for e-commerce app using Penpot (FOSS Figma alternative); create interactive hotspots.

5. Build clickable prototypes in Penpot with transitions/animations for mobile banking app.
6. Refactor poor interfaces (screenshot analysis) applying consistency, feedback, affordance using Python Tkinter.
7. Use WAVE (webaim.org) and Lighthouse (Chrome DevTools) to audit websites; fix violations with HTML/CSS.
8. Create accessible web forms; test with NVDA screen reader; implement ARIA labels/roles.
9. Use Python OpenCV to simulate deuteranomaly/protanomaly; redesign dashboards for 8% color vision deficiency population.
10. Apply Nielsen's 10 heuristics to evaluate 3 websites; score and prioritize issues collaboratively.
11. Record users (5 participants) on Python Tkinter app using OBS Studio; perform qualitative analysis.
12. Measure SUS scores, task completion time, error rates on A/B tested interfaces using Google Forms + Python pandas.
13. Use OpenCV + FER library for real-time facial emotion detection; create adaptive UI responses.
14. Prototype conversational agent in Python (ChatterBot); evaluate dialogue flow with conversation analysis.
15. Use PsychoPy for gaze-contingent display changes; analyze attention heatmaps on web interfaces.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain HCI foundations, human-centered design principles, cognitive models, and interaction styles, and apply them to analyze user tasks and mental models	L2	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO10, PO11
CO2	Design user interfaces using usability principles, prototyping tools, and UX goals to create low/high-fidelity prototypes for diverse applications.	L3	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO3	Implement accessibility standards, inclusive design for diverse users, and assistive technologies, evaluating interfaces for multimodal and adaptive usability.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO4	Conduct usability evaluations using heuristic analysis, cognitive walkthroughs, think-aloud protocols, and metrics	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9,

	to identify and prioritize interface issues.		PO10, PO11
CO5	Develop emerging HCI systems incorporating affective computing, conversational agents, BCI, and IoT interfaces, addressing ethical concerns like privacy and bias.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human-Computer Interaction”, 5th Edition, Pearson, 2023.
2. Don Norman, “The Design of Everyday Things”, MIT Press, 2017
3. Ben Shneiderman et al., “Designing the User Interface”, 6th Edition, Pearson, 2022
4. Jenny Preece, Yvonne Rogers, Helen Sharp, “Interaction Design: Beyond Human-Computer Interaction”, Wiley, 2023
5. Jeff Johnson, “Designing with the Mind in Mind”, Morgan Kaufmann, 2020

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	1	1	1	2	1	-	-	2	2	2	2	2	–
CO2	3	3	2	3	2	2	2	1	1	2	2	3	2	3	–
CO3	3	3	2	2	3	3	2	1	1	3	2	3	2	3	2
CO4	3	3	3	2	2	2	3	2	1	2	2	3	2	3	–
CO5	3	3	3	2	3	3	2	2	2	3	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE11	Subject Title	INTERNET OF THINGS
Category	Professional Elective	L-T-P-C	3-0-2-4
Regulation	2025	Semester	II
Prerequisites	Knowledge of embedded systems, networking fundamentals, programming skills (C/Python), and basic understanding of sensors and communication protocols.		

Course Objectives:

1. To introduce the fundamentals of IoT architecture, communication protocols, and hardware platforms.
2. To enable students to design and develop IoT-based applications using sensors, actuators, and microcontrollers.
3. To explore IoT security, cloud integration, and real-world use cases across domains.

Course Content:

[INTRODUCTION TO IOT AND ARCHITECTURE] (9 Hours)

IoT definition, characteristics, and evolution - Applications of IoT: smart home, health, agriculture, industry - IoT reference architecture (three-layer and five-layer) - IoT ecosystem and enabling technologies - Comparison of IoT with traditional embedded systems and CPS

[SENSORS, ACTUATORS, AND EMBEDDED PLATFORMS] (9 Hours)

Types of sensors and actuators - Signal conditioning and data acquisition - Microcontrollers and embedded platforms: Arduino, Raspberry Pi, ESP32 - GPIO, ADC, PWM, UART, I2C, SPI interfaces - Interfacing sensors and controlling actuators

[IOT COMMUNICATION PROTOCOLS] (9 Hours)

Communication models: device-to-device, device-to-cloud, edge-to-cloud - Protocols: MQTT, CoAP, HTTP, Bluetooth LE, ZigBee, LoRa, NB-IoT - IP addressing and 6LoWPAN - Wireless sensor networks and IoT topology - Fog and edge computing overview

[IOT DATA ANALYTICS, CLOUD, AND APPLICATIONS] (9 Hours)

Data collection, preprocessing, and storage - IoT cloud platforms: AWS IoT, Azure IoT Hub, Google IoT Core - Integration with REST APIs and Web dashboards - Real-time analytics and event handling - Case studies: smart agriculture, smart city, wearable health tech

[IOT SECURITY, STANDARDS, AND FUTURE TRENDS] (9 Hours)

Security challenges in IoT: physical, network, application layers - Lightweight encryption, authentication mechanisms - Privacy concerns and data protection - IoT standards: IEEE, IETF, oneM2M - Future directions: AIoT, blockchain in IoT, green IoT

Total Hours: 45

List of Experiments:

1. IoT Ecosystem Setup: Configure Arduino IDE + ESP32; blink LED via Serial Monitor; visualize 3/5-layer IoT architecture.
2. Sensor Data Acquisition: Interface DHT11 (temp/humidity) with Arduino; plot real-time data using Serial Plotter.
3. IoT vs Embedded Comparison: Toggle LED with button (embedded) vs WiFi remote control (IoT) using ESP8266 NodeMCU.

4. Multi-Sensor Fusion: Read analog (LDR), digital (PIR), I2C (BMP180 pressure) sensors on Raspberry Pi; GPIO control servo motor.
5. ESP32 Interfaces: UART (HC-05 Bluetooth), SPI (MFRC522 RFID), PWM (DC motor speed control) experiments.
6. Signal Conditioning: Amplify potentiometer signal via op-amp; ADC sampling on Arduino; anti-aliasing filter demo.
7. MQTT Publisher/Subscriber: ESP32 publishes sensor data to Mosquitto broker; Node-RED dashboard subscriber visualization.
8. HTTP/CoAP Server: Create REST API on ESP32; GET temperature, POST LED control using curl/Postman.
9. LoRa Communication: SX1278 LoRa modules (device-to-device); transmit sensor data 1km range (campus demo).
10. ThingSpeak Integration: ESP32 sends data to ThingSpeak; create MATLAB analytics visualization (temp trends).
11. Node-RED Dashboard: Raspberry Pi + flow editor; real-time charts, gauges for smart home monitoring.
12. Smart Agriculture Demo: Soil moisture + pump control; irrigation automation with threshold logic.
13. Lightweight Encryption: AES-128 encrypt MQTT payloads using Arduino Crypto library; decryption verification.
14. Secure Boot Simulation: ESP32 firmware signing; OTA update with HTTPS; replay attack prevention.
15. Edge AI Demo: TensorFlow Lite Micro on ESP32; gesture recognition with MPU6050 accelerometer.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain IoT fundamentals, reference architectures (3/5-layer), ecosystem components, and enabling technologies, comparing IoT with traditional embedded systems	L2	PO1, PO2, PO3, PO4, PO5, PO10, PO11
CO2	Interface sensors/actuators with embedded platforms (Arduino, ESP32, Raspberry Pi) using GPIO/ADC/PWM/I2C/SPI, implementing signal conditioning and data acquisition.	L3	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO10, PO11
CO3	Analyze and apply communication protocols (MQTT, CoAP, HTTP, LoRa, ZigBee) for device-to-device/cloud/edge networking and wireless sensor topologies.	L4	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO10, PO11
CO4	Design IoT applications with cloud platforms (AWS IoT, ThingSpeak), data analytics, REST APIs, and real-time	L5	PO1, PO2, PO3, PO4, PO5, PO6,

	dashboards for domain-specific use cases like smart agriculture.		PO7, PO8, PO9, PO10, PO11
CO5	Develop secure IoT systems addressing physical/network/application layer threats, implementing lightweight encryption, authentication, and standards (oneM2M) while considering AIoT trends.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-On Approach”, Universities Press, 2023.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, “Internet of Things: Principles and Paradigms”, Morgan Kaufmann, 2022
3. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, Wiley, 2021
4. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley, 2022
5. Pethuru Raj, Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press, 2021

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	1	2	2	–	–	–	–	1	2	2	2	2	–
CO2	3	3	1	3	2	–	–	1	1	1	2	3	2	3	–
CO3	2	3	2	3	2	–	–	1	1	1	2	3	2	3	–
CO4	2	3	2	3	3	1	1	2	2	2	2	3	2	3	2
CO5	2	3	3	2	2	3	1	2	2	2	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE12	**Subject Title**	MALWARE ANALYSIS
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	II
Prerequisites	Fundamental knowledge of computer networks, operating systems, programming skills (C/C++/Python), and basics of cybersecurity and cryptography.		

Course Objectives:

1. To understand the fundamentals, types, and propagation methods of malware.
2. To learn static and dynamic techniques for analyzing malware behavior.
3. To equip students with the tools, techniques, and ethical practices to investigate and mitigate malware threats.

Course Content:

[INTRODUCTION TO MALWARE AND THREAT LANDSCAPE] (9 Hours)

Types of malware: virus, worm, Trojan, rootkits, ransomware, spyware - Malware lifecycle and infection vectors - Advanced persistent threats (APT) - Signature-based vs. behavior-based detection - Legal, ethical, and privacy considerations in malware analysis

[STATIC MALWARE ANALYSIS TECHNIQUES] (9 Hours)

Basics of reverse engineering - Disassembly using IDA Pro, Ghidra - PE (Portable Executable) file format - Strings extraction and metadata analysis - Code obfuscation and packing techniques

[DYNAMIC MALWARE ANALYSIS TECHNIQUES] (9 Hours)

Sandboxing and behavioral analysis - Monitoring file system, registry, process, and network activity - Tools: Process Monitor, ProcDump, Wireshark, Cuckoo Sandbox - Memory forensics: Volatility framework - Anti-analysis techniques and evasion strategies

[MALWARE CLASSIFICATION] (9 Hours)

Categorizing malware based on functionality and behavior - Analyzing known malware samples - Case studies: Stuxnet, WannaCry, Mirai Botnet - Rootkit detection and analysis - Malware attribution and threat intelligence

[MALWARE DETECTION, DEFENSE, AND FUTURE TRENDS] (9 Hours)

Malware detection systems and antivirus engines - Role of machine learning in malware classification - Malware in IoT and mobile ecosystems - Cloud-based malware analysis - Emerging threats and AI-driven malware

Total Hours: 45

List of Experiments:

1. Download safe samples from VirusShare, MalwareBazaar; classify types using file, strings commands.
2. Analyze phishing email attachments (ZIP/EXE) with binwalk, exiftool; extract embedded payloads.
3. Compare ClamAV signatures vs YARA rules on benign/malicious samples.
4. Parse Portable Executable headers using pev, pestudio; analyze sections, imports, resources.
5. Use strings, floss for obfuscated strings; analyze timestamps, compiler artifacts.

6. Disassemble EXE samples; identify main functions, API calls, control flow graphs.
7. Sandbox Execution Monitoring: Run samples in Cuckoo Sandbox; analyze behavioral reports (file/registry/network activity).
8. Use procmon (Sysinternals), Wireshark for API monitoring, DNS/C2 communication capture.
9. Dump processes from VM memory; detect injected code, hidden modules.
10. Write custom YARA signatures for ransomware (file encryption patterns), Trojans (C2 domains).
11. Analyze LKMs with lsmod, volatility rootkit plugins; detect DKOM techniques.
12. Dissect WannaCry (EternalBlue exploit), Mirai botnet binaries using static/dynamic tools.
13. Train RandomForest on EMBER dataset features using scikit-learn; predict PE malware.
14. Reverse engineer Mirai variants for ARM/MIPS using Ghidra; telnet brute-force simulation.
15. Analyze VM/sandbox detection (redpill, timing attacks); debugger evasion techniques.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain malware types, lifecycle, infection vectors, APTs, and detection approaches, considering ethical/legal aspects.	L2	PO1, PO2, PO3, PO4, PO6, PO7, PO8, PO10, PO11
CO2	Perform static analysis on PE files using tools to extract metadata, detect obfuscation/packing, and identify API calls/strings.	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO10, PO11
CO3	Conduct dynamic malware analysis in sandboxes to monitor file/registry/network behavior and counter anti-analysis evasion techniques	L3	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO10, PO11
CO4	Classify malware functionality through case studies, rootkit detection, and attribution using behavioral patterns and threat intelligence.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11
CO5	Develop malware detection systems using ML classifiers, custom YARA rules, and defenses against IoT/mobile threats and AI-driven malware.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Michael Sikorski, Andrew Honig, "Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software", No Starch Press, 2023.

2. Monnappa K A, "Learning Malware Analysis: Explore the Concepts, Tools, and Techniques to Analyze and Investigate Windows Malware", 2nd Edition, Packt, 2023.

3. Alexey Kleymenov, "Mastering Malware Analysis: Investigate, Analyze, and Respond to

Malicious Software Attacks Like Never Before", Packt, 2022.

4. Eoghan Casey, "Handbook of Digital Forensics and Investigation", Elsevier, 2020.
5. Jared Carstensen et al., "Cybersecurity and Cyberwarfare: Malware Analysis", Springer, 2021

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	1	1	–	3	2	1	–	2	2	2	2	2	–
CO2	2	3	2	3	1	1	1	–	–	1	2	3	2	3	–
CO3	2	3	2	3	1	1	1	1	–	1	2	3	2	3	–
CO4	3	3	2	2	1	2	2	1	1	2	2	3	2	3	–
CO5	2	3	3	3	2	3	2	2	2	3	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

PROFESSIONAL ELECTIVE - IV

Subject Code	25CSPE13	**Subject Title**	DEEP LEARNING AND GENERATIVE AI
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of machine learning, linear algebra, probability, and Python programming.		

Course Objectives:

1. To understand the theoretical foundations and architectures of deep learning models for intelligent systems.
2. To analyze and apply deep learning algorithms for solving real-world problems in computer vision, NLP, and data analytics.
3. To design and develop generative AI models for creating intelligent applications in various domains.

Course Content:

[INTRODUCTION TO DEEP LEARNING] (9 Hours)

Introduction to Artificial Intelligence and Machine Learning – Neural networks fundamentals – Perceptron and Multilayer Perceptron – Activation functions – Gradient descent and backpropagation – Optimization techniques – Regularization techniques – Introduction to deep learning frameworks.

[DEEP NEURAL NETWORK ARCHITECTURES] (9 Hours)

Deep neural networks and training challenges – Convolutional Neural Networks (CNN): architecture, convolution, pooling – Image classification using CNN – Recurrent Neural Networks (RNN) – Long Short-Term Memory (LSTM) and GRU – Sequence modeling and time-series analysis.

[ADVANCED DEEP LEARNING MODELS] (9 Hours)

Transfer learning and fine-tuning – Attention mechanisms – Transformers architecture – Natural Language Processing with deep learning – BERT and GPT architectures – Applications in text classification, sentiment analysis, and machine translation.

[GENERATIVE AI MODELS] (9 Hours)

Introduction to generative models – Variational Autoencoders (VAE) – Generative Adversarial Networks (GAN) – Diffusion models – Prompt engineering – Large Language Models (LLMs) – Generative AI applications in image synthesis, text generation, and creative AI.

[APPLICATIONS, ETHICS AND FUTURE TRENDS] (9 Hours)

Applications of deep learning and generative AI in healthcare, finance, autonomous systems, and smart cities – Model evaluation and performance metrics – Explainable AI – Ethical issues in AI – Bias and fairness – Responsible AI – Future trends in generative AI and intelligent systems.

Total Hours: 45

List of Experiments:

1. Implementation of Perceptron algorithm using Python and NumPy.
2. Training a Multilayer Perceptron using TensorFlow/Keras.
3. Implementation of activation functions and gradient descent optimization.
4. Image classification using Convolutional Neural Networks (CNN) on MNIST dataset.
5. Experiment with data augmentation techniques for improving model performance.
6. Implementation of transfer learning using pre-trained VGG16 or ResNet models.
7. Sentiment analysis using Recurrent Neural Networks (RNN).
8. Text generation using LSTM networks.
9. Implementing attention mechanism in sequence models.
10. Fine-tuning BERT model for text classification using Hugging Face Transformers.
11. Implementation of Variational Autoencoder (VAE) for image generation.
12. Training a Generative Adversarial Network (GAN) for synthetic image generation.
13. Image synthesis using Stable Diffusion or Diffusers library.
14. Prompt engineering experiments with Open-source LLMs (LLaMA, GPT-Neo).
15. Model evaluation and visualization using TensorBoard and SHAP for explainability.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the fundamental concepts of neural networks, deep learning architectures, and optimization techniques.	L2	PO1, PO2, PO11
CO2	Apply deep learning algorithms such as CNNs and RNNs to solve problems in image processing and sequence modeling.	L3	PO1, PO2, PO4, PO11
CO3	Analyze advanced deep learning models including transformers and attention mechanisms for NLP applications.	L4	PO1, PO2, PO3, PO4, PO11
CO4	Evaluate generative AI models such as GANs, VAEs, and diffusion models for intelligent content generation.	L5	PO1, PO2, PO3, PO4, PO9, PO11
CO5	Design and develop generative AI applications addressing real-world problems with ethical and responsible AI practices.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.

2. Francois Chollet, Deep Learning with Python, Manning Publications, 2nd Edition, 2018.

3. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly, 3rd Edition, 2022.

4. Jay Alammar and Maarten Grootendorst, Hands-On Large Language Models, O'Reilly, 2024 Edition.

5. Tom Hope, Itay Lieder, and others, Learning Generative AI with Python and PyTorch, Packt Publishing, 2017.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	–	–	–	–	–	–	–	–	1	2	2	3	–
CO2	2	3	–	3	–	–	–	–	–	–	1	3	2	3	–
CO3	2	3	2	2	–	–	–	–	–	–	1	3	2	3	–
CO4	2	2	3	2	–	–	–	–	1	–	1	3	2	3	–
CO5	2	3	3	2	2	2	1	1	2	2	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE14	**Subject Title**	VIRTUAL REALITY AND AUGMENTED REALITY
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of computer graphics, programming (C#/Python), and human–computer interaction.		

Course Objectives:

1. To understand the concepts, architecture, and technologies used in Virtual Reality (VR) and Augmented Reality (AR) systems.
2. To analyze interaction techniques, tracking systems, and visualization methods used in immersive environments.
3. To design and develop VR and AR applications using modern tools and open-source frameworks.

Course Content:

[INTRODUCTION TO VR AND AR] (9 Hours)

Introduction to Virtual Reality – History and evolution of VR – Characteristics of immersive environments – Types of VR systems – Augmented Reality and Mixed Reality concepts – VR vs AR vs MR – Components of VR systems – Applications in gaming, education, healthcare, and industry.

[VR HARDWARE AND INTERACTION TECHNIQUES] (9 Hours)

VR hardware components – Head Mounted Displays (HMDs) – Motion tracking sensors – Input devices and controllers – Haptic feedback systems – Gesture recognition – Interaction techniques in virtual environments – Navigation and manipulation in VR.

[COMPUTER GRAPHICS AND 3D MODELING FOR VR/AR] (9 Hours)

3D modeling fundamentals – Coordinate systems and transformations – Rendering techniques – Scene graph structures – Lighting and shading models – Real-time rendering – Game engines for VR/AR development – Introduction to Unity and Unreal Engine.

[AUGMENTED REALITY TECHNOLOGIES] (9 Hours)

AR architecture – Marker-based and markerless AR – Camera calibration and pose estimation – Feature detection and tracking – Simultaneous Localization and Mapping (SLAM) – AR frameworks (ARCore, ARKit, Vuforia) – Mobile AR applications.

[VR/AR APPLICATIONS AND FUTURE TRENDS] (9 Hours)

Applications of VR and AR in healthcare, training, education, smart cities, and entertainment – Collaborative virtual environments – Industrial simulation and digital twins – Ethical issues and privacy concerns – Metaverse and immersive computing – Future trends in XR technologies.

Total Hours: 45

List of Experiments:

1. Installation and setup of Unity 3D environment for VR development.
2. Creating a basic 3D scene and navigation environment in Unity.
3. Implementing camera movement and interaction controls in VR environment.
4. Developing a simple VR environment using Unity XR toolkit.
5. Creating 3D objects and animations using Blender for VR scenes.
6. Implementing collision detection and physics in VR applications.
7. Marker-based AR application using Vuforia SDK.
8. Developing mobile AR applications using ARCore or ARKit.
9. Implementing gesture-based interaction in VR environment.
10. Camera calibration and feature tracking using OpenCV.
11. Creating an AR object overlay on real-world images.
12. Developing interactive VR training simulation.
13. Implementing SLAM-based AR navigation demo.
14. Developing multi-user collaborative VR environment.
15. Performance evaluation and usability testing of VR/AR applications.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the fundamental concepts, components, and architectures of Virtual Reality and Augmented Reality systems.	L2	PO1, PO2, PO11
CO2	Apply VR hardware, sensors, and interaction techniques to develop immersive environments.	L3	PO1, PO2, PO4, PO11
CO3	Analyze computer graphics techniques and 3D modeling approaches used in VR/AR applications.	L4	PO1, PO2, PO3, PO4, PO11
CO4	Evaluate AR technologies including tracking, SLAM, and mobile AR frameworks for real-world applications.	L5	PO1, PO2, PO3, PO4, PO11
CO5	Design and develop VR/AR applications for domains such as education, healthcare, and industrial simulation.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Steven M. LaValle, Virtual Reality, Cambridge University Press, 2023.
2. Dieter Schmalstieg and Tobias Hollerer, Augmented Reality: Principles and Practice, Addison-Wesley, 2016.
3. Tony Parisi, Learning Virtual Reality, O'Reilly Media, 2015.
4. Jonathan Linowes, Augmented Reality for Developers, Packt Publishing, 2017.
5. Alan B. Craig, Understanding Augmented Reality: Concepts and Applications, Morgan Kaufmann, 2013.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2	–	–	–	–	–	–	–	–	1	2	2	2	–
CO2	2	3	–	3	–	–	–	–	–	–	1	3	2	3	–
CO3	2	3	2	2	–	–	–	–	–	–	1	3	2	3	–
CO4	2	2	3	2	–	–	–	–	–	–	1	3	2	3	–
CO5	2	3	3	2	2	2	1	1	2	2	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE15	**Subject Title**	EDGE AND FOG COMPUTING NETWORKS
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of computer networks, cloud computing, distributed systems, and programming.		

Course Objectives:

1. To understand the architecture, principles, and technologies of edge and fog computing in distributed environments.
2. To analyze resource management, networking, and service deployment techniques in edge–fog infrastructures.
3. To design and implement edge computing applications for IoT and real-time data processing systems.

Course Content:

[INTRODUCTION TO EDGE AND FOG COMPUTING] (9 Hours)

Evolution of distributed computing – Limitations of cloud computing – Edge computing concepts – Fog computing architecture – Edge vs Fog vs Cloud computing – Characteristics and benefits – Edge computing reference models – Applications in IoT, smart cities, healthcare, and industrial automation.

[EDGE COMPUTING ARCHITECTURE AND NETWORKING] (9 Hours)

Edge node architecture – Micro data centers – Virtualization and containerization at the edge – Edge networking protocols – Software-defined networking (SDN) in edge environments – Network function virtualization (NFV) – Edge service orchestration.

[RESOURCE MANAGEMENT AND TASK OFFLOADING] (9 Hours)

Resource allocation strategies – Task scheduling and load balancing – Computation offloading techniques – Latency-aware computing – Energy-efficient edge computing – QoS-aware service provisioning – Edge caching and content delivery.

[SECURITY AND PRIVACY IN EDGE AND FOG COMPUTING] (9 Hours)

Security challenges in edge computing – Authentication and access control – Secure data transmission – Privacy preservation techniques – Blockchain for edge security – Intrusion detection systems – Trust management in distributed edge environments.

[EDGE AI AND APPLICATIONS] (9 Hours)

Edge intelligence and AI at the edge – Machine learning models for edge devices – Edge analytics and real-time processing – Applications in smart transportation, healthcare monitoring, autonomous systems – Digital twins and Industry 4.0 – Future trends in edge and fog computing.

Total Hours: 45

List of Experiments:

1. Installation and configuration of Edge computing simulation environment using iFogSim.
2. Simulation of fog computing architecture using CloudSim/iFogSim.
3. Implementation of task offloading between edge devices and cloud servers.
4. Performance evaluation of latency and bandwidth in edge vs cloud processing.
5. Deploying Docker containers on edge nodes for microservices.
6. Implementing load balancing algorithms in edge environments.
7. Simulation of IoT data processing using edge computing frameworks.
8. Edge data analytics using Python and Apache Kafka.
9. Implementation of edge-based video processing application using OpenCV.
10. Deploying machine learning inference on edge devices using TensorFlow Lite.
11. Implementing secure communication between edge devices using TLS.
12. Blockchain-based secure data sharing in edge computing.
13. Resource allocation experiment using Kubernetes edge clusters.
14. Simulation of energy-efficient task scheduling in fog computing.
15. Development of a smart city edge computing prototype application.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the principles, architectures, and technologies of edge and fog computing networks.	L2	PO1, PO2, PO11
CO2	Apply networking and virtualization techniques to design edge computing infrastructures.	L3	PO1, PO2, PO4, PO11
CO3	Analyze resource management, computation offloading, and QoS provisioning in distributed edge systems.	L4	PO1, PO2, PO3, PO4, PO11
CO4	Evaluate security, privacy, and trust management mechanisms in edge and fog computing environments.	L5	PO1, PO2, PO3, PO4, PO11
CO5	Design and develop intelligent edge computing applications for IoT and real-time analytics.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Rajkumar Buyya, Satish Narayana Srirama, Fog and Edge Computing: Principles and Paradigms, Wiley, 2019.
2. Weisong Shi, Jie Cao, Edge Computing: Vision and Challenges, IEEE Press, 2016.
3. Pethuru Raj and Anupama Raman, Fog Computing: Concepts, Frameworks and Applications, CRC Press, 2018.
4. Flavio Bonomi et al., Fog Computing and Its Role in the Internet of Things, Elsevier, 2012.
5. Shahid Mumtaz, Edge Computing for IoT Applications, Academic Press, 2022.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	–	–	–	–	–	–	–	–	1	2	2	2	–
CO2	2	3	–	3	–	–	–	–	–	–	1	3	2	3	–
CO3	2	3	2	2	–	–	–	–	–	–	1	3	2	3	–
CO4	2	2	3	2	–	3	–	–	–	–	1	3	2	3	–
CO5	2	3	3	2	2	2	1	1	2	2	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE16	**Subject Title**	BIOMETRICS
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of pattern recognition, machine learning, digital image processing, and statistics.		

Course Objectives:

1. To understand the principles, characteristics, and modalities of biometric systems used for human identification and authentication.
2. To analyze biometric feature extraction, matching techniques, and performance evaluation methods.
3. To design secure biometric authentication systems addressing privacy, security, and real-world deployment challenges.

Course Content:

[INTRODUCTION TO BIOMETRIC SYSTEMS] (9 Hours)

Biometrics fundamentals – Need for biometric authentication – Characteristics of biometrics – Verification vs identification – Biometric system architecture – Enrollment and authentication process – Performance metrics: FAR, FRR, EER – Applications in security, banking, border control, and healthcare.

[PHYSIOLOGICAL BIOMETRIC MODALITIES] (9 Hours)

Fingerprint recognition – Minutiae extraction and matching – Face recognition techniques – Iris recognition systems – Retina recognition – Hand geometry – Palmprint recognition – Advantages and limitations of physiological biometrics.

[BEHAVIORAL BIOMETRICS] (9 Hours)

Behavioral biometric traits – Signature recognition – Keystroke dynamics – Voice recognition – Gait recognition – Data acquisition and preprocessing – Feature extraction techniques – Pattern classification approaches.

[BIOMETRIC SYSTEM DESIGN AND SECURITY] (9 Hours)

Multimodal biometric systems – Fusion techniques: sensor level, feature level, score level, decision level – Spoofing attacks and countermeasures – Template security – Cryptographic techniques in biometrics – Privacy preservation in biometric systems.

[BIOMETRIC APPLICATIONS AND FUTURE TRENDS] (9 Hours)

Biometrics in mobile authentication – Biometric systems in IoT and smart environments – Deep learning for biometrics – Biometric databases and evaluation standards – Ethical, legal, and social implications – Emerging biometric technologies.

Total Hours: 45

List of Experiments:

1. Implementation of fingerprint image enhancement using OpenCV.
2. Fingerprint minutiae extraction and matching algorithm using Python.
3. Face detection using Haar cascade classifier in OpenCV.
4. Face recognition using Eigenfaces and Fisherfaces algorithms.
5. Iris segmentation and feature extraction using Python image processing libraries.
6. Voice recognition experiment using MFCC feature extraction with Python Librosa.
7. Signature verification using machine learning classification algorithms.
8. Implementation of keystroke dynamics authentication system.
9. Gait recognition using video processing techniques.
10. Multimodal biometric fusion using face and fingerprint datasets.
11. Implementation of biometric template protection techniques.
12. Evaluation of biometric system performance using FAR, FRR, and EER metrics.
13. Deep learning-based face recognition using TensorFlow or PyTorch.
14. Implementation of liveness detection for biometric spoof prevention.
15. Development of a biometric authentication prototype application.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the concepts, architecture, and performance metrics of biometric systems.	L2	PO1, PO2, PO11
CO2	Apply feature extraction and pattern recognition techniques for biometric identification systems.	L4	PO1, PO2, PO4, PO11
CO3	Analyze physiological and behavioral biometric modalities for authentication applications.	L3	PO1, PO2, PO3, PO4, PO11
CO4	Evaluate security challenges, spoofing attacks, and privacy mechanisms in biometric systems.	L5	PO1, PO2, PO3, PO4, PO11
CO5	Design and develop intelligent biometric authentication systems using modern machine learning techniques.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Anil K. Jain, Arun Ross, Karthik Nandakumar, Introduction to Biometrics, Springer, 2016.
2. John D. Woodward, Nicholas M. Orlans, Peter T. Higgins, Biometrics: Identity Assurance in the Information Age, McGraw Hill, 2003.
3. David Zhang, Biometric Solutions for Authentication in an e-World, Springer, 2012.
4. Nalini K. Ratha and Ruud M. Bolle, Automatic Fingerprint Recognition Systems, Springer, 2003.
5. Stan Z. Li and Anil K. Jain, Handbook of Face Recognition, Springer, 2011.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	–	–	–	–	–	–	–	–	1	2	2	2	–
CO2	2	3	–	3	–	–	–	–	–	–	1	3	2	3	–
CO3	2	3	2	2	–	–	–	–	–	–	1	3	2	3	–
CO4	2	2	3	2	–	3	–	–	–	–	1	3	2	3	–
CO5	2	3	3	2	2	2	1	1	2	2	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

PROFESSIONAL ELECTIVE - V

Subject Code	25CSPE17	**Subject Title**	MULTI-MODAL ARTIFICIAL INTELLIGENCE
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of Machine Learning, Deep Learning and Python programming.		

Course Objectives:

1. To understand the fundamentals of multimodal data representation and fusion techniques.
2. To analyze multimodal learning models used in vision, language, and audio processing.
3. To design intelligent multimodal AI systems for real-world applications.

Course Content:

[FUNDAMENTALS OF MULTIMODAL ARTIFICIAL INTELLIGENCE] (9 Hours)

Introduction to Multimodal AI – Types of data modalities (text, image, audio, video) – Multimodal learning challenges – Data representation techniques – Feature extraction methods – Multimodal datasets – Cross-modal learning – Multimodal architectures – Applications of multimodal AI.

[DEEP LEARNING FOR MULTIMODAL DATA] (9 Hours)

Deep neural networks for multimodal processing – CNN for image features – RNN and LSTM for sequential data – Transformer architectures – Embedding techniques – Attention mechanisms – Multimodal representation learning – Pre-trained multimodal models.

[MULTIMODAL FUSION TECHNIQUES] (9 Hours)

Early fusion – Late fusion – Hybrid fusion methods – Feature level fusion – Decision level fusion – Cross-modal retrieval – Multimodal embedding spaces – Multimodal transformers – Performance evaluation metrics.

[APPLICATIONS OF MULTIMODAL AI] (9 Hours)

Image captioning – Visual question answering – Speech recognition – Multimodal sentiment analysis – Video understanding – Human-computer interaction – Autonomous systems – Multimodal recommendation systems – AI assistants.

[ADVANCED TOPICS AND RESEARCH TRENDS] (9 Hours)

Generative multimodal models – Diffusion models – Multimodal Large Language Models – Multimodal conversational agents – Ethical issues in multimodal AI – Bias and fairness – AI explainability – Future trends and case studies.

Total Hours: 45

List of Experiments:

1. Dataset exploration of multimodal datasets (image, text, audio).
2. Feature extraction from images using CNN.

3. Text feature extraction using word embeddings.
4. Audio signal processing using Librosa.
5. Implement multimodal data preprocessing pipeline.
6. Implement image captioning model using deep learning.
7. Visual question answering using pretrained models.
8. Multimodal sentiment analysis combining text and images.
9. Implement cross-modal retrieval system.
10. Multimodal fusion using early fusion technique.
11. Multimodal fusion using late fusion technique.
12. Implement transformer-based multimodal model.
13. Develop a multimodal recommendation system.
14. Implement multimodal chatbot using LLM APIs.
15. Evaluate multimodal model performance using standard metrics.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the concepts, architectures and challenges of multimodal artificial intelligence.	L2	PO1, PO2, PO11
CO2	Analyze multimodal learning models and data fusion techniques.	L3	PO1, PO3, PO4
CO3	Apply multimodal AI algorithms for vision, speech and language applications.	L4	PO2, PO4, PO5
CO4	Evaluate the performance of multimodal AI models using appropriate metrics and tools.	L5	PO3, PO6, PO10
CO5	Design and develop innovative multimodal AI solutions for real-world problems.	L6	PO4, PO8, PO9

Reference Books:

1. Jiebo Luo, Multimedia Data Mining and Analytics, Springer, 2023.
2. Yaser Sheikh, Bernt Schiele, Computer Vision and Multimodal Learning, Springer, 2022.
3. Li Fei-Fei, Justin Johnson, Deep Learning for Vision Systems, O'Reilly, 2022.
4. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 3rd Edition, O'Reilly, 2022.
5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	1	–	–	–	–	–	–	–	–	1	2	2	2	–
CO2	2	3	2	1	–	–	–	–	–	–	1	3	2	3	–
CO3	1	2	1	3	2	–	–	–	–	–	1	3	2	3	–
CO4	1	1	3	2	1	1	–	–	–	2	1	3	2	3	–
CO5	2	2	2	2	2	1	1	3	3	1	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE18	**Subject Title**	DATA ETHICS, PRIVACY, AND GOVERNANCE
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of data management, information security and legal aspects of computing.		

Course Objectives:

1. To understand ethical principles, privacy concepts and governance frameworks related to data management.
2. To analyze privacy-preserving techniques, regulatory policies and compliance standards.
3. To design responsible and ethical data-driven systems ensuring security, fairness and accountability.

Course Content:

[FOUNDATIONS OF DATA ETHICS] (9 Hours)

Introduction to data ethics – Ethical theories and principles – Responsible data usage – Bias and fairness in data – Algorithmic bias – Ethical decision-making models – Transparency and accountability – Ethical challenges in AI and big data – Case studies in data ethics.

[DATA PRIVACY CONCEPTS] (9 Hours)

Introduction to data privacy – Personal and sensitive data – Privacy threats and risks – Data anonymization and pseudonymization – Privacy models (k-anonymity, l-diversity, t-closeness) – Differential privacy – Privacy preserving data mining – Privacy challenges in cloud and big data.

[DATA GOVERNANCE FRAMEWORKS] (9 Hours)

Data governance principles – Data lifecycle management – Data quality management – Data stewardship and ownership – Metadata management – Data governance frameworks and models – Role of organizations in governance – Enterprise data governance tools.

[LEGAL AND REGULATORY COMPLIANCE] (9 Hours)

Data protection laws and regulations – GDPR – Data protection laws in India – Digital Personal Data Protection Act – HIPAA and international regulations – Compliance management – Data breach management – Risk assessment and mitigation.

[ETHICAL AI AND RESPONSIBLE DATA SYSTEMS] (9 Hours)

Responsible AI principles – Ethical AI frameworks – Explainable AI – Transparency in machine learning models – Fairness in automated decision systems – AI governance – Societal impact of data-driven systems – Future challenges in data governance.

Total Hours: 45

List of Experiments:

1. Study of data ethics case studies using open datasets.
2. Implement data anonymization techniques.
3. Implement pseudonymization techniques.
4. Perform k-anonymity using ARX tool.
5. Implement l-diversity privacy model.
6. Implement differential privacy using Python libraries.
7. Bias detection in datasets using AI Fairness 360.
8. Fairness evaluation of machine learning models.
9. Data quality assessment techniques.
10. Data governance workflow design using open-source tools.
11. Privacy-preserving data mining implementation.
12. Risk assessment for data governance frameworks.
13. Implement explainable AI techniques using SHAP or LIME.
14. Ethical impact analysis of AI decision systems.
15. Develop a privacy-aware data processing pipeline.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the principles of data ethics, privacy concepts and governance frameworks.	L2	PO1, PO6, PO11
CO2	Analyze ethical issues, privacy risks and regulatory compliance in data-driven systems.	L3	PO2, PO6
CO3	Apply privacy-preserving techniques and governance mechanisms in data processing systems.	L4	PO2, PO5, PO10
CO4	Evaluate ethical implications and regulatory requirements in AI and data analytics applications.	L5	PO3, PO6, PO10
CO5	Design responsible and secure data governance frameworks for real-world applications.	L6	PO7, PO8, PO9

Reference Books:

1. Bart Custers, Alan M. Sears, Data Protection and Privacy: The Internet of Bodies, Hart Publishing, 2023.
2. Solon Barocas, Moritz Hardt, Arvind Narayanan, Fairness and Machine Learning, MIT Press, 2023.
3. Kirsten Martin, Ethical Data and Information Management, Springer, 2022.
4. Nataraj Venkataramanan, Data Governance and Data Management, Springer, 2022.
5. Julia Lane et al., Privacy, Big Data and the Public Good, Cambridge University Press, 2014.

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	1	–	–	–	1	–	–	–	1	1	1	2	1	1
CO2	2	3	1	1	–	2	–	–	–	3	1	1	2	1	1
CO3	1	2	1	3	2	2	–	–	–	2	1	2	2	2	1
CO4	1	1	3	2	1	3	–	–	–	3	1	2	2	2	1
CO5	2	2	2	2	2	3	1	3	2	2	2	2	2	2	1
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval
Date:

Subject Code	25CSPE19	**Subject Title**	QUANTUM COMPUTING
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of linear algebra, probability theory and classical computing concepts.		

Course Objectives:

1. To introduce the principles of quantum mechanics and quantum computation models.
2. To analyze quantum algorithms, quantum gates, and quantum circuit design techniques.
3. To develop and evaluate quantum computing applications using modern quantum programming frameworks.

Course Content:

[FUNDAMENTALS OF QUANTUM COMPUTING] (9 Hours)

Introduction to quantum computing – Limitations of classical computing – Quantum mechanics concepts: superposition, entanglement, measurement – Qubits and quantum states – Bloch sphere representation – Quantum parallelism – Postulates of quantum mechanics – Quantum information basics.

[QUANTUM GATES AND QUANTUM CIRCUITS] (9 Hours)

Quantum logic gates – Single qubit gates (Pauli gates, Hadamard gate, Phase gate) – Multi-qubit gates (CNOT, Toffoli gate) – Quantum circuits – Quantum gate universality – Circuit representation – Quantum teleportation – Quantum entanglement circuits.

[QUANTUM ALGORITHMS] (9 Hours)

Quantum algorithm fundamentals – Deutsch and Deutsch–Jozsa algorithms – Simon's algorithm – Grover's search algorithm – Shor's factoring algorithm – Quantum speedup – Complexity of quantum algorithms – Applications of quantum algorithms.

[QUANTUM ERROR CORRECTION AND QUANTUM COMMUNICATION] (9 Hours)

Sources of quantum noise – Quantum error correction principles – Shor code and Steane code – Quantum cryptography – Quantum key distribution (BB84 protocol) – Quantum communication networks – Security aspects of quantum systems.

[QUANTUM PROGRAMMING AND APPLICATIONS] (9 Hours)

Quantum programming frameworks – Qiskit and Cirq – Quantum circuit simulation – Hybrid quantum-classical computing – Variational quantum algorithms – Quantum machine learning – Applications in cryptography, optimization, and chemistry – Future trends in quantum computing.

Total Hours: 45

List of Experiments:

1. Installation and setup of Qiskit environment.
2. Creating and visualizing a single qubit quantum circuit.
3. Implementing Pauli and Hadamard gates using Qiskit.
4. Bloch sphere visualization of qubit states.
5. Implementing multi-qubit circuits with CNOT gate.
6. Simulation of entanglement using Bell states.
7. Implementation of Deutsch algorithm.
8. Implementation of Deutsch-Jozsa algorithm.
9. Implementation of Grover's search algorithm.
10. Simulation of Shor's algorithm using Qiskit.
11. Quantum teleportation experiment.
12. Quantum key distribution using BB84 protocol simulation.
13. Quantum error correction using Shor code.
14. Variational Quantum Eigensolver implementation.
15. Hybrid quantum-classical optimization experiment.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand the principles of quantum mechanics and quantum information used in quantum computing systems.	L2	PO1, PO2, PO11
CO2	Analyze quantum circuits, quantum gates, and computational models used in quantum algorithms.	L3	PO1, PO2
CO3	Apply quantum algorithms and programming frameworks to solve computational problems.	L4	PO2, PO3, PO4
CO4	Evaluate quantum error correction methods and secure communication protocols in quantum systems.	L5	PO3, PO5
CO5	Design quantum computing applications and hybrid quantum-classical solutions for complex problems.	L6	PO4, PO8, PO9

Reference Books:

1. Michael A. Nielsen, Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2010.
2. Jack D. Hidary, Quantum Computing: An Applied Approach, Springer, 2021.
3. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2020.
4. Eleanor Rieffel, Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2011.
5. S. Yanofsky and M. Mannucci, Quantum Computing for Computer Scientists, Cambridge University Press, 2012.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	1	–	–	–	–	–	–	–	–	1	2	2	2	–
CO2	2	3	1	1	–	–	–	–	–	–	1	3	2	3	–
CO3	1	2	1	3	1	–	–	–	–	–	1	3	2	3	–
CO4	1	1	3	2	1	–	–	–	–	3	1	3	2	3	–
CO5	2	2	2	2	2	–	1	3	3	1	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSPE20	**Subject Title**	BLOCKCHAIN TECHNOLOGY AND APPLICATIONS
Category	Professional Elective	**L-T-P-C**	3-0-2-4
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of computer networks, cryptography, and distributed systems.		

Course Objectives:

1. To understand the principles, architecture, and cryptographic foundations of blockchain technology.
2. To analyze blockchain platforms, consensus mechanisms, and smart contract development.
3. To design blockchain-based applications for secure decentralized systems.

Course Content:

[FUNDAMENTALS OF BLOCKCHAIN] (9 Hours)

Introduction to blockchain – Distributed ledger technology – Evolution of blockchain – Structure of blocks – Hash functions and Merkle trees – Public vs private blockchain – Blockchain architecture – Cryptocurrency fundamentals – Bitcoin blockchain overview.

[CRYPTOGRAPHY AND CONSENSUS MECHANISMS] (9 Hours)

Cryptographic primitives – Digital signatures – Public key cryptography – Hashing algorithms – Proof of Work (PoW) – Proof of Stake (PoS) – Delegated PoS – Practical Byzantine Fault Tolerance (PBFT) – Consensus protocols and security challenges.

[SMART CONTRACTS AND BLOCKCHAIN PLATFORMS] (9 Hours)

Smart contracts fundamentals – Ethereum architecture – Solidity programming language – Smart contract lifecycle – Hyperledger Fabric architecture – Chaincode – Decentralized applications (DApps) – Blockchain APIs and development tools.

[BLOCKCHAIN SECURITY AND PRIVACY] (9 Hours)

Blockchain security threats – Double spending attack – 51% attack – Smart contract vulnerabilities – Privacy preserving techniques – Zero knowledge proofs – Secure blockchain design – Regulatory and legal considerations.

[BLOCKCHAIN APPLICATIONS AND FUTURE TRENDS] (9 Hours)

Blockchain applications in finance, healthcare, supply chain, and IoT – Cryptocurrency systems – Decentralized finance (DeFi) – Non-Fungible Tokens (NFTs) – Blockchain for digital identity – Blockchain interoperability – Emerging research trends and future challenges.

Total Hours: 45

List of Experiments:

1. Installation and setup of Ethereum blockchain environment using Ganache.
2. Creating cryptocurrency wallet using MetaMask.
3. Understanding blockchain transactions using Ethereum test network.
4. Writing simple smart contracts using Solidity.
5. Deploying smart contracts using Remix IDE.
6. Testing smart contracts using Truffle framework.
7. Implementing token creation using ERC20 standard.
8. Implementing decentralized voting system using smart contracts.
9. Creating decentralized application (DApp) using Web3.js.
10. Exploring blockchain data using blockchain explorers.
11. Setting up private blockchain network using Hyperledger Fabric.
12. Writing chaincode for Hyperledger Fabric applications.
13. Implementing supply chain tracking using blockchain.
14. Security analysis of smart contracts using static analysis tools.
15. Developing decentralized identity management system prototype.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Understand blockchain architecture, cryptographic concepts, and distributed ledger technologies.	L2	PO1, PO2, PO11
CO2	Analyze consensus mechanisms, blockchain structures, and decentralized network models.	L4	PO1, PO2, PO3
CO3	Apply smart contract programming and blockchain development tools to build decentralized applications.	L3	PO2, PO4, PO5
CO4	Evaluate blockchain security, privacy mechanisms, and legal implications in real-world systems.	L5	PO3, PO6, PO10
CO5	Design innovative blockchain-based solutions for decentralized applications across various domains.	L6	PO4, PO8, PO9

Reference Books:

1. Imran Bashir, Mastering Blockchain, Packt Publishing, 2019.
2. Andreas M. Antonopoulos, Mastering Bitcoin, O'Reilly Media, 2023.
3. Arvind Narayanan et al., Bitcoin and Cryptocurrency Technologies, Princeton University Press, 2016.
4. Daniel Drescher, Blockchain Basics, Apress, 2017.
5. Joseph Bonneau et al., SoK: Research Perspectives and Challenges for Bitcoin and Cryptocurrencies, IEEE Publications. 2015.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	1	–	–	–	–	–	–	–	–	1	2	2	2	–
CO2	2	3	1	1	–	–	–	–	–	–	1	3	2	3	–
CO3	1	2	1	3	1	–	–	–	–	–	1	3	2	3	–
CO4	1	1	3	2	1	1	–	–	–	3	1	3	2	3	–
CO5	2	2	2	2	2	–	1	3	3	1	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

AUDIT COURSE

Subject Code	25ZAC001	**Subject Title**	DISASTER MANAGEMENT
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites	Basic awareness of current affairs and environmental issues		

Course Objectives:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humani multiple perspectives tarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

Course Content:

[INTRODUCTION TO DISASTER] (6 Hours)

Concepts of Hazard, Vulnerability, Risks, Natural Disasters (earthquake, Cyclone, Floods, Volcanoes), an d Man Made Disaster (Armed conflicts and civil strip, Technological disasters, Human Settlement, Slow Disasters (famine, draught, epidemics) and Rapid Onset Disasters(Air Crash, tidal waves, Tsunami) Risks, Difference between Accidents and Disasters, Simple and Complex Disasters, Refugee problems, Political, Social, Economic impacts of Disasters, Gender and Social issues during disasters, principles of psychosocial issues and recovery during emergency situations, Equity issues in disasters, Relationship between Disasters and Development and vulnerabilities, different stake holders in Disaster Relief. Refugee operations during disasters, Human Resettlement and Rehabilitation issues during and after disasters, Inter-sectoral coordination during

disasters, Mode ls in Disasters.

[APPROACHES TO DISASTER RISK REDUCTION] (6 Hours)

Disaster Risk Reduction Strategies, Disaster Cycle, Phases of Disaster, Preparedness Plans, Action Plans and Procedures, Early warning Systems Models in disaster preparedness, Components of Disaster Relief(Water, food, sanitation, shelter, Health and Waste Management), Community based DRR, Structural nonstructural measures in DRR, Factors affecting Vulnerabilities, Mainstreaming disaster risk reduction in development, Undertaking risk and vulnerability assessments

[DISASTER PREPAREDNESS](6 Hours)

Policies for Disaster Preparedness Programs, Preparedness Planning, Roles and Responsibilities, Public Awareness and Warnings, Conducting a participatory capacity and vulnerability analysis, Sustainable Management, Survey of Activities Before Disasters Strike, Survey of Activities During Disasters, DRR Master Planning for the Future, Capacity Building, Sphere Standards. Rehabilitation measures and long term reconstruction. Psychosocial care provision during the different phases of disaster.

[DISASTER RISK MANAGEMENT IN INDIA] (6 Hours)

Hazard and Vulnerability Profile India,, Disaster Management Indian scenario, India's vulnerability profile, Disaster Management Act 2005 and Policy guidelines, National Institute of Disaster Management, National Disaster Response Force (NDRF)National Disaster Management Authority, States Disaster Management Authority, District Disaster Management Authority Cases Studies : Bhopal Gas Disaster, Gujarat Earth Quake, Orissa Super-cyclone, south India Tsunami, Bihar floods,

Plague-Surat, Landslide in North East, Heat waves of AP& Orissa, 278 Cold waves in UP. Bengal famine

[BEST PRACTICES IN DISASTER MANAGEMENT] (6 Hours)

Local Knowledge Appropriate Technology and local Responses, Indigenous Knowledge, Development projects in India (dams, SEZ) and their impacts, Logistics management in specific emergency situation. Rajiv Gandhi Rehabilitation package, Integrated Coastal Zone Management, National Flood Risk Mitigation Project (NFRMP), Mines Safety in India, Indian Meteorological Department, National Crisis Management Committee, Indian NATIONAL Centre for Oceanic Information System (INCOIS)

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain concepts of hazards, vulnerabilities, disaster types, risk reduction strategies, and India's disaster management framework.	L2	PO1,PO10
CO2	Apply disaster preparedness plans, early warning systems, relief components, and vulnerability assessment techniques in emergency scenarios.	L3	PO2,PO5
CO3	Analyze disaster cycles, inter-sectoral coordination, psychosocial recovery issues, and case studies like Bhopal and Tsunami impacts.	L4	PO2,PO10
CO4	Evaluate DRR policies, NDRF effectiveness, Sphere standards compliance, and best practices like coastal zone management projects.	L5	PO6,PO10
CO5	Develop disaster management plans integrating community DRR, rehabilitation measures, and risk mitigation strategies.	L6	PO2,PO8,PO10

Reference Books:

1. Disaster Management Guidelines. GOI-UNDP Disaster Risk Reduction Programme (2009-2012.
2. Watts S Humphrey, " Managing the Software Process", Pearson Education Inc
3. Gordon G Schulmeyer, "Handbook of Software Quality Assurance", Third Edition,
4. Artech House Publishers 2007
5. Aim and Scope of Disaster Management. Study Guide prepared by Sharman and
6. Hansen. UW-DMC, University of Washington
7. Geneva: Sphere Project. http://www.sphereproject.org/ handbook/
8. Sphere Project (2011). Humanitarian Charter and Minimum Standards in Disaster Response.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	2	–	–	–	–	–	–	–	–	3	–	–	1	–	–
CO2	–	3	–	–	2	–	–	–	–	–	–	–	1	–	–
CO3	–	3	–	–	–	–	–	–	–	3	–	–	1	–	–
CO4	–	–	–	–	–	3	–	–	–	3	–	–	1	–	–
CO5	–	3	–	–	–	–	–	2	–	3	–	–	1	–	–
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25ZAC002	**Subject Title**	ENGLISH FOR RESEARCH PAPER WRITING
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites	Basic proficiency in academic English writing and grammar		

Course Objectives:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title

Course Content:

[PLANNING AND PREPARATION] (6 Hours)

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

[HIGHLIGHTING] (6 Hours)

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.

[LITERAURE REVIEW] (6 Hours)

Review of the Literature, Methods, Results, Discussion, Conclusions, TheFinal Check

[KEY SKILLS] (6 Hours)

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature

[WRITING SKILLS] (6 Hours)

Writing Skills, Results skills , Writing skills during discussion, when writing the Conclusions useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain principles of academic writing clarity, paragraph structuring, literature review organization, and research paper section conventions.	L2	PO1, PO7
CO2	Apply techniques for concise writing, ambiguity avoidance, paraphrasing without plagiarism, and effective abstract/title composition.	L3	PO4, PO7
CO3	Analyze sentence structures, redundancy patterns, hedging strategies, and rhetorical effectiveness across paper sections.	L4	PO2,PO7
CO4	Evaluate research paper drafts for readability, logical flow, critical discussion strength, and submission readiness standards.	L5	PO3,PO7

CO5	Develop complete research manuscripts integrating planning, highlighting findings, literature synthesis, and polished conclusions.	L6	PO3,PO7,PO11

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.

3. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	–	–	–	–	–	3	–	–	–	–	–	1	–	1
CO2	–	–	–	2	–	–	3	–	–	–	–	–	1	–	1
CO3	–	3	–	–	–	–	3	–	–	–	–	–	1	–	1
CO4	–	–	3	–	–	–	3	–	–	–	–	–	1	–	1
CO5	–	–	3	–	–	–	3	–	–	–	3	–	1	–	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25SAC003	**Subject Title**	STRESS MANAGEMENT
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites	Basic self-awareness of personal stress triggers and responses		

Course Objectives:

1. To achieve overall health of body and mind
2. To overcome stress
3. Developing a sense of Humor.

Course Content:

[UNDERSTANDING STRESS] (6 Hours)

Meaning – Symptoms – Works Related Stress – Individual Stress – Reducing Stress – Burnout.

[COMMON STRESS FACTORS TIME & CAREER PLATEAUING] (6 Hours)

Time Management – Techniques – Importance of planning the day – Time management schedule – Developing concentration – Organizing the Work Area – Prioritizing – Beginning at the start – Techniques for conquering procrastination – Sensible delegation – Taking the right breaks – Learning to say 'No'.

[CRISIS MANAGEMENT] (6 Hours)

Implications – People issues – Environmental issues – Psychological fall outs – Learning to keep calm – Preventing interruptions – Controlling crisis – Importance of good communication – Taking advantage of crisis – Pushing new ideas – Empowerment.

[WORK PLACE HUMOUR] (6 Hours)

Developing a sense of Humor – Learning to laugh – Role of group cohesion and team spirit – Using humor at work – Reducing conflicts with humor.

[SELF DEVELOPMENT] (6 Hours)

Improving Personality – Leading with Integrity – Enhancing Creativity – Effective decision Making – Sensible Communication – The Listening Game – Managing Self – Meditation for peace – Yoga for Life.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain stress symptoms, work-related factors, crisis implications, humor benefits, and self-development techniques for well-being.	L2	PO1,PO10
CO2	Apply time management schedules, prioritization methods, crisis communication strategies, workplace humor, and meditation practices.	L3	PO2, PO7
CO3	Analyze burnout patterns, procrastination triggers, environmental stress factors, and personality traits	L4	PO2, PO11

	affecting stress resilience.		
CO4	Evaluate time management techniques, delegation effectiveness, humor's conflict resolution impact, and yoga/meditation outcomes.	L5	PO6,PO8
CO5	Develop personalized stress management plans integrating time organization, crisis response protocols, and self-improvement routines.	L6	PO8,PO11

Reference Books:

1. Cooper, Managing Stress, Sage, 2011.
2. Waltschafer, Stress Management ,Cengage Learning, 4th Edition 2009.
3. Jeff Davidson, Managing Stress, Prentice Hall of India, New Delhi, 2012.
4. Juan R. Alascal, Brucata, Laurel Brucata, Daisy Chauhan. Stress Mastery- The art of coping gracefully. Pearson, 2012.
5. Argyle. The Psychology of Happiness. Tata McGraw Hill, Oct 2013.
6. Bartlet. Stress – Perspectives & Process. Tata McGraw Hill. 2012.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	2	–	–	–	–	–	–	–	–	3	–	–	–	–	1
CO2	–	3	–	–	–	–	3	–	–	–	–	–	–	–	1
CO3	–	3	–	–	–	–	–	–	–	–	3	–	–	–	1
CO4	–	–	–	–	–	3	–	2	–	–	–	–	–	–	1
CO5	–	–	–	–	–	–	–	3	–	–	3	–	–	–	1
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25SAC004	**Subject Title**	PEDAGOGY STUDIES
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites			

Course Objectives:

1. Review existing evidence on the review topic to inform programme design
2. Policy making undertaken by the DfID, other agencies and researchers
3. Identify Critical evidence gaps to guide the development

Course Content:

[INTRODUCTION AND METHODOLOGY] (6 Hours)

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

[THEMATIC OVERVIEW] (6 Hours)

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

[PEDAGOGICAL PRACTICES EFFECTIVENESS] (6 Hours)

Evidence on the effectiveness of pedagogical practices - Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

[PROFESSIONAL DEVELOPMENT] (6 Hours)

Professional development: alignment with classroom practices and follow-up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

[RESEARCH GAPS AND FUTURE DIRECTIONS] (6 Hours)

Research design - Contexts - Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain pedagogical theories, curriculum frameworks, teacher education models, and evidence-based practices in developing countries.	L2	PO1, PO5
CO2	Apply research methodologies, thematic analysis techniques, and professional development strategies to classroom pedagogical improvements.	L3	PO2, PO3, PO7

CO3	Analyze effectiveness of pedagogic practices, teacher attitudes, peer support systems, and barriers like resource limitations.	L4	PO2, PO3
CO4	Evaluate alignment between teacher training, curriculum materials, assessment methods, and actual classroom implementation outcomes.	L5	PO2, PO6, PO10
CO5	Develop pedagogy programs integrating theory of change, professional development support, and context-specific teaching strategies.	L6	PO3, PO8, PO11

Reference Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	2	–	–	–	–	–	–	–	1	–	1
CO2	–	3	2	–	–	–	2	–	–	–	–	–	1	–	1
CO3	–	3	2	–	–	–	–	–	–	–	–	–	1	–	1
CO4	–	2	–	–	–	2	–	–	–	3	–	–	1	–	1
CO5	–	–	3	–	–	–	–	2	–	–	3	–	1	–	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25SAC005	**Subject Title**	PRINCIPLES OF MANAGEMENT
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites	Basic understanding of organizational structures from engineering project work		

Course Objectives:

1. Organization management and role of managers.
2. Planning and Policies and decision making.
3. Organizing, controlling and directing.

Course Content:

[OVERVIEW OF MANAGEMENT] (6 Hours)

Organization - Management - Role of managers - Evolution of Management thought - Organization and the environmental factors - Managing globally - Strategies for International Business.

[PLANNING] (6 Hours)

Nature and purpose of planning - Planning process - Types of plans – Objectives - Managing by objective (MBO) Strategies - Types of strategies - Policies - Decision Making - Types of decision - Decision Making Process - Rational Decision Making Process - Decision Making under different conditions.

[ORGANIZING] (6 Hours)

Nature and purpose of organizing - Organization structure - Formal and informal groups organization - Line and Staff authority - Departmentation - Span of control - Centralization and

Decentralization - Delegation of authority - Staffing - Selection and Recruitment - Orientation - Career Development - Career stages – Training - Performance Appraisal.

[DIRECTING] (6 Hours)

Creativity and Innovation - Motivation and Satisfaction - Motivation Theories Leadership -

Leadership theories - Communication - Hurdles to effective communication - Organization Culture - Elements and types of culture - Managing cultural diversity.

[CONTROLLING] (6 Hours)

Process of controlling - Types of control - Budgetary and non-budgetary control techniques -

Managing Productivity - Cost Control - Purchase Control - Maintenance Control - Quality Control - Planning operations.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain management evolution, organizational structures, planning processes, directing functions, and control mechanisms.	L2	PO1
CO2	Apply MBO techniques, decision-making processes, delegation strategies, motivation theories, and budgetary control methods.	L3	PO2, PO8

CO3	Analyze span of control effects, centralization impacts, leadership theory applications, and communication barriers in organizations.	L4	PO2, PO7
CO4	Evaluate strategy-policy alignment, staffing effectiveness, organizational culture diversity management, and productivity control systems.	L5	PO5, PO8, PO10
CO5	Develop comprehensive management plans integrating global strategies, staffing frameworks, and quality control operations.	L6	PO2, PO8, PO9

Reference Books:

1. Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th editioN, 2005.

2. Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.

3. Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach', Thomson South Western, 10th edition, 2007.

4. Harold Koontz, Heinz Weihrich and Mark V Cannice, 'Management – A global & Entrepreneurial Perspective', Tata Mcgraw Hill, 12th edition, 2007.

5. Andrew J. Dubrin, 'Essentials of Management', Thomson Southwestern, 7th edition, 2007.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	–	–	–	1
CO2	–	3	–	–	–	–	–	2	–	–	–	–	–	–	1
CO3	–	3	–	–	–	–	2	–	–	–	–	–	–	–	1
CO4	–	–	–	–	2	–	–	3	–	2	–	–	–	–	1
CO5	–	3	–	–	–	–	–	3	2	–	1	–	–	–	1
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25SAC006	**Subject Title**	PROFESSIONAL ETHICS IN ENGINEERING
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites	Basic exposure to engineering design projects or laboratory work		

Course Objectives:

1. To enable the students to create an awareness on Engineering Ethics and Human Values
2. To instill Moral and Social Values and Loyalty
3. To appreciate the rights of others.

Course Content:

[ENGINEERING ETHICS] (6 Hours)

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

[ENGINEERING AS SOCIAL EXPERIMENTATION] (6 Hours)

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study.

[ENGINEER'S RESPONSIBILITY FOR SAFETY] (6 Hours)

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal.

[RESPONSIBILITIES AND RIGHTS] (6 Hours)

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

[GLOBAL ISSUES] (6 Hours)

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain engineering ethics concepts, moral dilemmas, safety responsibilities, professional rights, and global ethical challenges.	L2	PO1, PO6
CO2	Apply ethical theories, codes of conduct, risk assessment techniques, and conflict of interest resolution strategies.	L3	PO2, PO6

CO3	Analyze case studies like Challenger and Bhopal, Kohlberg's moral development stages, and multinational corporation ethical issues.	L4	PO2, PO3, PO10
CO4	Evaluate professional virtues, risk-benefit trade-offs, employee rights protections, and environmental ethics compliance.	L5	PO6, PO10
CO5	Develop engineering ethics policies integrating safety protocols, IPR frameworks, and moral leadership principles.	L6	PO6, PO8, PO9

Reference Books:

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw Hill, New York, 2005.

2. Charles E Harris, Michael S Pritchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Thompson Learning, 2000.

3. Charles D Fleddermann, “Engineering Ethics”, Prentice Hall, New Mexico, 2012.

Course Articulation matrix:

	PROGRAM OUTCOMES											**PROGRAM SPECIFIC OUTCOMES**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	–	–	–	–	3	–	–	–	–	–	–	–	–	1
CO2	–	3	–	–	–	3	–	–	–	–	–	–	–	–	1
CO3	–	2	2	–	–	–	–	–	–	3	–	–	–	–	1
CO4	–	–	–	–	–	3	–	–	–	3	–	–	–	–	1
CO5	–	–	–	–	–	3	–	2	2	–	1	–	–	–	1
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25SAC007	**Subject Title**	ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites	Basic mathematical aptitude for elasticity calculations and cost functions		

Course Objectives:

1. Demand, Supply and Analysis.
2. Knowledge about Production and cost analysis.
3. Knowledge of price and financial accounting.

Course Content:

[INTRODUCTION] (6 Hours)

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.

[DEMAND & SUPPLY ANALYSIS] (6 Hours)

Demand - Types of demand - Determinants of demand - Demand function - Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

[PRODUCTION AND COST ANALYSIS] (6 Hours)

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

[PRICING] (6 Hours)

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

[FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT)] (6 Hours)

Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain demand-supply dynamics, production functions, pricing strategies, and fundamental financial accounting statements.	L2	PO1
CO2	Apply elasticity calculations, cost-output decisions, price discrimination methods, and financial ratio computations.	L3	PO1, PO2, PO4
CO3	Analyze demand forecasting techniques, short-run vs long-run cost curves, market structure pricing impacts, and	L4	PO2, PO4

	cash flow patterns.		
CO4	Evaluate production optimization strategies, firm profitability through ratios, and financial statement comparative performance.	L5	PO2, PO5
CO5	Develop economic decision models integrating demand analysis, cost structures, pricing policies, and financial projections.	L6	PO2, PO3, PO9

Reference Books:

1. Samuelson. Paul A and Nordhaus W.D., 'Economics', Tata Mcgraw Hill Publishing Company Limited, New Delhi, July 2016.

2. McGuigan, Moyer and Harris, 'Managerial Economics; Applications, Strategy and Tactics', Thomson South Western, 10th Edition, 2005.

3. Paresh Shah, 'Basic Financial Accounting for Management', Oxford University Press,New Delhi, 2007.

4. Salvatore Dominick, 'Managerial Economics in a global economy'. Thomson South Western, 4th Edition, 2001.

5. Prasanna Chandra. 'Fundamentals of Financial Management', Tata Mcgraw Hill Publishing Ltd., 4th edition, 2005.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	–	–	–	–	–	–	–	–	–	–	–	–	–	1
CO2	2	3	–	2	–	–	–	–	–	–	–	–	–	–	1
CO3	–	3	–	2	–	–	–	–	–	–	–	–	–	–	1
CO4	–	3	–	–	2	–	–	–	–	–	–	–	–	–	1
CO5	–	3	2	–	–	–	–	–	2	–	–	–	–	–	1
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25SAC008	**Subject Title**	INDUSTRIAL AUTOMATION AND ROBOTICS
Category	Audit Course	**L-T-P-C**	2-0-0-0
Regulation	2025	**Semester**	II & III
Prerequisites	Basic understanding of engineering principles and automation concepts		

Course Objectives:

1. Read and write data from/to files in Python Programs.
2. Robotics in Science Fiction and future trends.
3. Industrial robots and Nano robots.

Course Content:

[EVOLUTION OF ROBOTICS AND AUTOMATION] (6 Hours)

Robotics in science fiction- industrial revolution-history and need of robotics-– definition of a robot – robot terminology- types and applications of robot – overview of present status and future trends – robotics market and future prospects

[INDUSTRIAL AUTOMATION] (6 Hours)

Reasons for automation – arguments for and against automation – type of Industries and components of automation

[ROBOTIC KITS] (6 Hours)

Introduction–Classification of robots–robot component–Industrial Robots–Mobile Robots–Nao Robot

[ROBOT ASSEMBLING] (6 Hours)

Assembly of robots using Lego, Vex and Tetrix Kits - Five minute bot, Line follower, Obstacle avoidance robot, Wall following robot and other simple applications.

[FIREBIRD KIT] (6 Hours)

Introduction, Architecture, programming using Atmel studio, Programming: Buzzer, Line following, LCD display and other simple applications.

Total Hours: 30

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain robotics history, automation rationale, robot classifications, kit architectures, and industrial applications.	L2	PO1
CO2	Apply robot terminology, automation component selection, Lego/Vex assembly techniques, and Firebird programming functions.	L3	PO1, PO4
CO3	Analyze robot market trends, automation pros/cons, mobile vs industrial robot differences, and line-follower algorithm performance.	L4	PO2, PO3

CO4	Evaluate robot kit suitability, obstacle avoidance strategies, buzzer/LCD integration effectiveness, and future robotics prospects.	L5	PO2, PO6
CO5	Develop functional robots using assembly kits integrating sensors, motors, and Atmel programming for practical applications.	L6	PO2, PO4, PO8

Reference Books:

1. Mikell P Groover, —Automation, Production Systems, and computer integrated Manufacturing, Prentice Hall, 2001.

2. Deb S R.and DebS., —Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010.

3. Manual Prepared by the Department of Robotics and Automation Engineering, 2015.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	2	2	2	–
CO2	2	–	–	3	–	–	–	–	–	–	–	3	2	3	–
CO3	–	3	2	–	–	–	–	–	–	–	–	3	2	3	–
CO4	–	3	–	–	–	2	–	–	–	–	–	3	2	3	–
CO5	–	3	–	3	–	–	–	2	–	–	–	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

OPEN ELECTIVE

Subject Code	25CSOE01	**Subject Title**	PYTHON PROGRAMMING
Category	Open Elective	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	III
Prerequisites	Familiarity with algorithmic thinking and problem-solving approaches		

Course Objectives:

1. Read and write data from/to files in Python Programs.
2. Problem solving in python
3. Knowledge of file ,Tuples, and Packages

Course Content:

[ALGORITHMIC PROBLEM SOLVING] (9 Hours)

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, and guess an integer number in a range, Towers of Hanoi.

[DATA, EXPRESSIONS, STATEMENTS] (9 Hours)

Python interpreter and interactive mode; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

[CONTROL FLOW, FUNCTIONS] (9 Hours)

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if- elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd,exponentiation, sum an array of numbers, linear search, binary search.

[LISTS, TUPLES, DICTIONARIES] (9 Hours)

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

[FILES, MODULES, PACKAGES] (9 Hours)

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain Python data types, control structures, functions, lists, tuples, dictionaries, and file operations fundamentals.	L2	PO1
CO2	Apply algorithmic strategies, conditional logic, loops, recursion, list comprehensions, and exception handling to	L3	PO2, PO4

	solve computational problems.		
CO3	Analyze program flow, variable scoping, mutability effects, sorting algorithm performance, and dictionary operations efficiency.	L4	PO2
CO4	Evaluate recursive vs iterative solutions, list slicing techniques, tuple assignment benefits, and exception handling strategies.	L5	PO2, PO3
CO5	Develop Python programs integrating modules, packages, file I/O, and advanced data structures for practical applications.	L6	PO2, PO3, PO4, PO11

Reference Books:

1. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd edition, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016
2. Guido van Rossum and Fred L. Drake Jr, “An Introduction to Python – Revised and updated for Python 3.2”, Network Theory Ltd., 2011.
3. Dr.A.Kannan, Dr.L.Sairamesh, “Problem Solving and Python programming”, United Global Publishers Pvt. Ltd., 2017.
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd.,
5. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2015.
6. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	3	2	3	–
CO2	–	3	–	2	–	–	–	–	–	–	–	3	2	3	–
CO3	–	3	–	–	–	–	–	–	–	–	–	3	2	3	–
CO4	–	2	2	–	–	–	–	–	–	–	–	3	2	3	–
CO5	–	3	3	3	–	–	–	–	–	–	2	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSOE02	**Subject Title**	SOFTWARE ENGINEERING
Category	Open Elective	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	III
Prerequisites	Basic programming experience and familiarity with software development lifecycle concepts.		

Course Objectives:

1. Verify and validate the software applications using different types of testing
2. Maintain the quality of software.
3. Application of Scrum Development Process to develop software.

Course Content:

[INTRODUCTION AND REQUIREMENTS MODELING] (9 Hours)

Software Engineering - Process models-Agile development - Software engineering Knowledge - Core Principles - Principles that guide each framework Activity - Requirements Engineering - Developing use cases - Building the requirements model - Negotiating, validating Requirements - Requirements Analysis - Requirements Modeling.

[SOFTWARE DESIGN AND ESTIMATION] (9 Hours)

Design Process - Design Concepts – Design Model - Architectural Design - Component level design – User interface design - pattern based design – Web App design – Case Study.

Software Project Estimation – Process and Project Metrics- Empirical Estimation model – Specialized Estimation Technique for Agile Development - Project Scheduling - Risk Management.

[SOFTWARE QUALITY AND TESTING] (9 Hours)

Software Quality - Software - Quality Dilemma - Achieving Software Quality - Testing: Strategic Approach to software Testing - Strategic Issues Testing: Strategies for Conventional Software, Object oriented software, Web Apps - Validating Testing - System Testing - Art of Debugging.

[SOFTWARE MAINTENANCE AND IMPROVEMENT] (9 Hours)

Software Maintenance - Software Supportability - Reengineering - Business Process Reengineering - Software Reengineering - Reverse Engineering - Restructuring - Forward Engineering.

[INTRODUCTION TO SCRUM DEVELOPMENT PROCESS] (9 Hours)

Basics of Scrum – Running a Scum project – Steps for transition to scrum – Metrics for scrum – Case Study.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	**Course Outcome**	**Bloom's Level**	**PO's Mapped**
CO1	Explain software process models, requirements engineering, design concepts, quality assurance principles, and Scrum framework fundamentals.	L2	PO1
CO2	Apply use case development, architectural design patterns, testing strategies, maintenance techniques, and Scrum sprint planning processes.	L3	PO2, PO4, PO8
CO3	Analyze requirements validation, project estimation	L4	PO2, PO3

	metrics, software quality dilemmas, reengineering challenges, and Scrum metrics effectiveness.		
CO4	Evaluate design model completeness, testing coverage adequacy, maintenance supportability, and Scrum project transition suitability.	L5	PO2, PO6
CO5	Develop complete software solutions integrating requirements traceability, component design, system testing, and iterative Scrum delivery.	L6	PO2, PO3, PO4, PO8

Reference Books:

1. Roger Pressman.S “Software Engineering: A Practitioner’s Approach” Eighth Edition, McGraw Hill, 2010

2. Ian Sommerville “Software Engineering” Nineth Edition, Pearson Education Asia, 2011

3. Shari Lawrence Pfleeger, Joanne M. Atlee, “Software Engineering: Theory and Practice”, Fourth Edition, Pearson Education, 2011.

4. Alistair Cockburn, "Agile Software Development”, First Edition, Pearson Education, 2001.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	–	–	–	–	–	–	–	–	–	–	3	2	3	–
CO2	–	3	–	2	–	–	–	2	–	–	–	3	2	3	–
CO3	–	3	2	–	–	–	–	–	–	–	–	3	2	3	–
CO4	–	3	–	–	–	2	–	–	–	–	–	3	2	3	–
CO5	–	3	3	3	–	–	–	3	–	–	1	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSOE03	**Subject Title**	ANDROID APPLICATION DEVELOPMENT
Category	Open Elective	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of Java programming and object-oriented concepts.		

Course Objectives:

1. An Open Platform for Mobile Development and Native Android Applications.
2. Creating Applications and building user interfaces.
3. Working with files and databases.

Course Content:

[INTRODUCTION TO ANDROID] (9 Hours)

Hello Android - A Little Background - Android: An Open Platform for Mobile Development - Native Android Applications - Android SDK Features - Introducing the Open Handset Alliance - Introducing the Development Framework. Getting Started: Developing for Android - Developing for Mobile and Embedded devices - Android Development Tools.

[CREATING APPLICATIONS AND BUILDING USER INTERFACES] (9 Hours)

Android Application - Introducing the Application Manifest File - Using the Manifest Editor - Externalizing Resources - The Android Application Lifecycle - Understanding an Application's Priority and its Process States - Introducing the Android Application Class - Fundamental Android UI Design - Android User Interface Fundamentals - Introducing Layouts - To-Do List Example - Introducing Fragments - The Android Widget Toolbox - Creating New Views - Introducing Adapters.

[BROADCAST RECEIVERS AND INTERNET] (9 Hours)

Introducing Intents - Creating Intent Filters and Broadcast Receivers - Using Internet Resources - Downloading and Parsing Internet Resources - Using the Download Manager - Using Internet Services - Connecting to Google App Engine - Best Practices for Downloading Data Without Draining the Battery.

[FILES AND DATABASES] (9 Hours)

Saving Simple Application Data - Creating and Saving Shared Preferences - Retrieving Shared Preferences - Creating a Setting Activity for the Earthquake Viewer - Introducing the Preference Framework and the Preference Activity - Creating a Standard Preference Activity for the Earthquake Viewer Persisting the Application Instance State - Including Static Files as Resources - Working with the File System Introducing Android Databases - Introducing SQLite - Contents Values and Cursors - Working with S QLite Databases - Creating Content Providers - Using Content Providers - Adding Search to Your Application - Creating a Searchable Earthquake Content Provider - Native Android Content Providers.

[ADVANCED USER EXPERIENCE] (9 Hours)

Designing for Every Screen Size and Density - Ensuring Accessibility - Introducing Android Text-to Speech - Using Speech Recognition - Controlling Device Vibration - Working with Animations - Enhancing Your Views - Advanced Drawable Resources - Copy, Paste and the Clipboard - Hardware Sensors - Using Sensors and the Sensor Manager - Monitoring a Device's Movement and Orientation -Introducing the Environmental Sensors - Using Location-Based Services - Using the Emulator with Location-Based Services - Selecting a Location Provider - Finding Your Current Location - Best Practice for Location Updates - Using Proximity Alerts - Using the Geocoder - Creating Map-Based Activities - Mapping Earthquakes Example.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain Android SDK architecture, application lifecycle, UI design principles, content providers, and location-based services.	L2	PO1, PO2, PO4, PO11
CO2	Apply manifest configuration, fragment layouts, broadcast receivers, SQLite operations, and sensor integration techniques.	L3	PO1, PO2, PO3, PO4, PO5, PO11
CO3	Analyze intent filtering mechanisms, battery-efficient networking, shared preferences persistence, and multi-screen density adaptations.	L4	PO1, PO2, PO3, PO4, PO5, PO11
CO4	Evaluate adapter patterns effectiveness, content provider security, location provider accuracy, and accessibility compliance.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO10, PO11
CO5	Develop complete Android applications integrating intents, databases, sensors, maps, and advanced UI animations.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Reto Meier, "Professional Android™ 4 Application Development", 2012 by John Wiley & Sons.
2. Wei-Meng Lee," Beginning Android™ 4 Application Development", 2012 by John Wiley & Sons.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	–	3	–	–	–	–	–	–	1	3	2	3	–
CO2	2	3	1	3	2	–	–	–	–	–	1	3	2	3	–
CO3	2	3	2	3	2	–	–	–	–	–	2	3	2	3	–
CO4	2	3	2	3	2	1	–	–	–	1	2	3	2	3	–
CO5	3	3	3	3	2	1	1	2	2	1	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSOE04	**Subject Title**	ESSENTIALS OF CLOUD COMPUTING
Category	Open Elective	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of computer fundamentals, networking concepts, and operating systems.		

Course Objectives:

1. Fundamentals of computing and cloud computing.
2. Cloud computing applications and their implementation platforms.
3. Cloud security infrastructures.

Course Content:

[INTRODUCTION TO CLOUD COMPUTING] (9 Hours)

Overview of Computing Paradigm: Recent trends in Computing - Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing - Introduction to Cloud Computing - Cloud issues and challenges- Cloud Computing (NIST Model) - History of Cloud Computing, - Cloud service provider s Properties, Characteristics & Disadvantages - Pros and Cons of Cloud Computing, Benefits of Cloud Computing - Role of Open Standards.

[CLOUD COMPUTING ARCHITECTURE AND VIRTUALIZATION] (9 Hours)

Cloud computing g stack - Comparison with traditional computing architecture (client/server), Services provided at various levels - Role of Networks in Cloud computing, protocols used, Role of Web services- Service Models (XaaS)- Infrastructure as a Service(IaaS) -Platform as a Service(PaaS) - Cloud Platform and Management – Software as a Service(SaaS)- Web services - Web 2.0 - Deployment Models -Public cloud -Private cloud -Hybrid cloud -Community cloud - Virtualization concepts - Introduction to virtualization - Types of Virtualization- Introduction to Various

Hypervisors - High Availability (HA)/Disaster Recovery (DR) using Virtualization, Moving VMs

[CLOUD APPLICATION PROGRAMMING AND THE ANEKA PLATFORM] (9 Hours)

Aneka - Frame work overview - anatomy of the Aneka container - Building Aneka clouds - Cloud programming an d management - Programming applications with threads - Multithreading with Aneka - Programming applications with Aneka threads - Task computing - Task-based application models - Aneka task-base d programming - Data-Intensive Computing - Aneka MapReduce programming

[CLOUD SECURITY] (9 Hours)

Infrastructure Security - Network level security, Host level security, Application level security - Data security and Storage - Data privacy and security Issues, Jurisdictional issues raised by Data location - Identity & Access Management -Access Control -Trust, Reputation, Risk , Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations.- Cloud Reliability and fault-tolerance -privacy - policy and compliance -Cloud federation, interoperability and standards.

[CLOUD APPLICATIONS AND CASE STUDY] (9 Hours)

Scientific applications : Healthcare – Biology – Geoscience - Business and consumer applications: CRM and ERP – Productivity - Social networking - Media applications - Multiplayer online gaming - Case Study on Open Source & Commercial Clouds – Eucalyptus - Microsoft Azure - Amazon EC2 - Google AppEngine.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain cloud computing paradigms, NIST models, service models (IaaS/PaaS/SaaS), virtualization	L2	PO1, PO2, PO4, PO10, PO11
CO2	Apply Aneka programming models, deployment strategies (public/private/hybrid), hypervisor	L3	PO1, PO2, PO3, PO4, PO5, PO11
CO3	Analyze cloud architecture stacks, network protocol roles, data privacy jurisdictional issues, and fault-	L4	PO1, PO2, PO3, PO4, PO5, PO6, PO10, PO11
CO4	Evaluate XaaS model suitability, Aneka container scalability, identity management effectiveness, and	L5	PO1, PO2, PO3, PO4, PO6, PO8, PO9, PO11
CO5	Develop cloud applications integrating multithreading, data-intensive computing, security controls, and hybrid deployment models.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	–	3	–	–	–	–	–	1	2	3	2	3	–
CO2	2	3	3	3	2	–	–	–	–	–	2	3	2	3	–
CO3	2	3	3	3	2	2	–	–	–	2	2	3	2	3	–
CO4	2	3	2	3	2	2	–	1	1	–	2	3	2	3	–
CO5	3	3	3	3	2	2	1	2	2	1	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSOE05	**Subject Title**	COMPUTER VISION
Category	Open Elective	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of linear algebra, probability, programming, and fundamentals of digital image processing.		

Course Objectives:

1. Fundamentals of image processing techniques for computer vision.
2. Shape and pattern analysis.
3. Hough Transform and its applications to detect lines, circles, ellipses.

Course Content:

[LOW LEVEL VISION] (9 Hours)

Images and Imaging Operations – Image Filtering and Morphology – The Role of Thresholding – Edge detection – Corner,Interest Point and Invariant Feature Detection – Texture Analysis.

[INTERMEDIATE LEVEL VISION] (9 Hours)

Binary Shape Analysis – Boundary Pattern Analysis – Line, Circle and Ellipse Detection – The generalized Hough Transform – Object Segmentation and Shape Models.

[MACHINE LEARNING AND DEEP LEARNING NETWORKS] (9 Hours)

Basic Classification Concepts – Machine Learning: Probabilistic Methods – Deep Learning Networks.

[3D VISION AND MOTION] (9 Hours)

Three Dimensional World – Tackling the Perspective n-point Problem – Invariants and Perspective – Image Transformations and Camera Calibration – Motion.

[APPLICATIONS] (9 Hours)

Face Detection and Recognition: the Impact of Deep Learning – Surveillance – The Basic Geometry –Foreground-Background Separation – Particle Filters – Chamfer Matching, Tracking, and Occlusion – Combining Views from Multiple Cameras – Human Gait analysis – Application: In- Vehicle Vision System: Locating the Roadway – Location of Road Markings – Location of Road signs – Location of Vehicles – Locating Pedestrians.

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain image filtering, edge detection, shape analysis, Hough transforms, deep learning networks, and 3D vision principles.	L2	PO1, PO2, PO4, PO5, PO11
CO2	Apply thresholding techniques, corner detection, binary shape segmentation, probabilistic classification, and motion estimation algorithms.	L3	PO1, PO2, PO3, PO4, PO5, PO11
CO3	Analyze texture patterns, boundary representations, perspective-n-point problems, particle filter tracking,	L4	PO1, PO2, PO3, PO4, PO5, PO10,

	and multi-camera fusion.		PO11
CO4	Evaluate invariant feature effectiveness, Hough transform accuracy for geometric shapes, deep learning model performance, and surveillance system reliability.	L5	PO1, PO2, PO3, PO4, PO5, PO6, PO10, PO11
CO5	Develop computer vision pipelines integrating preprocessing, feature extraction, machine learning classification, and 3D reconstruction.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. E. R. Davies, “Computer Vision Principles,Algorithms,Applications,Learning”, Fifth Edition, Academic Press, 2018.

2. Computer Vision: Algorithms and Applications by Richard Szeliski,2010

3. Deep Learning, by Goodfellow, Bengio, and Courville,2016

4. Dictionary of Computer Vision and Image Processing, by Fisher et al, 2013

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	–	3	1	–	–	–	–	–	2	3	2	3	–
CO2	2	3	2	3	2	–	–	–	–	–	2	3	2	3	–
CO3	2	3	3	3	2	–	–	–	–	1	2	3	2	3	–
CO4	2	3	3	3	2	1	–	–	–	2	2	3	2	3	–
CO5	3	3	3	3	2	1	1	2	2	2	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

Course Designed By

BOS Approval

Date:

Subject Code	25CSOE06	**Subject Title**	HIGH PERFORMANCE COMPUTING
Category	Open Elective	**L-T-P-C**	3-0-0-3
Regulation	2025	**Semester**	III
Prerequisites	Basic knowledge of computer architecture, operating systems, and data structures.		

Course Objectives:

1. Performance evaluation of systems and networks.
2. Performance issues and cache coherence issues.
3. Multicore architectures and social computing.

Course Content:

[PERFORMANCE EVALUATION OF SYSTEMS AND NETWORKS](9 Hours)

Performance Characteristics – Requirement Analysis: Concepts –User, Device, Network Requirements – Process –Developing RMA ,Delay, Capacity Requirements – Flow Analysis – Identifying and Developing Flows –Flow Models –Flow Prioritization – Specification.

[MULTIPROCESSORS](9 Hours)

Symmetric and distributed shared memory architectures – Cache coherence issues - Performance Issues – Synchronization issues – Models of Memory Consistency - Interconnection networks – Buses, crossbar and multi-stage switches.

[MULTI-CORE ARCHITECTURES](9 Hours)

Software and hardware multithreading – SMT and CMP architectures – Design issues – Case studies – Intel Multi-core architecture – SUN CMP architecture – IBM cell architecture.- hp architecture.

[QUANTUM COMPUTATION](9 Hours)

Quantum Computing History, Postulates of Quantum Theory, Dirac Notation, the Quantum Circuit Model, Simple Quantum Protocols: Teleportation, Super dense Coding, Foundation Algorithms

[SOCIAL COMPUTING AND EVOLUTIONARY COMPUTING](9 Hours)

Social Computing Online communities, Online discussions, Twitter, Social Networking Systems, Web 2.0, social media, Crowdsourcing, Facebook, blogs, wikis, social recommendations, Collective intelligence. Evolutionary Computing: Introduction to Genetic Algorithms, Genetic Operators and Parameters, Genetic Algorithms in Problem Solving, Theoretical Foundations of Genetic Algorithms, Implementation Issues

Total Hours: 45

Upon successful completion of this course, students will be able to:

CO	Course Outcome	Bloom's Level	PO's Mapped
CO1	Explain performance metrics, multiprocessor architectures, multicore design issues, quantum computing principles, and social computing paradigms.	L2	PO1, PO2, PO4, PO11
CO2	Apply RMA analysis, cache coherence protocols, SMT/CMP threading models, quantum circuit design, and genetic algorithm operators.	L3	PO1, PO2, PO3, PO4, PO5, PO11
CO3	Analyze flow prioritization effects, memory consistency models, interconnection network latencies, and evolutionary computing convergence patterns.	L4	PO1, PO2, PO3, PO4, PO5, PO11
CO4	Evaluate multi-stage switch scalability, Intel/SUN/IBM multicore effectiveness, quantum teleportation protocols, and crowdsourcing solution quality.	L5	PO1, PO2, PO3, PO4, PO8, PO9, PO11
CO5	Develop high-performance applications integrating multiprocessor synchronization, multicore optimization, and genetic algorithm problem solving.	L6	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11

Reference Books:

1. James D.McCabe, Network Analysis, Architecture and Design,2nd Edition, Elsevier, 2003.

2. John L. Hennessey and David A. Patterson, "Computer Architecture – A quantitative approach", Morgan Kaufmann / Elsevier, 4th. Edition, 2007.

3. William Stallings, " Computer Organization and Architecture – Designing for Performance", Pearson Education, Seventh Edition, 2006

4. Danah Boyd, "It's Complicated: The Social Lives of Networked Teens", Yale University Press, 2015

5. M. Mitchell, "An Introduction to Genetic Algorithms", Prentice-Hall, 1996

Course Articulation matrix:

	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P010**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PS O4**
CO1	3	2	–	2	–	–	–	–	–	–	2	3	2	3	–
CO2	2	3	2	3	2	–	–	–	–	–	2	3	2	3	–
CO3	2	3	3	3	2	–	–	–	–	–	2	3	2	3	–
CO4	2	3	2	3	1	–	–	2	2	–	2	3	2	3	–
CO5	3	3	3	3	2	1	1	2	2	1	3	3	2	3	2
Correlation Levels: 3 - Strong, 2 - Medium, 1 - Low, - (dash) - No correlation															

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