MANAKULA VINAYAGAR
INSTITUTE OF TECHNOLOGY
An Autonomous Institution
Affiliated to Pondicherry University, Approved by AICTE, New Delhi,
Accredited by NBA, New Delhi and NAAC with 'A' Grade
Kalitheerthalkuppam, Puducherry- 605 107.

Curriculum & Syllabus

for

PG Degree Course

in

M.Tech

Computer Science and Engineering

R 2025

2025-26

STRUCTURE FOR POST GRADUATE ENGINEERING PROGRAM

Sl.No	Course Category	Credits
1.	Humanities and Social Science(HS)	-
2.	Basic Science(BS)	-
3.	Engineering Science(ES)	-
4.	Professional Core (PC)	34
5.	Professional Elective(PE)	9
6.	Open Elective(OE)	3
7.	Research Methodology and IPR Courses (RMC)	5
8.	Project Work and Internship(PA)	24
9.	Employability Enhancement Courses(EEC)	5
10.	Mandatory Course (MC)	-
	TOTAL CREDITS	**80**

SCHEME OF CREDIT DISTRIBUTION – SUMMARY

Sl.No	Course Category	Credits per Semester				Total Credits
		I	II	III	IV	
1.	Humanities and Social Science(HS)	-	-	-	-	-
2.	Basic Science(BS)	-	-	-	-	-
3.	Engineering Science(ES)	-	-	-	-	-
4.	Professional Core (PC)	17	17	-	-	34
5.	Professional Elective(PE)	-	3	6	-	9
6.	Open Elective(OE)	-	-	3	-	3
7.	Research Methodology and IPR Courses	3	2	-	-	5
8.	Project Work and Internship(PA)	-	-	8	16	24
9.	Employability Enhancement Courses(EEC)	1	1	3	-	5
10.	Mandatory Course (MC)	-	-	-	-	-
TOTAL CREDITS						**80**

M.TECH-COMPUTER SCIENCE AND ENGINEERING

SEMESTER –I

SI.No	Course Code	Course Title	Category	L	T	P	Credits
THEORY							
1	25PCST11	Advanced Data Structure and Algorithms	PC	3	1	0	4
2	25PCST12	Artificial Intelligence For Industrial Applications	PC	2	1	0	3
3	25PCST13	Advanced Software Engineering and Testing	PC	2	1	0	3
4	25PCST14	Advanced Database Technology	PC	2	1	0	3
5	25PCST15	Research Methodology and IPR	RMC	2	1	0	3
PRACTICAL							
6	25PCSP11	Advanced Data Structure and Algorithms Lab	PC	0	0	4	2
7	25PCSP12	Advanced Software Engineering and Testing Lab	PC	0	0	4	2
EMPLOYABILITY ENHANCEMENT COURSES							
8	25PCSE11	Certification course-I #	EEC	0	0	2	1
TOTAL CREDITS = 21							

SEMESTER-II

SI.No	Course	Course Title	Category	L	T	P	Credits
THEORY							
1	25PCST21	Deep Learning	PC	3	0	0	3
2	25PCST22	Full Stack Development Frameworks	PC	3	1	0	4
3	25PCST23	Cryptocurrencies and Blockchain Technology	PC	3	0	0	3
4	25PCST24	High Performance Networking	PC	3	0	0	3
5	25PCSLxx	Elective -I	PE	3	0	0	3
PRACTICAL							
6	25PCSP21	Deep-Learning Lab	PC	0	0	4	2
7	25PCSP22	Full Stack Development	PC	0	0	4	2
8	25PCSP23	Technical Report Writing and Seminar	RMC	0	0	4	2
EMPLOYABILITY ENHANCEMENT COURSES							
9	25PCSE21	Certification course-II#	EEC	0	0	2	1
TOTAL CREDITS = 23							

SEMESTER-III

SI.No	Course Code	Course Title	Category	L	T	P	Credits
THEORY							
1	25PCSLxx	Elective -II	PE	3	0	0	3
2	25PCSLxx	Elective -III	PE	3	0	0	3
3	25PCSOxx	Open Elective -I	OE	3	0	0	3
PRACTICAL							
4	25PCSW31	Project Phase - I	PA	0	0	16	8
5	25PCSN31	NPTEL/SWAYAM/ MOOC	EEC	0	0	12	3
Total Credits =20							

SEMESTER-IV

SI.No	Course Code	Course Title	Category	L	T	P	Credits
1	25PCSW41	Project Phase - II	PA	0	0	32	16
TOTAL CREDITS = 16							

TOTAL CREDITS: 80

CREDIT DISTRIBUTION

Semester	I	II	III	IV	Total
Credits	21	23	20	16	80

LIST OF PROFESSIONAL ELECTIVES FOR PG PROGRAMMES

SI.No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
Professional Elective-I			**L**	**T**	**P**	
1.	25PCSL01	Advanced Network Principles and Protocols	3	0	0	3
2.	25PCSL02	Internet of Things and Cognitive Computing	3	0	0	3
3.	25PCSL03	Fog Networks in IoT	3	0	0	3
4.	25PCSL04	Quantum Computing	3	0	0	3
5.	25PCSL05	Agile and DevOps	3	0	0	3
6.	25PCSL06	Software Design Architectures	3	0	0	3
7.	25PCSL07	Big Data Analytics using Artificial Intelligence Technologies	3	0	0	3
8.	25PCSL08	Generative Artificial Intelligence	3	0	0	3
9.	25PCSL09	Cognitive Science	3	0	0	3
10.	25PCSL10	Knowledge Management	3	0	0	3
Professional Elective-II						
11.	25PCSL11	Data warehousing and Data mining	3	0	0	3
12.	25PCSL12	Digital & Cyber Forensics	3	0	0	3
13.	25PCSL13	Reinforcement Learning	3	0	0	3
14.	25PCSL14	Deep Generative Models	3	0	0	3
15.	25PCSL15	Natural Language Processing and its Applications	3	0	0	3
16.	25PCSL16	Computer Vision on Edge Computing	3	0	0	3
17.	25PCSL17	Social network Analysis	3	0	0	3
18.	25PCSL18	Optimization Techniques	3	0	0	3
19.	25PCSL19	Cyber Security Operations	3	0	0	3
20.	25PCSL20	Human Computer Interaction	3	0	0	3
Professional Elective-III						
21.	25PCSL21	Data Science	3	0	0	3
22.	25PCSL22	Advanced Machine Learning Algorithms	3	0	0	3
23.	25PCSL23	Virtual & Augmented Reality	3	0	0	3
24.	25PCSL24	Database Systems Design: Relational And Nosql	3	0	0	3
25.	25PCSL25	Agent Based Intelligent System	3	0	0	3
26.	25PCSL26	Microservices and Service Based Architectures	3	0	0	3
27.	25PCSL27	Business Data Analytics	3	0	0	3
28.	25PCSL28	Ethical Hacking	3	0	0	3
29.	25PCSL29	Data Visualization Techniques	3	0	0	3
30.	25PCSL30	Statistical Machine Learning	3	0	0	3

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SI.No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	25PCSO01	Embedded Automation	3	0	0	3
2.	25PCSO02	Robotics and Automation	3	0	0	3
3.	25PCSO03	Numerical Methods	3	0	0	3
4.	25PCSO04	Human Values and Ethics	3	0	0	3
5.	25PCSO05	VLSI Design Fundamentals	3	0	0	3
6.	25PCSO06	Electric Vehicle Technology	3	0	0	3
7.	25PCSO07	Bioinformatics	3	0	0	3
8.	25PCSO08	Entrepreneurship Development	3	0	0	3
9.	25PCSO09	Financial Management for Engineers	3	0	0	3
10.	25PCSO10	Micro and Small Business Management	3	0	0	3

SYLLABUS

SEMESTER-I

25PCST11	ADVANCED DATA STRUCTURES AND ALGORITHM	Category	L	T	P	Credit	Total Hours
		PC	3	1	0	4	60

Preamble/ Course Objective

- To equip students with advanced knowledge of data structures and algorithmic strategies, emphasizing analysis, implementation, and real-world problem solving. The course enables learners to apply abstract data types, optimize performance, and tackle computationally intensive problems using effective algorithmic techniques.

Prerequisite

- Basics of Data Structures and Algorithms

Course Outcome : On the successful completion of the course, students will be able to

CO1	Compare the time complexity of various algorithms	Understand
CO2	Design and analyze self-balancing binary search trees	Apply
CO3	Apply various multidimensional search trees to searching and querying	Apply
CO4	Apply heap and disjoint-set operations on various graph algorithms	Apply
CO5	Demonstrate ability to prove that a problem is NP-complete	Apply

Syllabus

UNIT- I Basic Data Structures and Algorithmic Analysis 12 Hours

Linear and Non-linear Data Structures. Linked Lists, Stacks, Queues, Trees, Graphs - Asymptotic analysis of algorithms recurrence tree method Master theorem- Recurrence Equations – Solving Recurrence Equations – Memory Representation of Multi-dimensional Arrays – Time-Space Tradeoffs.

UNIT- II Binary Search Trees and Suffix Trees 12 Hours

Binary Search tree - AVL tree - Splay trees Red-black trees -2-3 Trees - Tries Suffix Trees- m-way Search Trees B+ trees - Quad trees- k-d Trees Nearest Neighbor Search- Heapsort – Quicksort – Topological sort - Sorting in Linear Time – Elementary Data Structures – Hash Tables – Hash Functions.

UNIT- III Text Processing Operations 12 Hours

Text Processing: String Operations - Brute-Force Pattern Matching - The Boyer-Moore Algorithm - The Knuth-Morris-Pratt Algorithm - Standard Tries - Compressed Tries - Suffix Tries - The Huffman Coding Algorithm - The Longest Common Subsequence Problem (LCS) - Applying Dynamic Programming to the LCS Problem.

UNIT- IV Heaps and Disjoint Sets 12 Hours

Skew heaps - Leftist Heaps Applications to Dijkstra's and Prim's algorithmsTreaps - Disjoint-set data structure Applications to Kruskal’s algorithms - union by rank- Elementary graph Algorithms – Minimum Spanning Trees – Single Source Shortest Paths- All Pairs Shortest Paths – Maximum

Flow - Multithreaded Algorithms – Matrix Operations.

UNIT- V Complexity classes **12 Hours**

Classes of P, NP and NP-complete - Polynomial reductions including 3SAT, CLIQUE, VERTEX COVER, INDEPENDENT SET- Linear programming – Polynomials and Fast Fourier Transform – Number Theoretic Algorithms – Computational Geometry –NPCompleteness – Approximation Algorithms. **TOTAL HOURS : 60**

Text Book

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, "Introduction to Algorithms", MIT Press, 2022.
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", AddisonWesley, 2014.
3. .Michael T. Goodrich, Roberto Tamassia, David Mount, "Data Structures and Algorithms in C++", John Wiley, 2016.

Reference Book

1. Robert L Kruse, Clovis L Tondo, "Data Structures and Program design in C", Pearson, 2013.
2. Sahni Sartaj, "Data Structures, Algorithms and Applications in C++", Silicon Press, 2013.
3. Motwani R, Raghavan P ,"Randomized Algorithms", Cambridge University Press, 2014.
4. David P. Williamson, David B. Shmoys, "The design of approximation algorithms", Cambridge University Press, 2011.

Web Resources

1. https.//www.uoitc.edu.iq/images/documents/informatics-institute/Competitive_exam/DataStructures.pdf - Unit 1 & 2 Covered
2. https.//www.baeldung.com/cs/multi-way-search-trees –Searching Concepts

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Google form	5
Project based assignment	Demo and viva	5
Attendance		5
Total		**40**

25PCST12	ARTIFICIAL INTELLIGENCE FOR INDUSTRIAL APPLICATIONS	Category	L	T	P	Credit	Total Hours
		PC	2	1	0	3	45

Course Objective

- To impart foundational and advanced knowledge of Artificial Intelligence techniques applicable to industrial domains and analyze, design, and implement AI-based solutions for automation, optimization, and predictive analytics in industries.

Prerequisite

- Basics of Artificial Intelligence

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand and explain the fundamental concepts of Artificial Intelligence, problem-solving methods, search strategies, and knowledge representation techniques used in industrial contexts.	**Understand**
CO2	Apply industrial challenges and evaluate the suitability of different AI technologies for solving real-world industrial problems and enhancing value transformation.	**Apply**
CO3	Apply technical elements and AI algorithms in various industrial AI scenarios such as predictive maintenance, intelligent operations, and cyber-physical systems.	**Apply**
CO4	Analyze industrial organizations' AI capability maturity and propose strategies for implementing AI-driven transformation using assessment frameworks and case studies.	**Analyze**
CO5	Design and evaluate AI-based solutions for industrial automation using machine learning, NLP, computer vision, and digital platforms through real-time case studies.	**Create**

Syllabus :

UNIT- I - Introduction to Al and Production Systems **9 Hours**

Introduction to Al - Problem formulation, Problem Definition - Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production systems - Problem solving methods -Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing, Depth first and Breath first, Constraints satisfaction, Knowledge Representation and Reasoning.

UNIT- II The Development and Application of AI Technology **9 Hours**

Why do we need Industrial AI New Perspective in industrial systems for AI, Basic problem in Industry, Basic method of problem solving with AI, what kind of AI Technology is most suitable for industry, Machine Intelligence meets industry, Difference between industry AI and AI, Challenge of AI in Industry, New opportunity spaces for industry AI to realize industrial value transformation. Definition and Meaning of Industrial AI The Beginning of Industrial AI, Purpose and value of Industrial AI, GE predix success and failure.

UNIT- III Technical Elements and Algorithm of Industrial AI **9 Hours**

Technical Element Data, Analytics, Platform, Operation and Human Machine Technology, CPS, Industrial AI. Categories of Algorithm, Industrial AI Algorithm. Selection and Application. Application Scenario Types of Industrial AI, Enabling Industrial AI system Intelligence monitoring

and maintenance platform for CNC machine, Intelligence operation, intelligence rail transit predictive maintenance system.

UNIT- IV How to Establish Industry AI Technology and Capability 9 Hours

Assessment of Basic capability Maturity during industrial intelligence transformation Assessment Tools for global industrial AI enterprise transformation achievement Foxconn Lighthouse factory How to construct organizational intelligence transformation ability in industrial enterprises Open-source industrial big data competitions.

UNIT- V Industrial AI applications and Case Studies 9 Hours

Applications of Industrial AI in Monitoring, optimization and control.AI applications in Industry Automation using -Natural Language Processing-Speech Recognition-Computer vision. Machine Learning Models for Industrial Applications, AI & Digital Platforms case study. A Framework for Learning System for Complex Industrial Processes.

TOTAL HOURS : 45

Text Book

1. Elaine Rich, "Artificial Intelligence", 2nd Edition, McGraw Hill, 2005 2.
2. AI and Learning Systems - Industrial Applications and Future Directions, Konstantinos Kyprianidis and Erik Dahlquist, published in London, United Kingdom, 2021.
3. Industrial AI Application with sustainable performance, Jay Lee, Springer Publication, 2020.

Reference Book

1. Anuradha Srinivasaraghavan, Vincy Joseph "Machine Learning", Wiley, 2019
2. Wolfgang Ertel," Introduction to Artificial Intelligence", Second Edition, Springer, 2017.
3. Rajiv Chopra, "Deep Learning", 1st edition, Khanna Publishing House, 2018.

Web Resources

1. https.//nptel.ac.in/courses/106106140 –Artificial Intelligence
2. https.//nptel.ac.in/courses/106105195 - AI with Applications

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	1	2	3	-	-	2	-	3
CO2	1	2	3	2	2	2	-	3
CO3	1	2	3	1	3	3	1	3
CO4	2	2	3	1	3	3	1	3
CO5	2	3	3	1	3	3	-	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Google form	5
Project based assignment	Demo and viva	5
Attendance		5
Total		**40**

25PCST13	ADVANCED SOFTWARE ENGINEERING AND TESTING	Category	L	T	P	Credit	Total Hours
		PC	2	1	0	3	45

Course Objective

- The objective of this course is to provide students with a comprehensive understanding of advanced software engineering principles, development methodologies, and architectural design strategies for building large-scale, maintainable software systems. It aims to equip learners with the knowledge and skills necessary to plan, design, develop, and test complex software applications using modern engineering practices.

Prerequisite

- Software Engineering, Software Testing

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand and compare various software process models, scenario-based and object-oriented modeling techniques, and apply project planning and risk management practices for effective software development.	Understand
CO2	Apply software design principles, architectural patterns, and user-centered design strategies and system software.	Apply
CO3	Analyze system dependability and security principles such as fault tolerance, reliability, safety, and cybersecurity techniques to engineer secure and resilient systems.	Analyze
CO4	Demonstrate knowledge of service-oriented and real-time software engineering practices, including embedded system design, system operation, and timing analysis using appropriate architectural frameworks.	Apply
CO5	Apply various software testing techniques and configuration management strategies to ensure quality assurance, traceability, and version control across software environments.	Apply

Syllabus

UNIT- I Software Process Models and Project Management Activities 9 Hours

Software engineering concepts Software Process Software lifecycle models - waterfall RAD - Prototyping Evolutionary - Spiral Agile XP Scrum Kanban Requirements Engineering – Scenario-based Modelling – Class-based Modelling – Functional Modelling – Behavioural Modelling. - Software project management Management Activities - Project planning Scheduling Risk management Software Configuration Management.

UNIT- II Software Design 9 Hours

Design Concepts – Design Model – Software Architecture – Architectural Styles – Architectural Design – Component-Level Design – User Experience Design – Design for Mobility – PatternBased Design

UNIT- III System Dependability And Security 9 Hours

Dependable Systems – Dependability Properties – Sociotechnical Systems – Redundancy and Diversity – Dependable Processes – Formal Methods and Dependability – Reliability Engineering – Availability and Reliability – Reliability Requirements – Fault-tolerant Architectures – Programming for Reliability – Reliability Measurement – Safety Engineering – Safety-critical Systems – Safety Requirements – Safety Engineering Processes – Safety Cases – Security

Engineering – Security and Dependability – Safety and Organizations – Security Requirements – Secure System Design – Security Testing and Assurance – Resilience Engineering – Cybersecurity – Sociotechnical Resilience – Resilient Systems Design.

UNIT- IV Service-Oriented Software Engineering **9 Hours**

Service-oriented Architecture – RESTful Services – Service Engineering – Service Composition – Systems Engineering – Sociotechnical Systems – Conceptual Design – System Procurement – System Development – System Operation and Evolution – Real-time Software Engineering – Embedded System Design – Architectural Patterns for Real-time Software – Timing Analysis – Real-time Operating Systems.

UNIT- V Software Testing And Software Configuration Management **9 Hours**

Software Testing Strategy – Unit Testing – Integration Testing – Validation Testing – System Testing – Debugging – White-Box Testing – Basis Path Testing – Control Structure Testing – Black-Box Testing – Software Configuration Management (SCM) – SCM Repository – SCM Process – Configuration Management for Web and Mobile Apps. **TOTAL HOURS : 45**

Text Book

1. Roger Pressman, Software Engineering. A Practitioner's Approach, 7th Edition, McGraw-Hill, 2010.
2. Ian Sommerville, Software Engineering, 9th Edition, Addison-Wesley, 2010.
3. Pankaj Jalote, A Concise Introduction to Software Engineering, Springer,2008.
4. William E. Lewis, "Software Testing and Continuous Quality Improvement", Third Edition, Auerbach Publications, 2008.

Reference Book

1. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd edition, PHI Learning Pvt. Ltd., 2010.
2. Bernd Bruegge, Alan H Dutoit, Object-Oriented Software Engineering, 2nd edition, Pearson Education, 2004.

Web Resources

1. https://www.coursera.org –Testing and Validation

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	3	3	3	3	3	-	3
CO2	2	3	3	3	2	3	-	3
CO3	3	1	2	2	1	2	1	3
CO4	2	3	1	2	1	2	1	3
CO5	3	3	1	2	2	2	-	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Google form	5
Project based assignment	Demo and viva	5
Attendance		5
Total		**40**

25PCST14	ADVANCED DATABASE TECHNOLOGY	Category	L	T	P	Credit	Total Hours
		PC	2	1	0	3	45

Course Objective

- The objective of this course is to provide students with an in-depth understanding of advanced database concepts, architectures, and technologies beyond traditional relational models. It aims to equip learners with the knowledge and skills to design, implement, and manage complex databases, including distributed databases, NoSQL systems, data warehousing, and big data technologies.

Prerequisite

- Database Management System

Course Outcome : On the successful completion of the course, students will be able to

CO1	Convert Entity-Relationship (ER) models into relational schemas, populate relational databases, and construct efficient SQL queries for data retrieval and manipulation.	Understand
CO2	Develop and validate well-structured XML documents for representing semi-structured data in modern database applications.	Apply
CO3	Apply distributed query processing techniques to execute and optimize queries across multiple database systems.	Apply
CO4	Design and implement secure database architectures with a focus on authentication, authorization, and data protection mechanisms.	Create
CO5	Utilize data definition, control, and manipulation operations in NoSQL databases for handling unstructured and large-scale data efficiently.	Apply

Syllabus

UNIT- I Relational Data Model **9 Hours**

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization.

UNIT- Distributed Database and Open Database Connectivity **9 Hours**

Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Event Condition Action Model – Design and Implementation Issues for Active Databases – Open Database Connectivity.

UNIT- III XML Databases **9 Hours**

Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery

UNIT- IV NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS **9 Hours**

NoSQL – Categories of NoSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Wide Column NoSQL Systems – Hbase Data Model – Hbase Crud Operations – Hbase Storage and Distributed System Concepts – NoSQL Graph Databases and Neo4j – Cypher Query Language of Neo4j – Big Data – MapReduce – Hadoop – YARN.

UNIT- V Database Security **9 Hours**

Database Security Issues – Discretionary Access Control Based on Granting and Revoking Privileges – Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection – Statistical Database Security – Flow Control – Encryption and Public Key Infrastructures – Preserving Data Privacy – Challenges to Maintaining Database Security – Database Survivability – Oracle Label-Based Security.

TOTAL HOURS:45

Text Book

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education 2016.
2. Henry F. Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2019.
3. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006

Reference Book

1. Raghu Ramakrishnan , Johannes Gehrke "Database Management Systems", Fourth Edition, McGraw Hill Education, 2015.
2. Harrison, Guy, "Next Generation Databases, NoSQL and Big Data" , First Edition, Apress publishers, 2015
3. Peter rob, Carlos Coronel, "Database Systems – Design, Implementation, and Management", 10th Edition, Thomson Learning, 2014.

Web Resource:

1. https://web.stanford.edu/class/cs145/ - NOSQL Database
2. https://www.w3schools.com/sql/ - Database ssytem
3. https://university.mongodb.com/ - Mangodb
4. https://codex.cs.yale.edu/avi/db-book/ - Database Security

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	1	3	1	2	-	3
CO2	2	2	-	2	1	1	1	3
CO3	3	1	2	1	-	1	1	3
CO4	3	2	2	1	1	1	1	3
CO5	2	3	1	1	-	1	1	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project based assignment	Demo and viva	5
Attendance		5
Total		**40**

25PCST15	RESEARCH METHODOLOGY AND IPR	Category	L	T	P	Credit	Total Hours
		RMC	2	1	0	3	45

Course Objective

- The objective of this course is to impart fundamental knowledge of research principles, methodologies, and ethics. It also introduces students to the essentials of Intellectual Property Rights (IPR), enabling them to understand how innovations are legally protected and how research translates into patents and other forms of intellectual assets.

Prerequisite

- Basic knowledge of scientific methods
- Familiarity with technical writing
- Understanding of ethics and legal systems is helpful but not required

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand research processes, problem formulation, and hypothesis development	Understand
CO2	Apply various research design and data collection methodologies	Apply
CO3	Analyze and interpret data using appropriate statistical tools	Analyze
CO4	Explain the significance of IPR and the process of patent filing	Understand
CO5	Evaluate ethical and legal considerations in research and intellectual property	Evaluate

Syllabus

UNIT I. Research Fundamentals **9 Hours**

Definition and objectives of research – Characteristics and types of research – Research approaches – Criteria of good research – Research process – Defining and formulating the research problem – Review of literature – Research gap identification.

UNIT II. Research Design and Data Collection **9 Hours**

Research design. Exploratory, descriptive, experimental – Sampling design – Measurement scales – Methods of data collection – Questionnaire design – Case study method – Reliability and validity – Sources of error.

UNIT III. Data Analysis and Interpretation **9 Hours**

Processing and analysis of data – Measures of central tendency and dispersion – Correlation and regression – Hypothesis testing – ANOVA – Chi-square test – Use of statistical tools and software (SPSS/R/Excel) – Report writing and presentation.

UNIT IV. Intellectual Property Rights (IPR) **9 Hours**

Introduction to IPR – Types of Intellectual Property. Patents, Copyrights, Trademarks, Industrial Design, Trade Secrets – Process of patenting and grant of patent – Infringement, piracy, and penalties – Case studies on patent disputes.

UNIT V. IPR in Academia and Industry **9 Hours**

Patentable and non-patentable inventions – Patent search and databases – Licensing and technology transfer – Role of IPR in academic research – Startups and innovation protection – IPR ethics – National and international IPR organizations (WIPO, IPO, TRIPS).

TOTAL HOURS: 45
Text Book 1. C.R. Kothari and Gaurav Garg, Research Methodology. Methods and Techniques, New Age International Publishers. **2.** R. Subbaram, Intellectual Property Rights Made Easy, Lexis Nexis.
Reference Book 1. C.R. Kothari and Gaurav Garg, Research Methodology. Methods and Techniques, New Age International Publishers. **2.** R. Subbaram, Intellectual Property Rights Made Easy, Lexis Nexis. **Web Resources** 1. https.//nptel.ac.in/courses/121106007 – NPTEL. Research Methodology 2. https.//www.wipo.int – World Intellectual Property Organization 3. https.//ipindia.gov.in – Government of India Intellectual Property Office 4. https.//www.coursera.org/learn/research-methods – Coursera. Research Methods

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	2	3	2	3	-	3
CO2	3	-	1	-	1	3	-	3
CO3	3	-	-	1	1	2	-	3
CO4	3	-	-	1	1	1	1	3
CO5	3	-	-	1	1	1	1	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSP11	ADVANCED DATA STRUCTURE AND ALGORITHMS LAB	Category	L	T	P	Credit	Total Hours
		PC	0	0	2	2	45

Course Objective

- To provide practical knowledge and hands-on experience on implementing advanced data structures and algorithms, with emphasis on time-space complexity analysis, efficient data handling, and solving real-world computational problems.

Prerequisite

- Knowledge about Data Structures and Algorithms

Course Outcome : On the successful completion of the course, students will be able to

CO1	Evaluate the algorithm‟s / program‟s efficiency in terms of time and space complexity	Evaluate
CO2	Solve the given problem by identifying the appropriate Data Structure.	Apply
CO3	Construct various applications based on sorting and tree data structure	Apply
CO4	Apply graph data structures to solve real time applications such as network flow and linear programming.	Apply
CO5	Illustrate the performance of the polynomial time algorithm.	Understand

List of Experiments

1. Write a C / C++ program for the implementation of Arrays and Structures
2. Singly and Doubly Linked List
3. Stacks and Queues using Linked Lists
4. Binary Search Tree using Linked Lists - Searching, Insertion and Deletion
5. AVL Trees – Insertion and Deletion
6. Splay Trees – Insertion and Deletion
7. 2-3 Trees - Searching, Insertion and Deletion
8. B+ tree - Searching, Insertion and Deletion
9. Skew and Leftist Heaps – Insertion and Del-Min
10. Dijkstra’s and Prim’s Algorithms using Heaps
11. Treaps – Insertion and Deletion
12. Kruskal’s algorithm using Disjoint Set operations

TOTAL HOURS : 45

HARDWARE/SOFTWARE REQUIREMENTS

1. 64-bit Open source Linux or its derivative
2. Open Source C++ Programming tool like G++/GCC

Reference Book

1.Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, “Introduction to Algorithms”, MIT Press, 2022.
2. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, AddisonWesley, 2014.
3.Michael T. Goodrich, Roberto Tamassia, David Mount, “Data Structures and Algorithms in C++”, John Wiley, 2016.
4.Robert L Kruse, Clovis L Tondo, “Data Structures and Program design in C”, Pearson, 2013.
5.Sahni Sartaj, "Data Structures, Algorithms and Applications in C++", Silicon Press, 2013.
6.Motwani R, Raghavan P ,“Randomized Algorithms”, Cambridge University Press, 2014.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	**Assessment Tools**	**Marks**
Laboratory Conduction	Observation	10
Record work		10
Model exam		15
Viva		5
Virtual lab assignment	Coding assignments submitted online	10
Attendance		10
Total		60

25PCSP12	ADVANCED SOFTWARE ENGINEERING AND TESTING LAB	Category	L	T	P	Credit	Total Hours
		PC	0	0	30	2	45

Course Objective

To impart state-of-the-art knowledge on Software Engineering and UML in an interactive manner through the Web. Present case studies to demonstrate practical applications of different concepts. Provide a scope to students where they can solve small, real-life problems.

Prerequisite

- Software Engineering

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand a clear and bounded problem statement for a real-time software project and identify an appropriate software process model with its associated activities and task sets.	Understand
CO2	Develop a detailed Software Requirements Specification (SRS), use case models, and design diagrams including activity, class, sequence, collaboration, and state transition diagrams using modeling tools.	Apply
CO3	Construct data design models using Data Flow Diagrams (DFDs), Decision Tables, and Entity Relationship (ER) diagrams for efficient data representation and system analysis.	Apply
CO4	Design and execute effective software testing strategies by writing test cases mapped to SRS, and apply software metrics such as Function Point Analysis for size estimation.	Create
CO5	Estimate project cost using COCOMO and COCOMO II models, and plan, schedule, and track the project using CPM, PERT, Gantt charts, and timeline tracking tools..	Evaluate

List of Experiments

1. Define the problem statement and business case for a project.
2. Identify the appropriate process model suitable for the project.
3. Develop the project plan and schedule.
4. Identify requirements and develop SRS.
5. Develop the various UML diagrams.
6. Create the System and Architecture design.
7. Create the User Interface design.
8. Develop a Test Plan.
9. Perform Unit testing & Integration Testing.
10. Perform System testing.
11. Devise the metrics for the Product.
12. Perform Size Estimation.

TOTAL HOURS : 45

Software Requirements:

Microsoft Word, Google Docs, Microsoft Project, Jira, Lucidchart, StarUML, Figma, TestRail, JUnit, Google Test, Selenium, SonarQube, Jenkins, COCOMO Estimation Tools

Reference Book

1.Roger Pressman, Software Engineering: A Practitioner's Approach, 7th Edition, McGraw-Hill, 2010

2.Ian Sommerville, Software Engineering, 9th Edition, Addison-Wesley, 2010.

3.Pankaj Jalote, A Concise Introduction to Software Engineering, Springer,2008.
4.William E. Lewis, “Software Testing and Continuous Quality Improvement”, Third Edition, Auerbach Publications, 2008.
5.Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd edition, PHI Learning Pvt. Ltd., 2010.
6.Bernd Bruegge, Alan H Dutoit, Object-Oriented Software Engineering, 2nd edition, Pearson Education, 2004.
7.Srinivasan Desikan and Gopalaswamy Ramesh, ―Software Testing – Principles and Practices‖, Pearson Education, 2006.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	3	3	3	3	3	-	3
CO2	2	3	3	3	2	2	-	3
CO3	3	1	2	2	1	2	1	3
CO4	2	3	2	2	1	-	1	3
CO5	2	3	1	2	1	-	1	3

Assessment Methodology	Assessment Tools	Marks
Laboratory Conduction	Observation	10
Record work		10
Model exam		15
Viva		5
Virtual lab assignment	Assignments on testing frameworks / tools	10
Attendance		10
Total		60

SEMESTER-II

25PCST21	DEEP LEARNING ARCHITECTURES	Category	L	T	P	Credit	Total Hours
		PC	3	0	0	3	45

Course Objective

- This course aims to equip students with the theoretical foundations and practical implementation strategies of deep learning architectures. It focuses on training complex neural networks, optimization strategies, and real-world applications across domains such as computer vision, natural language processing, and generative modeling.

Prerequisite

- Basic knowledge of Machine Learning
- Linear Algebra, Probability, and Calculus
- Python programming (NumPy, TensorFlow or PyTorch basics)

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand the differences between generative and discriminative models and explore the foundational principles of generative modeling, including representation learning and deep neural networks.	Understand
CO2	Apply deep generative modeling techniques such as autoregressive models and flow-based models to real-world datasets and evaluate their performance using practical case studies.	Apply
CO3	Analyze latent variable models like probabilistic PCA and variational autoencoders, and explore hierarchical extensions for modeling complex data distributions.	Analyze
CO4	Construct hybrid generative models including GANs, energy-based models, and restricted Boltzmann machines, and address training challenges through case-based learning.	Apply
CO5	Evaluate advanced generative architectures such as VAEs, GANs, transformers, and attention-based models through real-world applications in AI art, music, and text generation.	Evaluate

Syllabus

UNIT- I Generative Modeling **9 Hours**

Introduction - Generative Versus Discriminative Modeling - Advances in Machine Learning - The Rise of Generative Modeling - The Generative Modeling Framework – Probabilistic Generative Models - The Challenges of Generative Modeling - Representation Learning -Setting Up Your Environment – Deep Learning – Structural and unstructural data – Deep Neural Network – Example – Improving model.

UNIT- II - Deep Generative Modeling **9 Hours**

Types – Autoregressive models - Autoregressive Models Parameterized by Neural Networks - Deep Generative Autoregressive Model: an example Flow based models - Flows for Continuous Random Variables - Change of Variables for Deep Generative Modeling - Building Blocks of RealNVP – example - Flows for Discrete Random Variables - Flows in R or Maybe Rather in Z - Integer Discrete Flows. Case study using Deep generative modeling

UNIT- III Latent Variable Models **9 Hours**

probabilistic principal component analysis - Variational Auto-Encoders: Variational Inference

for Non-linear Latent Variable Models - Improving Variational Auto-Encoders - Hierarchical Latent Variable Models

UNIT- IV Hybrid Modeling and GAN **9 Hours**

Naïve approach – shared parameterization approach – example – Energy based models – model formation – training – example – restricted Boltzmann machines Generative adversarial networks – GAN architecture – GAN challenges – Wassertein GAN – WGAN – GP. Case study using Hybrid approach with GAN

UNIT- V Advanced Architectures and Generative Modeling **9 Hours**

Autoencoders – Variational Autoencoders (VAE) – Generative Adversarial Networks (GANs) – Transformer Models – Attention Mechanisms – applications of generative modelling Case studies – BERT – GPT-2- MuseNet – ProGAN – SAGAN – BigGAN – StyleGAN – AI Art – AI Music.

TOTAL HOURS:45

Text Book :

1. David Foster, Generative Deep Learning, Teaching Machines to Paint, Write, Compose, and Play, O'Reilly Media, Inc., 2019, ISBN: 9781492041948
2. Jakub M. Tomczak, Deep Generative Modeling, Springer nature, Edition 1, 2022, ISBN - 978- 3-030-93157-5
3. Kailash Ahirwar, Generative Adversarial Networks Projects, build next-generation generative models using TensorFlow and Keras, pakt publisher, 2019.

Reference Book

1.Roozbeh Razavi-Far, Ariel Ruiz-Garcia, Vasile Palade, Juergen Schmidhuber, Generative Adversarial Learning: Architectures and Applications, (2022), Springer Cham
2.Jakub M. Tomczak, Deep Generative Modeling, Springer, 2022, 978-3-030-93158-2

Web Resources

- https://developer.ibm.com/articles/cc-machine-learning-deep-learning- architectures/- Latent Variable Model.
- https://www.coursera.org/specializations/deep-learning - Deep Generative models.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	-	3	3	3	-	1	3
CO2	2	1	3	3	2	2	1	3
CO3	3	1	2	2	1	2	2	3
CO4	2	1	2	2	1	2	2	3
CO5	2	2	1	2	1	2	2	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCST22	FULL STACK DEVELOPMENT FRAMEWORKS	Category	L	T	P	Credit	Total Hours
		PC	3	1	0	4	60

Course Objective

- The course emphasizes the design and development of responsive user interfaces, RESTful APIs, server-side logic, and database integration using technologies such as React, Angular, Node.js, Express, and MongoDB

Prerequisite

- Web Technology

Course Outcome : On the successful completion of the course, students will be able to

CO1	Design and develop modular and maintainable web applications using TypeScript.	Apply
CO2	Develop robust front-end applications using Angular with advanced routing and form handling.	Apply
CO3	Implement asynchronous backend operations and file handling in Node.js.	Analyze
CO4	Build RESTful services using Express.js and manage routing, middleware, and error handling.	Create
CO5	Apply CRUD operations, indexing, and aggregation to store and retrieve data using MongoDB.	Apply

Syllabus

UNIT- I FUNDAMENTALS & TYPESCRIPT LANGUAGE 12 Hours

Server-Side Web Applications. Client-Side Web Applications. Single Page Application. About TypeScript. Creating TypeScript Projects. TypeScript Data Types. Variables. Expression and Operators. Functions. OOP in Typescript. Interfaces. Generics. Modules. Enums. Decorators. Enums. Iterators. Generators.

UNIT- II - ANGULAR 12 Hours

About Angular. Angular CLI. Creating an Angular Project. Components. Components Interaction. Dynamic Components. Angular Elements. Angular Forms. Template Driven Forms. Property, Style, Class and Event Binding. Two way Bindings. Reactive Forms. Form Group. Form Controls. About Angular Router. Router Configuration. Router State. Navigation Pages. Router Link. Query Parameters. URL matching. Matching Strategies. Services. Dependency Injection. HttpClient. Read Data from the Server. CRUD Operations. Http Header Operations. Intercepting requests and responses.

UNIT- III - NODE.js 12 Hours

About Node.js. Configuring Node.js environment. Node Package Manager NPM. Modules. Asynchronous Programming. Call Stack and Event Loop. Callback functions. Callback errors. Abstracting callbacks. Chaining callbacks. File System. Synchronous vs. asynchronous I/O. Path and directory operations. File Handle. File Synchronous API. File Asynchronous API. File Callback API. Timers. Scheduling Timers. Timers Promises API. Node.js Events. Event Emitter. Event Target and Event API. Buffers. Buffers and TypedArrays. Buffers and iteration. Using buffers for binary data. Flowing vs. non-flowing streams. JSON.

UNIT- IV EXPRESS.Js 12 Hours

Express.js. How Express.js Works. Configuring Express.js App Settings. Defining Routes. Starting the App. Express.js Application Structure. Configuration, Settings. Middleware. body-

parser. cookie-parser. express-session. response-time. Template Engine. Jade. EJS. Parameters. Routing. router.route(path). Router Class. Request Object. Response Object. Error Handling. RESTful.

UNIT- V MONGODB **12 Hours**

Introduction to MongoDB. Documents. Collections. Subcollections. Database. Data Types. Dates. Arrays. Embedded Documents. CRUD Operations. Batch Insert. Insert Validation. Querying The Documents. Cursors. Indexing. Unique Indexes. Sparse Indexes. Special Index and Collection Types. Full-Text Indexes. Geospatial Indexing. Aggregation framework.

TOTAL HOURS:60

Text Book

1. Philip Ackermann, Full Stack Web Development - The Comprehensive Guide, Rheinwerk Computing, 2023.
2. Paul Wellens, Practical Web Development, Packt Publishing, 2015.
3. Sammie Smith, Full Stack Web Development Guide, Fullstack Publication, 2022.
4. Chris Northwood, The Full Stack Developer, Apress Publications, 2018.

Reference Book

1. Jack Chan, Ray Chung, & Jack Huang, Python API Development Fundamentals, Packt Publishing, 2019.
2. Anthony Accomazzo, Ari Lerner, Nate Murray, Clay Allsopp, David Gutman, and Tyler McGinnis, Fullstack React – The Complete Guide to ReactJs and Friends, Fullstack.io, 2017.
3. Len Bass, Ingo Weber and Liming Zhu,DevOps – A Software Architect's Perspective, Pearson Education, 2015.

Web Resources

- https://www.coursera.org/professional-certificates/ibm-full-stack-cloud-developer - Full Stack Developer
- https://www.simplilearn.com/full-stack-developer-course-mern-certification-training-RactJs and Node JS

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	-	-	2	3	3	3	2	3
CO2	-	-	2	3	3	3	2	3
CO3	2	2	2	1	3	3	2	3
CO4	2	2	2	1	3	3	2	3
CO5	2	2	1	2	3	3	2	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCST23	CRYPTOCURRENCIES AND BLOCKCHAIN TECHNOLOGY	Category	L	T	P	Credit	Total Hours
		PC	3	0	0	3	45

Course Objective

- This course aims to provide a solid foundation in the principles and architecture of blockchain technology and its applications in cryptocurrencies. It introduces learners to distributed ledgers, consensus mechanisms, cryptographic techniques, and smart contracts. The course also explores real-world blockchain platforms and use cases, focusing on security, scalability, and the future of decentralized applications.

Prerequisite

- Knowledge about Cryptocurrencies
- Knowledge about Blockchain Technology

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand the fundamental concepts of cryptocurrencies and their integration within blockchain technology.	Understand
CO2	Design and apply various cryptographic algorithms to ensure security and integrity in blockchain-based systems.	Apply
CO3	Develop and implement blockchain network protocols and analyze their role in decentralized communication.	Analyze
CO4	Evaluate the architecture and functionalities of Ethereum and its application in deploying cryptocurrency solutions.	Evaluate
CO5	Apply artificial intelligence techniques to enhance blockchain functionalities such as fraud detection, smart contract optimization, and intelligent consensus mechanisms.	Apply

Syllabus

UNIT- I Introduction **9 Hours**

Introduction to cryptocurrency Basics of crypto and cryptocurrencies: Cryptographic Hash functions - Hash Pointers Digital Signatures Examples - Public Key as Identities Mechanics of Bitcoin: Bitcoin Transactions Bitcoin Scripts - Applications of Bitcoin Scripts Bitcoin Blocks - Bitcoin Network - Limitations and Improvements - Construction of a Cryptocurrency Portfolio - Understanding Crypto Trading -Wallets - Public Key - Private Key

UNIT- II - Bitcoin Technology **9 Hours**

Bitcoin Technology-Introduction Bitcoin storage Hot and Cold Storage, Splitting and Sharing Keys Online wallets and Exchanges, Payment Services - Simplified Payment Verification (SPV) - Transaction Fees - Currency Exchange Markets - Managing secret keys of wallet - Hardware wallet - Paper wallet - Bitcoin Mining Cryptocurrencies as investment option- Example - Analytical framework for crypto investment option Fundamental Analysis and Technical analysis - Network Metrics as a price indicator

UNIT- III Blockchain Technology **9 Hours**

Blockchain Technology-Introduction Basics of Blockchain Technology - Introduction to Ledgers, Working of financial systems -Difference between blockchain with database History of Blockchain - Characteristics of Blockchain - Distributed Ledger and Blockchain Comparison of Distributed Ledger and Blockchain - Types of Blockchain- – Public, Private, Consortium - Blockchain layers – Forks - Double Spending Problem - Byzantine Fault Tolerance protocol - Voting Protocol - Sybil resistance - Permissioned Consensus - Streamlet: A blockchain protocol

- Nakamoto consensus protocol - Mining Incentives – Case Study: Bitcoin vs Bitcoin cash

UNIT- IV Decentralized Finance **9 Hours**

Decentralized Finance (DeFi)-Introduction History of Decentralized Finance (DeFi) - DeFi Foundations – Characteristics - Advantages of DeFi - DeFi Primitives: Transaction Mechanisms - Fungible Token - NonFungible Token Example -Supply and Ownership: Custody – supply Adjustment - incentives Exchanges: Centralized Exchange decentralized exchange (DEX) - Use cases Automated Market Makers (AMM) - Uniswap - Collateralized Loan – Flash Loans - Incentives for Liquidity providers

UNIT- V Cryptocurrency Techniques **9 Hours**

Cryptocurrency Techniques-Introduction Privacy for cryptocurrency Anonymity Privacy of Digital Payments Privacy of Digital Payments – demo Understanding Ethereum Privacy in Ethereum Privacy in Bitcoin - Coin Mixing - Litecoin (LTC) - Altcoins – Example unidirectional, bi-directional and UTXO - Examples. **TOTAL HOURS:45**

Text Book

1. Koushik Raj, "Foundation of Blockchain: The pathway to Cryptocurrencies and Decentralised Blockchain Applications ", Kindle Edition, 2019.
2. Arvind Narayanan, Joesph Bonnecau, Edward Felten, Andrew Miller, and Steven Goldfeder." Bitcoin and cryptocurrency technologies: A Comprehensive Introduction" Princeton University Press, 2016

Reference Book

1. Cryptocurrencies and Blockchain Technology Applications. United States: Wiley, 2020.
2. Drescher, Daniel. Blockchain Basics: A Non-Technical Introduction in 25 Steps. United States: Apress, 2017.

Web Resources

1. https://www.coursera.org/learn/cryptocurrency - Bitcoin and cryptocurrencies
2. https://tech.seas.harvard.edu/free-blockchain - Blockchian Technology

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	1	3	3	2	3	1	3
CO2	2	1	2	3	2	2	1	3
CO3	2	1	3	1	3	3	2	3
CO4	2	1	2	2	3	3	2	3
CO5	2	1	2	2	3	3	2	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCST24	HIGH PERFORMANCE NETWORKING	Category	L	T	P	Credit	Total Hours
		PC	3	0	0	3	45

Course Objective

- This course introduces the fundamental concepts of High Performance Computing (HPC), focusing on its architecture, design, and computational principles. It explores the network and software infrastructure essential for building and maintaining HPC systems, along with real-time analytics capabilities.

Prerequisite

- Computer Networking

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand the basics concepts of High Performance computing systems.	Understand
CO2	Apply the concepts of network and software infrastructure for high performance computing	Apply
CO3	Apply real time analytics using high performance computing.	Apply
CO4	Apply the security models and big data applications in high performance computing	Apply
CO5	Apply the emerging big data applications.	Apply

Syllabus

UNIT- I Introduction **9 Hours**

The Emerging IT Trends- IOT/IOE-Apache Hadoop for big data analytics-Big data into big insights and actions – Emergence of BDA discipline – strategic implications of big data – BDA Challenges – HPC paradigms – Cluster computing – Grid Computing – Cloud computing – Heterogeneous computing – Mainframes for HPC - Supercomputing for BDA – Appliances for BDA.

UNIT- II - NETWORK & SOFTWARE INFRASTRUCTURE FOR HIGH PERFORMANCE **9 Hours**

Design of Network Infrastructure for high performance BDA – Network Virtualization – Software Defined Networking – Network Functions Virtualization – WAN optimization for transfer of big data – started with SANs- storage infrastructure requirements for storing big data – FC SAN – IP SAN – NAS – GFS – Panasas – Luster file system – Introduction to cloud storage.

UNIT- III REAL TIME ANALYTICS USING HIGH PERFORMANCE COMPUTING **9 Hours**

Technologies that support Real time analytics – MOA: Massive online analysis – GPFS: General parallel file system – Client case studies – Key distinctions – Machine data analytics – operational analytics – HPC Architecture models – In Database analytics – In memory analytics

UNIT- IV SECURITY AND TECHNOLOGIES **9 Hours**

Security, Privacy and Trust for user – generated content: The challenges and solutions – Role of real time big data processing in the IoT – End to End Security Framework for big sensing data streams – Clustering in big data

UNIT- V EMERGING BIG DATA APPLICATIONS **9 Hours**

Deep learning Accelerators – Accelerators for clustering applications in machine learning - Accelerators for classification algorithms in machine learning – Accelerators for Big data Genome Sequencing.

TOTAL HOURS:45

Text Book

1."High performance computing: Modern systems and practices", Thomas Sterling, Matthew Anderson, Morgan Kaufmann publishers,1st Edition,2017.

2."High-Performance Data Mining And Big Data Analytics" , Khosrow Hassibi, Create Space Independent Publishing Platform,!st Edition,2014.

3. "High Performance Computing for Big Data: Methodologies and Applications", Chao wang ,CRC Press,1st Edition,2018.

Reference Book

1. Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, "HighPerformance Big-Data Analytics: Computing Systems and Approaches", Springer, 1st Edition, 2015.
2. "Big Data Management and Processing", Kuan-Ching Li , Hai Jiang, Albert Y. Zomaya,CRC Press,1st Edition,2017

Web Resources

1. https://www.hpcwire.com/
2. http://hpc.fs.uni-lj.si/sites/default/files/HPC_for_dummies.pdf .
3. https://www.nics.tennessee.edu/computing-resources/what-is-hpc

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	1	3	3	-	3	1	3
CO2	-	-	2	3	2	2	1	3
CO3	1	1	3	-	3	3	2	3
CO4	3	1	2	2	3	3	2	3
CO5	2	1	2	2	3	3	2	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSP21	DEEP LEARNING LAB	Category	L	T	P	Credit	Total Hours
		PC	0	0	2	2	45

Course Objective

To acquire knowledge about supervised and unsupervised learning algorithms, understand and perform feature engineering, statistical data analysis and outlier analysis, develop, deploy and evaluate machine learning models with explain ability.

Prerequisite

1. Basic knowledge of Python programming
2. Understanding of machine learning fundamentals
3. Linear algebra and probability basics
4. Familiarity with neural networks (theoretical)

Course Outcome : On the successful completion of the course, students will be able to

CO1	Implement basic neural networks and backpropagation from scratch and using frameworks	Apply
CO2	Design, train and evaluate CNNs for image classification tasks	Apply
CO3	Develop RNNs, LSTMs for sequential and time-series data	Apply
CO4	Apply transfer learning and fine-tune pre-trained models on new datasets	Apply
CO5	Deploy deep learning models for real-world applications in vision, NLP, and forecasting	Create

List of Experiments:

1. Understanding "Mobile Price" dataset by doing feature analysis.
2. Execute data preprocessing step on the above dataset: perform outlier and missing data analysis towards building a refined dataset.
3. Build machine learning model/s to predict the actual price of the new mobile based on other given features like RAM, Internal Memory etc.
4. Calculate the prediction accuracy of the models used in Experiment 3 and do comparative analysis among them to identify the best technique.
5. Understanding "Second Hand Car Prediction Price" dataset by doing feature analysis.
6. Perform data preprocessing step on the above dataset: perform outlier and missing data analysis towards building a refined dataset.
7. Perform Feature Engineering towards building new feature which is more impactful. Build machine learning model/s to predict the price of the car based on other given features like Brand, Model, Year, Fuel Type etc.
8. Calculate the prediction accuracy of the models used in Experiment 7 and do comparative analysis among them to identify the best technique.
9. Plot the features (actual price and predicted price) in scatter plot to understand the variation.
10. Understanding "Marketing Campaign Positive Response Prediction" dataset by analysing all the features.
11. Perform exploratory data analysis on the above dataset: perform outlier and missing data analysis towards building a refined dataset. Show the outliers in box plot or through some statistical technique. Find the numerical and categorical features.
12. Perform Feature Engineering towards building new feature which is more impactful than the existing ones. Build the correlation matrix and show visually the relationship among various features.
13. Build machine learning model/s to predict the result of marketing campaign based on

other given features like customer details, gender, annual income etc.

14. Calculate the prediction accuracy of the models used in Experiment 13 and do comparative analysis among them to identify the best technique.
15. Find imbalanced classes, overfitting, and data bias in the above datasets and apply some technique to overcome it.

TOTAL HOURS : 45

Tools Used

TensorFlow, PyTorch, Keras, Google Co / Jupyter Notebook, pandas, NumPy,Matplotlib.

Reference Book

1. Hang Li, Machine Learning Methods - By Springer Nature Singapore (2023)
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron, 2019 (2nd edition)
3. Pattern Recognition and Machine Learning by Christopher M. Bishop, Springer (2006)
4. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto, 1998 (1st edition), 2018 (2nd edition)
5. Dr. R. Nageswara Rao, Machine Learning in Data Science Using Python - By Dreamtech Press (2022
6. Introduction to Machine Learning with Python by Andreas C. Müller and Sarah Guido(2016)

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	-	3	3	3	-	-	3
CO2	2	1	3	3	2	2	-	3
CO3	3	1	2	2	1	2	1	3
CO4	2	1	2	2	1	2	1	3
CO5	2	2	1	2	1	2	1	3

Assessment Methodology	Assessment Tools	Marks
Laboratory Conduction	Observation	10
Record work		10
Model exam		15
Viva		5
Application Based Projects	Demo and viva	10
Attendance		10
Total		60

25PCSP22	FULL STACK DEVELOPMENT FRAMEWORKS LAB	Category	L	T	P	Credit	Total Hours
		PC	0	0	2	2	45

Preamble/ Course Objective

- The objective of this course is to equip students with comprehensive knowledge and hands-on skills in full stack web development using modern front-end and back-end frameworks. The course emphasizes the design and development of responsive user interfaces, RESTful APIs, server-side logic, and database integration using technologies such as React, Angular, Node.js, Express, and MongoDB.

Prerequisite

- Basic knowledge of Python programming
- Understanding of machine learning fundamentals
- Linear algebra and probability basics
- Familiarity with neural networks (theoretical)

Course Outcome : On the successful completion of the course, students will be able to

CO1	Apply TypeScript language features to develop modular and object-oriented client-side applications.	Apply
CO2	Build dynamic and interactive web applications using Angular, including routing, forms, and HTTP client modules.	Apply
CO3	Implement server-side programming using Node.js with asynchronous file handling and event-driven architecture.	Analyze
CO4	Develop RESTful web services using Express.js and handle routing, middleware, and error responses effectively.	Create
CO5	Perform CRUD operations and advanced queries using MongoDB with integration in full stack web applications.	Evaluate

List of Experiments

1. Create a TypeScript project demonstrating data types, variables, functions, and classes.
2. Implement interfaces, enums, generics, and modules in TypeScript.
3. Set up an Angular project using Angular CLI and create basic components.
4. Develop an Angular application with component interaction and dynamic components.
5. Create Angular forms using both Template-driven and Reactive approaches with validation.
6. Implement Angular routing with navigation, query parameters, and lazy loading.
7. Use Angular's HttpClient to perform CRUD operations by consuming REST APIs.
8. Set up a Node.js environment and demonstrate asynchronous programming using callbacks.
9. Perform file system operations using Node.js (synchronous and asynchronous APIs).
10. Create a web server using Express.js with routing and middleware.
11. Build RESTful APIs with Express.js including error handling and request parameters.
12. Connect Node.js with MongoDB using Mongoose and perform CRUD operations.
13. Perform advanced queries, indexing, and aggregation in MongoDB.
14. Develop a full-stack MEAN application integrating Angular frontend, Node/Express backend, and MongoDB database.

TOTAL HOURS:45

Tools Used

HTML, CSS, JavaScript, PHP, MySQL, Node.js, Express.js, Docker, Apache/XAMPP, Text

Editor/IDE (VS Code), Web Browser, Postman.

Reference Book

1. Philip Ackermann, *Full Stack Web Development - The Comprehensive Guide*, Rheinwerk Computing, 2023.
2. Paul Wellens, *Practical Web Development*, Packt Publishing, 2015.
3. Sammie Smith, *Full Stack Web Development Guide*, Fullstack Publication, 2022.
4. Chris Northwood, *The Full Stack Developer*, Apress Publications, 2018.
5. Jack Chan, Ray Chung, & Jack Huang, *Python API Development Fundamentals*, Packt Publishing, 2019.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	-	-	2	3	3	3	2	3
CO2	-	-	2	3	3	3	2	3
CO3	2	2	2	1	3	3	2	3
CO4	2	2	2	1	3	3	2	3
CO5	2	2	1	2	3	3	2	3

Assessment Methodology	Assessment Tools	Marks
Laboratory Conduction	Observation	10
Record work		10
Model exam		15
Viva		5
Application Based Projects	Demo and viva	10
Attendance		10
Total		60

25PCSP23	TECHNICAL REPORT WRITING AND SEMINAR	Category	L	T	P	Credit	Total Hours
		HS	0	2	15	2	45

Course Objective

1. To help students choose a focused research topic and define clear objectives.
2. To build skills in collecting and analyzing relevant technical literature.
3. To develop structured technical writing and report preparation abilities.
4. To improve seminar presentation and academic communication skills.

Prerequisite

1. Basic knowledge of technical writing and documentation.
2. Familiarity with research methodology and literature review.
3. Ability to access and use digital libraries and academic databases.
4. Fundamental understanding of the core subject area (e.g., CSE concepts).

Course Outcome : On the successful completion of the course, students will be able to

CO1	Select a subject, narrowing the subject into a topic.	Understand
CO2	State an objective and collecting the relevant bibliography (at least 15 journal papers)	Understand
CO3	Study the papers and understanding the author‟s contributions and critically analyzing each paper	Apply
CO4	Prepare a working outline and linking the papers and preparing a draft of the paper.	Understand
CO5	Prepare a working outline and linking the papers and preparing a draft of the paper.	Understand

Syllabus

1. Selection of Research Area and Topic
2. Stating the Research Objective and Scope
3. Identifying Relevant Journals, Conferences, Authors, and Web Resources
4. Collecting and Filtering Research Papers from Digital Libraries
5. Critical Reading and Analysis of Research Papers (Using Structured Review Tables)
6. Drafting the Outline and Creating Classification/Categorization Diagram
7. Writing Abstract, Introduction, and Background Sections
8. Writing Main Sections Based on Literature Review and Survey Goals
9. Writing Conclusions and Identifying Future Research Directions
10. Preparing Final Draft with Proper Formatting and Plagiarism Check
11. Seminar Preparation: Slide Design, Presentation, and Viva Voce
12. Final Report Submission with Structured Technical Content and Referencing

TOTAL HOURS :45

Tools Used

Google Scholar, IEEE Xplore, ACM Digital Library, Scopus, ResearchGate, MS Word/LaTeX, Reference Managers, Plagiarism Checkers, Presentation Tools

Reference Book

1. **Ramesh Babu**, *Research Methodology in Computer Science and Engineering*, MJP Publishers, 2018.
2. **Robert A. Day and Barbara Gastel**, *How to Write and Publish a Scientific Paper*, Cambridge University Press, 8th Edition, 2016.
3. **Justin Zobel**, *Writing for Computer Science*, Springer, 3rd Edition, 2014.
4. **Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams**, *The Craft of Research*, University of Chicago Press, 4th Edition, 2016.
5. **Michael Alley**, *The Craft of Scientific Writing*, Springer, 4th Edition, 2018.
6. **George M. Hall**, *How to Write a Paper*, Wiley-Blackwell, 5th Edition, 2012.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	3	3	1	3	3	1	2
CO2	2	3	2	1	2	2	2	2
CO3	2	3	2	1	2	2	2	2
CO4	2	3	2	1	2	2	2	2
CO5	2	3	1	1	2	2	2	2

Assessment Methodology	Assessment Tools	Marks
Technical Report	Submission of a technical report	25
Seminar Presentation	Oral presentation	20
Viva		5
Attendance		10
Total		**60**

PROFESSIONAL ELECTIVE COURSES

25PCSL01	ADVANCED NETWORK PRINCIPLES AND PROTOCOLS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Basic knowledge of Computer Networks and Operating Systems
- To impart in-depth understanding of modern networking concepts, advanced protocols, and emerging networking technologies.
- To enable students to analyze, simulate, and optimize network performance and security.

Prerequisite: Basic knowledge of Computer Networks and Operating Systems.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand layered network architectures and explain advanced protocol functionalities.	Understand, Explain
CO2	Analyze protocol behavior in real-world network scenarios to identify performance issues.	Analyze
CO3	Examine congestion control techniques, QoS mechanisms, and implement performance tuning methods.	Analyze
CO4	Explore wireless, mobile, and sensor network technologies and their applications.	Explore
CO5	Implement network security concepts including cryptographic techniques for secure communications.	Apply

Syllabus

UNIT- I Advanced Internetworking Concepts **9 Hours**

IPv4 and IPv6 packet formats and addressing; Subnetting, Supernetting and CIDR; ICMPv4 and ICMPv6; ARP, RARP, DHCP and NAT; Multicasting and Broadcasting; Routing protocols – RIP, OSPF, BGP; IP packet fragmentation and reassembly.

UNIT- II Transport Layer Protocols And Congestion Control **9 Hours**

TCP operations: connection management, flow control, congestion control (AIMD, Slow Start); TCP variants (Tahoe, Reno, New Reno); UDP and real-time transport (RTP, RTCP); Quality of Service (QoS): IntServ, DiffServ, MPLS.

UNIT- III Wireless And Mobile Networks **9 Hours**

Wireless LANs (IEEE 802.11 standards); Cellular architecture and mobile IP; Routing in mobile ad hoc networks (AODV, DSR); Wireless sensor networks; Mobility management and handoff strategies; WiMAX and LTE overview.

UNIT- IV Network Security Protocols **9 Hours**

Cryptography fundamentals – symmetric and asymmetric encryption; Authentication and key distribution protocols (Kerberos, PKI); Secure protocols: IPSec, SSL/TLS, HTTPS, SSH; Email security: PGP and S/MIME; Firewalls, IDS/IPS.

UNIT- V Modern Networking Technologies **9 Hours**

Software Defined Networking (SDN) principles and architecture; OpenFlow protocol; Network Function Virtualization (NFV); Overlay networks; Introduction to InternetofThings(IoT) networking; Cloud-based network infrastructures.

TOTAL HOURS :45

Text Book

1. Behrouz A. Forouzan, "Data Communications and Networking", McGraw Hill, 5th Edition, 2017.
2. William Stallings, "Data and Computer Communications", Pearson, 10th Edition, 2021.
3. Larry L. Peterson and Bruce S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann, 5th Edition, 2011.

Reference Book

1. Andrew S. Tanenbaum, David J. Wetherall, "Computer Networks", Pearson, 5th Edition.
2. Douglas Comer, "Internetworking with TCP/IP – Principles, Protocols and Architecture", Pearson, 6th Edition.
3. Open Networking Foundation: https://opennetworking.org
4. Wireshark Protocol Analyzer Tool
5. Network Simulator tools: ns-3, GNS3

Web Resources

1. Advanced Internetworking Concepts : https://nptel.ac.in/courses/106106243
2. Wireless And Mobile Networks :https://nptel.ac.in/courses/106105160
3. Modern Networking Technologies : https://nptel.ac.in/courses/106105183

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL02	INTERNET OF THINGS AND COGNITIVE COMPUTING	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

Learn the basics of the Internet of Things (IoT) and cognitive computing to build a strong foundation in these emerging technologies. Understand various machine learning algorithms that are essential for implementing Cognitive IoT (CIoT) concepts effectively.

Prerequisite : Build Systems Integrating The **Internet Of Things (Iot)** And **Cognitive Computing,**

Course Outcome: On the successful completion of the course, students will be able to

CO1	Demonstrate Knowledge Of Basics Of The Internet Of Things And Cognitive Computing	Understand, Explain
CO2	Choose And Use Appropriate Machine Learning Algorithm For Ciot.	Analyze
CO3	Develop And Deploy The Iot Application Into The Cloud Environment	Analyze, Apply
CO4	Identify Efficient Parallel Programming Patterns To Solve Problems.	Explore
CO5	Implement Iot Application Using Zynq Programming	Apply

Syllabus

UNIT- I Introduction to IoT and Cognitive Computing 9 Hours

IoT definitions, IoT Characteristics, Impacts of IoT, Cognitive Computing, IoT and Cognition, Applications, Client and Server Side Scripting for IoT, MQTT and COAP Protocol, Introduction to Raspberry Pi and Python, Machine Learning Overview, Machine Learning Techniques, Introduction to TensorFlow, Introduction to PyTorch.

UNIT- II Machine Learning Algorithms For Enabling The Cognitive IoT 9 Hours

Data Analytics, Data Analytics for IoT Basics, Regression & Classification Techniques, Data Analytics for IoT Regression, Classification Artificial Neural Networks and CNN, CNN based Classification, ANN-based Classification, Data Analytics using DNN, Programming DNNs using TensorFlow, Industrial IoT, Industrial IoT Use Cases.

UNIT- III Cloud Computing in IoT 9 Hours

Introduction to Cloud Computing in IoT, Edge Computing in IoT, Event Driven Programming, JavaScript Basics, Node JS, Angular JS, IoT Programming using Node RED, Programming the Raspberry Pi using Node RED , Cloud IoT use cases.

UNIT- IV Cognitive computing using GPU 9 Hours

Parallel Programming for GPUs, GPU Parallel Programming in CUDA, CNN inference in GPU, Real-Time Operating Systems - Introduction, Real-Time Operating Systems – Key Characteristics, RealTime Operating Systems - Issues, Real-Time Operating Systems – Applications, Introduction to RTOS hardware devices, Introduction to Free RTOS,

Programming in Free RTOS Real-Time Operating Systems use Cases.

UNIT- V Advanced Cognitive computing **9 Hours**

Introduction to FPGAs, FPGA for IoT Computing , Introduction to Zynq 7000 SoCs, , Programming Zynq 7000 SoCs , Application Areas for Zynq –Python Productivity for Zynq, Case Study: Prototyping CNNs on Zynq for Space Applications, Using pynq.

TOTAL HOURS :45

Text Book

1. Learning with Python for Everyone, By Mark Fenner, Pearson Education, 2019
2. Real Machine -Time Embedded Components and Systems with Linux and RTOS, Sam Siewert and John Pratt, Mercury Learning 2015
3. Deep Learning with TensorFlow 2 and Keras, By Antonio Gulli, Amita Kapoor, Sujit Pal, Packt Publishing, 2019

Reference Book

1. Deep Learning with TensorFlow, By Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy, Packt Publishing, 2017
2. Exploring Zynq Mpsoc: With Pynq and Machine Learning Applications, Crockett H. Louise, Northcote David, Ramsay Craig, Strathclyde Academic Media, 2019

Web Resources

1. Foundation of Cloud IoT Edge ML – Course : https://onlinecourses.nptel.ac.in/noc23_cs65/preview
2. IoT and Cloud Computing : https://www.geeksforgeeks.org/cloud-computing/iot-and-cloud-computing/

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL03	FOG NETWORKS IN IOT	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Learn the Fundamentals Of Iot And The New Computing Paradigms and gain Knowledge About The Orchestration, Optimization And Middleware For Fog Computing.

Prerequisite : Cloud Computing and IoT

Course Outcome: On the successful completion of the course, students will be able to

CO1	Summarize The Need Of Fog Computing And Its Modelling Techniques	Understand, Explain
CO2	Explore The Orchestration, Optimization Techniques And Design Of Middleware For Fog Computing	Analyze
CO3	Apply Various Data Management Techniques And Analytics For Fog Computing	Apply
CO4	Examine The Security And Privacy Of Internet Of Things (Iot) Systems.	Analyze
CO5	Apply The Knowledge Of Ifogsim For Modelling And Simulation Of Application	Apply

Syllabus

Unit I: Introduction **9 Hour**

Internet of Things (Iot) and New Computing Paradigms: From Cloud to Fog --Need for Fog Computing-Why IoT Needs Fog Computing? - Fog Computing architecture - fog networks - Principles of Edge/P2P networking - Security and privacy in Fog. Integrating IoT, Fog and Cloud Infrastructures-Methodology: Modelling Technique-Analytical Models-Petri Net Models-Integer Linear Programming- Markov chains modelComputation Offloading in Fog Computing-FoG Computing Conceptual Model- Fog node architectural service models- Fog node deployment models.

Unit II: Orchestration, Optimization and Middleware for Fog Computing **9 Hour**

Orchestration of Network Slices in Fog- Formal Modeling Framework for Fog Computing-Metrics- Optimization Problem in fog computing- Optimization Techniques- Middleware for Fog Computing: Design IssuesNeed for Fog Computing Middleware-Design Goals-State-of-the-Art Middleware Infrastructures-System Model-Proposed Architecture.

Unit III: Data Management and Predictive Analysis in Fog Computing **9 Hour**

Structure of data management in fog computing-Fog data life cycle- Data Characteristics- Data Pre-Processing and Analytics- Data Privacy- Data Storage and Data Placement- e-Health Case Study- Proposed Architecture- Predictive Analysis to Support Fog Application Deployment: Motivating Example: Smart Building- Predictive Analysis with FogTorch- Comparing iFogSim and FogTorch.

Unit IV: Security And Privacy of Internet of Things (IoT) Systems **9 Hour**

Security and Privacy Issues in IoT-Security Concerns at Different Layers in IoT-Privacy Concerns in IoT Devices-Machine-Learning Algorithms in IoT- Use of Artificial Neural Networks (ANN) to Forecast and Secure IoT Systems-New Flavors of Attacks on IoT Devices-Effective ML Techniques to Achieve IoT Security-Machine Learning in Fog Computing.

Unit V: Modeling and Simulation of Fog Computing **9 Hour**

Environments Using iFogSim Toolkit: iFogSim Simulator and Its Components-Installation of iFogSim-Building Simulation with iFogSim-Example Scenarios: Create Fog Nodes with Heterogeneous ConfigurationsCreate Different Application Models-Application Modules with Different Configuration-Sensors with Different Tuple Emission Rate-Send Specific Number of Tuples from a Sensor-Mobility of a Fog Device-Connect Lower-Level Fog Devices with Nearby Gateways-Make Cluster of Fog Devices-Simulation of a Placement Policy- Exploiting Fog Computing in Health Monitoring: An Architecture of a Health Monitoring IoT-Based System with Fog Computing- Fog Computing Model for Evolving Smart Transportation Applications.

TOTAL HOURS :45

Text Book

1. Zaigham Mahmood FOG Computing: Concepts, Frameworks and Technologies, Springer Publications, 2018.
2. Buyya, Rajkumar, and Satish Narayana Srirama, Fog and Edge computing: Principles and Paradigms, 1st Edition, John Wiley & Sons, USA, 2019.

Reference Book

1. Mahmood, Zaigham (Ed.), Fog Computing Concepts, Frameworks and Technologies, Springer, 2018.
2. Bahga, Arshdeep, and Vijay Madisetti, Cloud computing: A hands-on approach, 2nd Edition, CreateSpace Independent Publishing Platform, USA. 2014.

Web Resources

1. Cloud Computing : Https://Nptel.Ac.In/Courses/106105167
2. Edge Computing: Https://Nptel.Ac.In/Courses/106104449
3. Distributed Systems,: Https://Nptel.Ac.In/Courses /106106168

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL04	QUANTUM COMPUTING	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Understand The Fundamentals Of Quantum Mechanics Relevant To Computation.
- Explore The Theoretical Framework And Algorithms Of Quantum Computing.

Prerequisite : Knowledge In Linear Algebra, Probability, And Basic Computer Science Fundamentals

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand The Mathematical Foundations Of Quantum Mechanics For Computing.	Understand, Explain
CO2	Analyze Quantum Algorithms Such As Grover's And Shor's Algorithm.	Analyze
CO3	Design And Evaluate Simple Quantum Circuits.	Apply
CO4	Use Quantum Programming Tools To Simulate And Implement Quantum Computations.	Apply
CO5	Apply Quantum Computing Concepts To Real-World Problems Such As Cryptography And Search.	Apply

Syllabus

Unit I: Fundamentals Of Quantum Mechanics **9 Hours**

Classical Vs. Quantum Computation – Qubits – Superposition – Entanglement – Measurement – Dirac Notation – Quantum State Vector – Postulates Of Quantum Mechanics – Tensor Product – No-Cloning Theorem.

Unit II: Quantum Logic Gates And Circuits **9 Hours**

Single And Multi-Qubit Gates – Pauli Matrices – Hadamard, Cnot, Phase, T, And Toffoli Gates – Gate Universality – Quantum Circuit Representation – Reversible Computing – Circuit Simplification.

Unit III: Quantum Algorithms **9 Hours**

Quantum Parallelism – Deutsch Algorithm – Deutsch-Jozsa Algorithm – Grover's Search Algorithm – Quantum Fourier Transform – Shor's Algorithm – Complexity Of Quantum Algorithms.

Unit IV: Quantum Error Correction And Communication **9 Hours**

Quantum Decoherence – Error Models – Bit Flip, Phase Flip, And Combined Errors – Quantum Error Correction Codes (Qecc) – Shor Code – Quantum Teleportation – Superdense Coding – Entanglement Swapping.

Unit V: Quantum Programming Frameworks And Applications **9 Hours**

Introduction To Qiskit, Cirq, Ibm Quantum Experience – Quantum Circuit Simulation – Quantum Algorithms In Practice – Cryptography, Optimization, Machine Learning – Near-Term Intermediate-Scale Quantum (Nisq) Devices.

TOTAL HOURS :45

Text Book

1. Michael A. Nielsen And Isaac L. Chuang, Quantum Computation And Quantum Information, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Phillip Kaye, Raymond Laflamme, And Michele Mosca, An Introduction To Quantum Computing, Oxford University Press, 2007.

Reference Book

1. Scott Aaronson, Quantum Computing Since Democritus, Cambridge University Press, 2013.
2. Mermin, N. David, Quantum Computer Science, Cambridge University Press, 2007.
3. Ibm Qiskit Documentation: Https://Qiskit.Org/Documentation/
4. Quantum Computing Playground: Https://Quantum-Computing.Ibm.Com/
5. Quantum Algorithm Zoo: Https://Quantumalgorithmzoo.Org

Web Resources

1. Quantum Computing: Https://Nptel.Ac.In/Courses/104104082
2. Introduction To Quantum Computing: Quantum Algorithms And Qiskit, Ibm And Iitm : Https://Nptel.Ac.In/Courses/106106232

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL05	AGILE AND DEVOPS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Agile methodologies follow iterative process models that emphasize flexibility, continuous feedback, and customer collaboration for efficient application design. DevOps integrates development and operations concepts to automate and streamline container-based application development and management.

Prerequisite : Software Engineering

Course Outcome: On the successful completion of the course, students will be able to

CO1	Demonstrate Understanding Of The Different Process Models In Agile Methodologies	Explain
CO2	Develop An Application Using Agile Methods For Efficient Project Management	Analyze
CO3	Implement the Challenges and Opportunities are associated with Devops	Apply
CO4	Apply Container-Based Application Development And Management Using Devops Tool	Apply
CO5	Demonstrate Web Applications Using Agile and Devops	Apply

Syllabus

Unit I: Foundations of Agile Development **9 Hours**

Introduction to Agile Development - Understanding the Origins and Evolution of Agile - Agile Manifesto: Values and Principles - Agile Methods Overview: Scrum, XP, Kanban, Lean. Agile Principles and Practices- Agile Roles: Scrum Master, Product Owner, Team Members - Agile Practices: Sprint Planning, Daily Stand-ups, Sprint Review, Retrospective - Continuous Integration and Test-Driven Development (TDD) - Agile Estimation and Planning Techniques – Tutorial on scrum master

Unit II: Advanced Agile Concepts **9 Hours**

Introduction to Large-Scale Scrum (LeSS) and Scaled Agile Framework (SAFe) - Distributed Agile Teams: Challenges and Best Practices - Agile at Enterprise Level: Portfolio Management and Release Planning. Agile Leadership and Culture- Servant Leadership in Agile Organizations - Creating a Culture of Collaboration and Continuous Improvement - Agile Transformation: Strategies and Challenges – Tutorial on Jira

Unit III: Introduction to DevOps **9 Hours**

Definition and Evolution of DevOps - Core Principles: Culture, Automation, Measurement, Sharing (CAMS) - DevOps vs. Traditional IT Operations: Contrasts and Similarities. DevOps Practices and Tools - Infrastructure as Code (IaC) and Configuration Management- Tutorial on CI/CD(GitLab)

Unit IV: DevOps Application Management and Tools **9 Hours**

Docker Engine Architecture, Docker Image, Basic Container Operations, Interacting with a Running Container, Inspecting a Container, Kubernetes Architecture, Kubernets -Scheduling, Logging & Monitoring, Cluster Maintenance, Security &Storage, Choosing Kubernetes infrastructure, Creating Helm charts- Tutorial on working with Docker images and using kubernetes for deployments.

Unit V: Collaborative Application Development **9 Hours**

DevOps Foundations and Automatic Testing, Strategy for Application Deployment, Monitoring, Introduction to GIT, Jenkins, Continuous Integration and Continuous Delivery (CI/CD) Pipelines - Automated Testing, Deployment, and Monitoring Tools -Synergies between Agile and DevOps Methodologies - DevOps in Agile Development Lifecycle: From Planning to Operations. Case studyDevelop 3 tier web applications using agile and DevOps-Tutorials on Jenkins tool.

TOTAL HOURS :45

Text Book

1. James Shore and Shane Warden," The Art of Agile Development", O'Reilly Media, Inc., 2021.
2. Robert C. Martin, "Agile Software Development, Principles, Patterns, and Practices", PHI, 2002
3. Gene Kim, Jez Humble, Patrick Debois, John Allspaw and John WillisJason Bell, The DevOps Handbook, IT revolutionPress, 2016.

Reference Book

1. Carlos Cordeiro & Dharma Agrawal, Ad Hoc & Sensor Networks: Theory And Applications, World Scientific, 2nd Edition, 2006.
2. Anna Hac, Wireless Sensor Network Designs, John Wiley, 2nd Edition, 2003.
3. Al-Sakib Khan Pathan Et Al., Wireless Sensor Networks: Current Status And Future Trends, Crc Press, 2016.

Web Resources

1. Wireless Ad Hoc And Sensor Networks : https://nptel.ac.in/courses/106105160
2. Advanced 3g And 4g Wireless Mobile Communications: Https://Nptel.Ac.In/Courses/117104099
3. Introduction To Wireless And Cellular Communications: Https://Nptel.Ac.In/Courses/106106167

Mapping with Programme Outcomes

COs	**Program Outcomes(Pos)**						**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	**Assessment Tools**	**Marks**
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL06	SOFTWARE DESIGN ARCHITECTURES	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To Understand Key Design Principles, Patterns, And Architectural Styles In Software Engineering. To Enable Students To Analyze, Design, And Document Software Architecture For Large-Scale Systems.

Prerequisite :

- Knowledge Of Object-Oriented Programming
- Basic Software Engineering Principles

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand Core Concepts In Software Architecture And Design.	Understand
CO2	Apply Architectural Patterns And Design Principles To Solve Software Problems.	Analyze
CO3	Construct the Software Designs Using Uml And Architecture Description Languages.	Apply
CO4	Evaluate Software Architecture Using Quality Attributes And Trade-Off Analysis.	Evaluate
CO5	Develop Reusable, Scalable, And Maintainable Software Systems.	Apply

Syllabus

Unit I: Introduction To Software Architecture **9 Hour**

Definition, Importance, Role Of Software Architecture In Software Development, Architectural Structures, Views, And Styles. Introduction To Uml. Architectural Quality Attributes – Performance, Modifiability, Availability, Scalability, Usability. Software Architecture Documentation.

Unit II: Design Principles And Design Patterns **9 Hours**

Solid Principles, Design Patterns: Creational, Structural, And Behavioral Patterns (Factory, Singleton, Adapter, Composite, Observer, Strategy, Etc.). Case Studies And Pattern Catalog Usage.

Unit III: Architectural Styles & Patterns **9 Hours**

Layered Architecture, Client-Server, Event-Driven, Microservices, Service-Oriented Architecture (Soa), Pipe-And-Filter, Blackboard, Mvc. Choosing An Architectural Style Based On Quality Attributes And Constraints.

Unit IV: Architecture Documentation & Modeling **9 Hours**

Uml For Architectural Modeling – Component Diagrams, Deployment Diagrams, Sequence Diagrams. Architecture Description Languages (Adls). Introduction To Tools Like Archimate, C4 Model, And Enterprise Architect.

Unit V: Evaluation And Case Studies **9 Hours**

Architecture Evaluation: Atam, Cbam, Scenario-Based Analysis. Case Studies Of Real-World Systems (E.G., E-Commerce, Social Media, Enterprise Applications). Migration And Evolution Of Software Architecture.

TOTAL HOURS :45

Text Book

1. Len Bass, Paul Clements, Rick Kazman, "Software Architecture In Practice", Addison-Wesley, 4th Edition, 2021.
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design Patterns: Elements

Of Reusable Object- Oriented Software", Addison-Wesley, 1994.
3. Mary Shaw And David Garlan, "Software Architecture: Perspectives On An Emerging Discipline", Pearson, 1996

Reference Book

1. Craig Larman, "Applying Uml And Patterns", Pearson Education, 3rd Edition
2. Ieee Software Architecture Standards – Ieee 1471
3. Uml 2.5 Specification – Omg
4. Https://Refactoring.Guru/Design-Patterns

Web Resources

1. Software Conceptual Design : Https://Nptel.Ac.In/Courses/106101235
2. Software Engineering : Https://Nptel.Ac.In/Courses/106105182
3. Software Project Management : Https://Nptel.Ac.In/Courses/106105218
4. Https://Martinfowler.Com/Architecture/

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL07	BIG DATA ANALYTICS USING ARTIFICIAL INTELLIGENCE TECHNOLOGIES	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Understand The Basics Of Hadoop And Related Technologies To Big Data Analytics And Examine The Ecosystem Tools In Hadoop and Provide With Comprehensive Apache Spark & Spark SQL Knowledge For Big Data Processing.

Prerequisite : Knowledge Of Big data insights via AI technologies.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Apply Mapreduce, HDFS And YARN Develop Big Data Applications	Apply
CO2	Provide With Comprehensive Apache Spark & Spark SQL Knowledge For Big Data Processing.	Analyze
CO3	Examine the Importance Of Spark Mllib And Structured Streaming.	Analyze
CO4	Construct the architecture, components, and functionalities of Apache Kafka, Zookeeper, and Apache Airflow, and implement workflows using Directed Acyclic Graphs (DAGs) for big data processing.	Apply
CO5	Apply ontologies to enhance data integration, interoperability, and knowledge representation in big data environments, utilizing RDF, OWL, and SPARQL for intelligent system development.	Apply

Syllabus

Unit I: Introduction to HDFS and Hive **9 Hours**

Overview of Hadoop – HDFS Architecture – Hadoop MapReduce – Processing Data with MapReduce – YARN Architecture – Anatomy of File Read and Write in Hadoop – Hadoop Shell Commands – Overview of Hadoop Ecosystem – Apache Hive – Data Types – Create, Alter and Drop Commands – Built-in Operators and Functions – Views – Interaction with Hadoop Framework.

Unit II: Apache Spark and SparkSQL **9 Hours**

Introduction to Apache Spark – Architecture of Apache Spark – RDDs (Resilient Distributed Datasets): Creation, Transformations, and Actions – Spark SQL – SQL Queries in Spark.

Unit III: Spark MLlib and Spark Structured Streaming **9 Hours**

Spark MLlib – PySpark – Spark Structured Streaming – Basic Concepts – Programming Model – APIs Using Streaming DataFrames – Creating Streaming DataFrames – Operations Using Streaming DataFrames.

Unit IV: Zookeeper and Apache Airflow **9 Hours**

Introduction to Apache Kafka – Cluster Architecture – Kafka Messaging – Components in Messaging – Creating and Deleting Kafka Topics – Creating Multiple Brokers – Kafka Producers – API for Kafka Producers – Producer Implementation – Three Ways to Send Kafka Message – Kafka Consumers – Consumer Groups – API for Kafka Consumers – Consumer Implementation – Integration with Spark, Apache Airflow – Directed Acyclic Graph (DAG) – CLI Commands.

Unit V: Ontology for Big Data **9 Hours**

Human Brain and Ontology – Ontology of Information Science – Ontology Properties – Advantages of Ontologies – Components of Ontologies – The Role Ontology Plays in Big Data – Ontology Alignment – Goals of Ontology in Big Data – Challenges with Ontology in Big Data – RDF: The Universal Data Format – Using OWL: Web Ontology Language – SPARQL Query Language – Building Intelligent Machines with Ontologies – Ontology Learning – Ontology Learning Process. Case Studies for Big Data Using Artificial Intelligence Technologies.

TOTAL HOURS :45

Text Book

1. Anand Deshpande& Manish Kumar, Artificial Intelligence for Big Data,Packt Publishing, 2018.
2. Rinku Sharma Dixit &ShaileeLohmorChoudhary, Big Data Analytics Using Artificial Intelligence Technologies Transforming Organizations, IK International Pvt. Ltd, 2021.
3. Seema Acharya, Big Data and Analytics, Wiley, 2019.

Reference Book

1. .Raj Kamal AND Preetisaxena, Big Data Analytics: Introduction TO Hadoop, Spark, AND Machine-Learning,Mcgraw Hill Education, 2019
2. Databricks Documentation: HTTPS://DOCS.DATABRICKS.COM/EN/INDEX.HTML

Web Resources

1. Tutorialspoint - Hadoop Tutorial : https://www.tutorialspoint.com/hadoop/index.htm
2. Databricks Spark Tutorial: https://databricks.com/spark/getting-started-with-apache-spark
3. SPARQL Query Language : https://www.w3.org/TR/rdf-sparql-query/

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL08	GENERATIVE ARTIFICIAL INTELLIGENCE	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Generative AI uses pre-trained Large Language Models (LLMs) to create context-aware content, which can be fine-tuned for specific tasks using techniques like parameter-efficient tuning. Reinforcement Learning further improves LLMs by teaching them to optimize responses based on feedback and rewards.

Prerequisite : Machine learning, natural language processing

Course Outcome: On the successful completion of the course, students will be able to

CO1	Outline the basics of Generative AI and Prompt Engineering, understanding content generation and prompt guidance.	Understand
CO2	Analyze various fine-tuning techniques for Large Language Models, including full fine-tuning and parameter-efficient methods.	Analyze
CO3	Construct the Reinforcement Learning techniques and their use with LLMs to improve outputs through feedback and rewards.	Apply
CO4	Examine the Lifecycle Of Generative AI And Its Applications	Analyze
CO5	Apply practical applications of Generative AI across industries like content creation, chatbots, and personalized assistants.	Apply

Syllabus

Unit I: Introduction to Generative AI and Large Language Models 9 Hours

Introduction to Generative AI and LLMs – Use Cases and Tasks of LLMs – Text Generation Before Transformers – Transformer Architecture – Generating Text with Transformers – Prompting and Prompt Engineering (Chain-of-Thought) – Retrieval-Augmented Generation (RAG) Technique – Generative Configuration – Generative AI Project Lifecycle – Pre-training Large Language Models – Computational Challenges in Training LLMs.

Unit II: Fine-tuning and Evaluation of Large Language Models 9 Hours

Instruction Fine-tuning – Fine-tuning on Single Task – Multi-task Instruction Fine-tuning – Model Evaluation and Benchmarks – Parameter-Efficient Fine-Tuning (PEFT) – PEFT Techniques 1: LoRA (Low-Rank Adaptation) – PEFT Techniques 2: Soft Prompts.

Unit III: Reinforcement Learning and LLM-Powered Applications 9 Hours

Aligning Models with Human Values – Reinforcement Learning from Human Feedback (RLHF) – Obtaining Human Feedback – Reward Modeling – Fine-tuning with Reinforcement Learning – Model Optimizations for Deployment – Generative AI Project Lifecycle – Using LLMs in Applications – Interacting with External Applications – Enhancing Reasoning with Chain-of-Thought – Program-Aided Language Models (PAL) – ReAct: Combining Reasoning and Action – LLM Application Architectures.

Unit IV: Advanced Generative AI Techniques and Tools 9 Hours

Advanced Prompt Engineering Techniques – Zero-shot, Few-shot Learning – Transfer Learning in LLMs – Use of APIs (e.g., OpenAI GPT, Anthropic Claude, Google Gemini) – Integration

with External Knowledge Bases – Retrieval-Augmented Generation (RAG) In-depth – Managing Hallucination and Bias – Data Privacy and Security in Generative AI – Monitoring and Maintaining Models in Production.

Unit V: Future Trends and Case Studies in Generative AI **9 Hours**

Emerging Trends in Generative AI and LLMs – Multimodal Models (Text, Image, Audio) – Foundation Models Beyond NLP – AI Co-Pilots and Assistants – Legal, Ethical, and Social Implications of Generative AI – Explainability and Interpretability – Case Studies on Generative AI in Industry – Strategic Roadmap for Adopting Generative AI in Organizations. **Case Study:** Present a strategic plan integrating generative AI with an organization's business goals. Include roadmap, risks, and ethical considerations. **TOTAL HOURS: 45**

Text Book

1. Edward R. Deforest, Prompt Engineering with Transformers and LLM – By Kindle (2024).
2. Altaf Rehmani, Generative AI for everyone – By Altaf Rehmani; 1st edition (2024).
3. Natural Language Processing with Transformers" by Lewis Tunstall, Leandro von Werra, and Thomas Wolf, O'Reilly Media(2022).

Reference Book

1. Deep Learning for NLP and Speech Recognition" by Uday Kamath, John Liu, and James Whitaker, Springer(2019)
2. Hands-On Natural Language Processing with PyTorch 1.x" by Thomas Wolf, Julien Chaumond, and Lysandre Debut, Packt Publishing(2020)

Web Resources

1. Retrieval-Augmented Generation (RAG): https://huggingface.co/blog/rag
2. Papers with Code – LLM Evaluation Benchmarks : https://paperswithcode.com/area/natural-language-processing/evaluation
3. ReAct: Reasoning + Acting with Language Models : https://arxiv.org/abs/2210.03629

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL09	COGNITIVE SCIENCE	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To know the theoretical background of cognition.
- To understand the link between cognition and computational intelligence.
- To explore probabilistic programming language.

Prerequisite : Basic knowledge of cognitive science or psychology fundamentals.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand the underlying theory behind cognition, including mental processes like perception, memory, and reasoning.	Understand
CO2	Implement cognitive elements such as belief, decision-making, and learning to computational models.	Apply
CO3	Implement mathematical and probabilistic functions through WebPPL, a probabilistic programming language.	Apply
CO4	Develop applications using cognitive inference models to simulate decision-making and reasoning.	Apply
CO5	Develop applications using cognitive learning models to replicate how humans learn from experience.	Apply

Syllabus

Unit I: Philosophy, Psychology, and Neuroscience **9 Hours**

Philosophy: Mental-Physical Relation – From Materialism to Mental Science – Logic and the Sciences of the Mind – Psychology: Place of Psychology within Cognitive Science – Science of Information Processing – Cognitive Neuroscience – Perception – Decision – Learning and Memory – Language Understanding and Processing.

Unit II: Computational Intelligence **9 Hours**

Machines and Cognition – Artificial Intelligence – Architectures of Cognition – Knowledge-Based Systems – Logical Representation and Reasoning – Logical Decision Making – Learning – Language – Vision.

Unit III: Probabilistic Programming Language **9 Hours**

WebPPL Language – Syntax – Using JavaScript Libraries – Manipulating Probability Types and Distributions – Finding Inference – Exploring Random Computation – Coroutines: Functions That Receive Continuations – Enumeration.

Unit IV: Inference Models of Cognition **9 Hours**

Generative Models – Conditioning – Causal and Statistical Dependence – Conditional Dependence – Data Analysis – Algorithms for Inference.

Unit V: Learning Models of Cognition **9 Hours**

Learning as Conditional Inference – Learning with a Language of Thought – Hierarchical Models – Learning (Deep) Continuous Functions – Mixture Models.

TOTAL HOURS: 45

Text Book

1. Vijay V Raghavan,Venkat N.Gudivada, VenuGovindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Handbook of Statistics 35), Elsevier publications, 2016.
2. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley Publications, 2015.
3. Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences",The MIT Press, 1999.
4. Jose Luis Bermúdez, Cognitive Science -An Introduction to the Science of the Mind, Cambridge University Press 2020.

Reference Book

1. Noah D. Goodman, Andreas Stuhlmuller, "The Design and Implementation of Probabilistic Programming Languages", Electronic version of book, https://dippl.org/.
2. Noah D. Goodman, Joshua B. Tenenbaum, the ProbMods Contributors, "Probabilistic Models of Cognition", Second Edition, 2016, https://probmods.org/

Web Resources

1. Stanford Encyclopedia of Philosophy : https://plato.stanford.edu/entries/mind-body/
2. Cognitive Architectures Overview : https://www.cs.cmu.edu/~fmclaugh/cogarch/
3. Hierarchical Bayesian Models: https://www.cs.ubc.ca/~murphyk/Bayes/bayes.html

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL10	KNOWLEDGE MANAGEMENT	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Learn the Evolution of Knowledge management and familiar with tools and exposed to Applications.

Prerequisite

- Basic Understanding of Information Systems familiarity with how information is stored, retrieved, and processed.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Explain the foundations, evolution, and ethical considerations of knowledge management, including cultural, technological, and organizational aspects.	Explain
CO2	Develop strategies to create a culture of learning and knowledge sharing by leveraging tacit knowledge, cooperation, and quality assurance principles.	Apply
CO3	Utilize tools such as telecommunications, networks, search engines, vocabulary control, and information mapping to support effective knowledge management.	Apply
CO4	Analyze and design knowledge management strategies through case studies in various domains such as libraries, healthcare, and developing countries.	Analyze
CO5	Design and develop enterprise applications.	Apply

Syllabus

UNIT I Introduction **9 Hours**

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNIT II Creating The Culture Of Learning And Knowledge Sharing **9 Hours**

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

UNIT III Knowledge Management-The Tools **9 Hours**

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNIT IV Knowledge Management Application **9 Hours**

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing

Countries).

UNIT V Future Trends And Case Studies **9 Hours**

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL HOURS :45

Text Book

1. Srikantaiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.
2. **Thomas H. Davenport & Laurence Prusak** - *Working Knowledge: How Organizations Manage What They Know*

Mapping with Programme Outcomes

COs	**Program Outcomes(Pos)**						**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	**Assessment Tools**	**Marks**
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL11	DATA WAREHOUSING AND DATA MINING	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To know the details of data warehouse Architecture To understand the OLAP Technology
- To understand the partitioning strategy
- To differentiate various schema
- To understand the roles of process manager & system manager

Prerequisite : Data mining and Database system

Course Outcome: On the successful completion of the course, students will be able to

CO1	Design data warehouse architecture for various Problems	Apply
CO2	Apply the OLAP Technology	Apply
CO3	Analyse the partitioning strategy	Analyze
CO4	Critically analyze the differentiation of various schema for given problem	Analyze
CO5	Develop the Frame roles of process manager & system manager	Apply

Syllabus

UNIT I Introduction To Data Warehouse **9 Hours**

Data warehouse Introduction - Data warehouse components- operational database Vs data warehouse – Data warehouse Architecture – Three-tier Data Warehouse Architecture - Autonomous Data Warehouse- Autonomous Data Warehouse Vs Snowflake - Modern Data Warehouse

UNIT II ETL And OLAP Technology **9 Hours**

What is ETL – ETL Vs ELT – Types of Data warehouses - Data warehouse Design and Modeling - Delivery Process - Online Analytical Processing (OLAP) - Characteristics of OLAP - Online Transaction Processing (OLTP) Vs OLAP - OLAP operations- Types of OLAP- ROLAP Vs MOLAP Vs HOLAP.

UNIT III Meta Data, Data Mart And Partition Strategy **9 Hours**

Meta Data – Categories of Metadata – Role of Metadata – Metadata Repository – Challenges for Meta Management - Data Mart – Need of Data Mart- Cost Effective Data Mart- Designing Data Marts- Cost of Data Marts- Partitioning Strategy – Vertical partition – Normalization – Row Splitting – Horizontal Partition.

UNIT- IV Data Mining Process **9 Hours**

Data mining process – KDD, CRISP-DM, SEMMA Prediction performance measures

UNIT- V Prediction Techniques **9 Hours**

Data visualization, Time series – ARIMA, Winter Holts,

TOTAL HOURS:45

Text Book

1. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Thirteenth Reprint 2008.
2. Ralph Kimball, “The Data Warehouse Toolkit: The Complete Guide to

Dimensional Modeling", Third edition, 2013.

Reference Book

1. Paul Raj Ponniah, "Data warehousing fundamentals for IT Professionals", 2012.
2. K.P. Soman, ShyamDiwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.

Web Resources

1. Data Mining (IIT Kharagpur, Prof. Pabitra Mitra)- https://onlinecourses.nptel.ac.in/noc21_cs06/preview
2. **Data Warehousing and Business Intelligence** – University of California, Irvine (Coursera) – https://www.coursera.org/learn/data-warehousing-business-intelligence

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL12	DIGITAL & CYBER FORENSICS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Preamble/ Course Objective

- To Equip Students With The Knowledge And Skills Required To Investigate Cybercrimes And Digital Evidence Using Forensic Tools And Methodologies.

Prerequisite

Basic Knowledge of Operating Systems, Computer Networks, and Information Security

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand The Fundamentals Of Digital Forensics And Cybercrime Investigation	Understand
CO2	Examine Digital Evidence Collection, Analysis, And Preservation Techniques	Analyze
CO3	Explore Legal Frameworks, Standards, And Procedures For Digital Forensics	Apply
CO4	Use Forensic Tools And Apply Best Practices For Different Platforms (Windows, Linux, Mobile)	Understand
CO5	Construct Cyber Forensic Investigations Involving Networks, Emails, And Web Logs	Apply

Syllabus

UNIT I: Introduction to Digital Forensics **9 Hours**

Introduction to Digital and Cyber Forensics – Types of Cyber Crimes – Digital Evidence: Characteristics and Types – Phases of Digital Forensics – Forensics Readiness – Anti-Forensics – Legal and Ethical Issues – Cyber Laws and Compliance (IT Act 2000).

UNIT II: Evidence Collection and Analysis **9 Hours**

Forensic Imaging and Data Acquisition – Chain of Custody – Write Blockers – File Systems and Metadata – Recovering Deleted Files – Memory and Disk Forensics – Volatile Data Acquisition – Analysis of Log Files and Browsers.

UNIT III: Forensics on Platforms and Devices **9 Hours**

Windows Forensics – Registry, Event Logs, Prefetch Files – Linux Forensics – File System Structures, Log Files – Mobile Forensics – SIM, App Data, SMS – Cloud Forensics – IoT Forensics (Introductory Concepts).

UNIT IV: Network and Email Forensics **9 Hours**

Network Traffic Capture and Analysis – Packet Sniffing – Intrusion Detection Logs – Email Header Analysis – Email Tracking and Recovery – Spoofing and Phishing Investigation – Web Log Analysis – DNS Forensics.

UNIT V: Tools and Case Studies **9 Hours**

Forensics Tools: Autopsy, FTK, EnCase, Volatility, Wireshark – Live Forensics – Report Writing and Documentation – Case Studies: Financial Fraud, Insider Threats, Intellectual Property Theft – Forensics in Law Enforcement and Industry.

TOTAL HOURS: 45

Text Book

1. Eoghan Casey, Digital Evidence and Computer Crime, Academic Press

2. Bill Nelson et al., Digital Forensics Live Investigation, Cengage
3. Official Tool Documentation (Volatility, Autopsy, FTK)

Reference Book

1. **Digital Forensics and Cyber Crime** by Sunit Belapure and Nishit Chhapparia
2. **Guide to Computer Forensics and Investigations** by Bill Nelson, Amelia Phillips, and Christopher Steuart
3. **Computer Forensics: Principles and Practices** by Linda Volonino and Reynaldo Anzaldua

Web Resources

1. Practical Cyber Security for Cyber Security Practitioners- https://onlinecourses.nptel.ac.in/noc25_cs120/preview
2. **Digital Forensics** – NPTEL (SWAYAM)- https://onlinecourses.swayam2.ac.in/nou25_cs19/preview

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL13	REINFORCEMENT LEARNING	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Preamble/ Course Objective

- Analyze The Foundational Concepts Of Reinforcement Learning.
- Build Knowledge On Finite Markov Decision Process And Dynamic Programming.
- Deliver The Concepts Of Monte Carlo Methods And Temporal Difference Learning.
- Equip Learners On Planning And Learning With Tabular Methods.
- Introduce The Basic Concepts Of Deep Reinforcement Learning.

Prerequisite : Basic Knowledge of Operating Systems, Computer Networks, and Information Security

Course Outcome: On the successful completion of the course, students will be able to

CO1	Comprehend The Building Concepts For Reinforcement Learning.	Understand
CO2	Identify Problems Which Are Markov Decision Processes And Solve Problems Using Dynamic Programming.	Understand
CO3	Apply Monte Carlo Methods And Temporal Difference Learning To Real World Problems.	Apply
CO4	Efficiently analyze the Plan And Learn Actions For Environments Using Tabular Methods.	Analyze
CO5	Apply The Basic Concepts Of Deep Reinforcement Learning.	Apply

Syllabus

UNIT I: Introduction to Reinforcement Learning and multi-arm bandits 9 Hours

Reinforcement Learning- Elements of Reinforcement Learning- Limitations and Scope- An n-Armed Bandit Problem- Action-Value Methods- Incremental Implementation- Tracking a Nonstationary ProblemOptimistic Initial Values-upper-confidence-bound action selection - associative search (contextual bandits) T1 Cartploe simulation in OpenAI gym environment T2 Carracing environment simulation.

UNIT II: - Finite Markov Decision Processes and Dynamic Programming 9 Hours

The Agent–Environment Interface, Goals and Rewards, Finite Markov Decision Process - The Agent–Environment Interface - Goals and Rewards - Returns and Episodes - Unified Notation for Episodic and Continuing Tasks - Policies and Value Functions - Optimal Policies and Optimal Value Functions - Optimality and Approximation , Dynamic Programming - Policy Evaluation (Prediction) - Policy Improvement - Policy Iteration - Value Iteration - Generalized Policy Iteration - Efficiency of Dynamic Programming - Asynchronous Dynamic Programming T3 Policies and value functions for Gridworld example T4 Policy evaluation for Gridworld example.

UNIT III: Monte Carlo Methods and Temporal Difference Learning 9 Hours

Model-free learning - Model-free prediction - Monte Carlo methods - Monte Carlo Prediction - Monte Carlo Estimation of Action Values - Temporal-Difference Learning - TD Prediction - Advantages of TD Prediction Methods - Optimality of TD(0) - n-step Bootstrapping - n-step TD Prediction - n-step Sarsa - Model-free control - Monte Carlo Control - Monte Carlo Control without Exploring Starts - Off policy learning - Importance sampling - Off-policy Monte Carlo Control - Sarsa: On-policy TD Control - Q-learning: Off-policy TD control, T5 TD Prediction implementation, T6 Cliff walking implementation.

UNIT IV: Planning and Learning with Tabular Methods 9 Hours

Integrated Planning, Acting and Learning - When the model is wrong - Prioritized Sweeping - Real-time Dynamic Programming - Monte Carlo Tree Search T7 Maze traversal implementation

T8 Dynamic Programming implementation.

UNIT V: - Deep Reinforcement Learning **9 Hours**

What is Deep Reinforcement Learning- Sequential Decision Problems- Tabular Value-Based Agents- Classic Gym Environments T9 – DRL implementation on Open AI Gym T10 - DRL implementation on Atari environment

TOTAL HOURS:45

Text Book

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction MIT Press; Second edition, 2018.
2. Sudharsan Ravichandiran , Hands-On Reinforcement Learning with Python: Master reinforcement and deep reinforcement learning using OpenAI Gym, Packt Publishing, Second Edition, 2020.

Reference Book

1. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto
2. Deep Reinforcement Learning Hands-On by Maxim Lapan
3. Algorithms for Reinforcement Learning by Csaba Szepesvári

Web Resources

1. Deep Reinforcement Learning Course by David Silver (UCL) - http://www0.cs.ucl.ac.uk/staff/d.silver/web/Teaching.html
2. Spinning Up in Deep RL by OpenAI - https://spinningup.openai.com/en/latest/

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL14	DEEP GENERATIVE MODELS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Preamble/ Course Objective

- Understand the basics of generative models and deep learning architectures.
- Understand the significance of autoregressive and flow-based models
- Apply latent variable models for non-linear variables and to improve the performance
- Understand various basic generative adversarial networks for different applications
- Explore deep gan models for various multimedia applications.

Prerequisite

Basic Machine Learning Concepts: Understanding of supervised vs. unsupervised learning.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Gain the knowledge on basic units of generative models and their types.	Explain
CO2	Implement autoregressive models and flow-based models with continuous and discrete random variables.	Apply
CO3	Implement the latent variable models and variational encoders.	Apply
CO4	Develop the hybrid model and energy-based models for different applications.	Apply
CO5	Apply various case studies that adapt deep gan models.	Apply

Syllabus

UNIT I: Generative Modeling **9 Hours**

Introduction - Generative Versus Discriminative Modeling - Advances in Machine Learning - The Rise of Generative Modeling - The Generative Modeling Framework – Probabilistic Generative Models - The Challenges of Generative Modeling - Representation Learning -Setting Up Your Environment – Deep Learning – Structural and unstructural data – Deep Neural Network – Example – Improving model.

UNIT II: - Deep Generative Modelling **9 Hours**

Types – Autoregressive models - Autoregressive Models Parameterized by Neural Networks - Deep Generative Autoregressive Model: an example Flow based models - Flows for Continuous Random Variables - Change of Variables for Deep Generative Modeling - Building Blocks of RealNVP – example - Flows for Discrete Random Variables - Flows in R or Maybe Rather in Z - Integer Discrete Flows. Case study using Deep generative modeling

UNIT III: Latent Variable Models **9 Hours**

Probabilistic Principal Component Analysis - Variational Auto-Encoders: Variational Inference For Non-Linear Latent Variable Models - Improving Variational Auto-Encoders - Hierarchical Latent Variable Models.

UNIT IV: Hybrid Modeling and GAN **9 Hours**

Naïve approach – shared parameterization approach – example – Energy based models – model formation – training – example – restricted Boltzmann machines Generative adversarial networks – GAN architecture – GAN challenges – Wassertein GAN – WGAN – GP. Case study

using Hybrid approach with GAN.

UNIT V: - Future Of Generative Modellin **9 Hours**

What is Deep Reinforcement Learning- Sequential Decision Problems- Tabular Value-Based Agents- Classic Gym Environments T9 – DRL implementation on Open AI Gym T10 - DRL implementation on Atari environment

TOTAL HOURS:45

Text Book

1. David Foster, Generative Deep Learning, Teaching Machines to Paint, Write, Compose, and Play, O'Reilly Media, Inc., 2019, ISBN: 9781492041948
2. Jakub M. Tomczak, Deep Generative Modeling, Springer nature, Edition 1, 2022, ISBN - 978- 3-030-93157-5
3. Kailash Ahirwar, Generative Adversarial Networks Projects, build next-generation generative models using TensorFlow and Keras, pakt publisher, 2019. ISBN: 978-1789136678

Reference Book

1. Roozbeh Razavi-Far, Ariel Ruiz-Garcia, Vasile Palade, Juergen Schmidhuber, Generative Adversarial Learning: Architectures and Applications, (2022), Springer Cham
2. Jakub M. Tomczak, Deep Generative Modeling, Springer, 2022, 978-3-030-93158-2

Web Resources

1. Deep Generative Models: https://lilianweng.github.io/lil-log/2018/08/12/gan-variations.html
2. Generative Adversarial Networks (GANs) Specialization: https://www.coursera.org/specializations/generative-adversarial-networks-gans

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL15	NATURAL LANGUAGE PROCESSING AND ITS APPLICATIONS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- Learn the basic concepts of NLP and the include the knowledge Of Preprocessing Techniques of NLP.

Prerequisite : Python Programming

Course Outcome: On the successful completion of the course, students will be able to

CO1	Comprehend The Ambiguity, Challenges, And Applications Of NLP.	Understand
CO2	Demonstrate NLP Techniques Such As Part-Of-Speech Tagging, Morphology, And Text Processing.	Analyze
CO3	Create Applications Using Probabilistic Models.	Apply
CO4	Develop Applications Utilizing Probabilistic Models.	Apply
CO5	Develop NLP Applications Using Machine Learning And Deep Learning Models.	Apply

Syllabus

UNIT I: NLP Overview **9 Hours**

History Of NLP, Applications Of NLP: Information Retrieval, Information Extraction, Question Answering, Sentiment Analysis Optical Character Recognition, Text Categorization Word Prediction, Speech Recognition Machine Translation, Introduction To Text Preprocessing, Tokenization, Lemmatization And Stemming, Feature Extraction NLP Terminology, Components Of NLP, Term Frequency (TF), Inverse Document Frequency (IDF), Modeling Using TF-IDF, Spam Filtering.

UNIT II: - NLP Techniques **9 Hours**

Parts of Speech: Tagsets for English, POS (Part of Speech) tagging, POS (Part of Speech) tagging, Named entity recognition (NER), Language Model Vectorization, Word Embedding, Bag of Words, Continuous Bag of Words, Word Cloud - Pre-trained models, Word2Vec, Discovering Semantic relationship using, Word2Vec , Glove, Elmo embedding, Topic Modeling, Latent Dirichlet Allocation (LDA) , Applications of LDA, Tutorial4 :Implementation of POS Tagging, NER.

UNIT III: Web Scraping and Language Models **9 Hours**

Basic HTML tags, Beautiful Soup, Web Scraping on HTML page, scraping ecommerce site, retrieve data with API, Modelling using N-Gram Model, Skip Gram, N-Gram, Document Similarity, Deep Learning models, Sequence modeling, Why Recurrence is necessary, Backpropagation through time (BPTT), Understanding gates, RNN, LSTM Basics, Multilayer LSTM, Bi-Directional LSTM.

UNIT IV: Large Language Models **9 Hours**

Attention Mechanism, Large Language Models, Encoder – Decoder Architecture, Transformers, BERT, XLNet, BART, GPT, Claude Gemma and Gemini APIs. Large Language models for Indian Languages – MURIL BERT, Multilingual models, mBERT, mBART.

UNIT V: Introduction to Generative AI **9Hours**

Generative AI and Large Language Models, Building Sarcasm Detection, End to End Case study, Generative AI using Hugging Face API, RAG model demonstration, Building Co-Pilots for health Care and Fin Tech, Handling Hallucination and data security.

TOTAL HOURS:45

Text Book

1. Mugan, J., Natural language text processing with Python: Hands-on NLP in Python using NLTK, spaCy, gensim, and scikit-learn., 2017
2. .In Loonycorn (Firm), From 0 to 1: Machine learning, NLP & Python: cut to the chase. &PacktPublishing, 2017**.**

Reference Book

1. Tunstall L., Werra L., and Wolf T, Natural Language Processing with Transformers. [ISBN-13: 978-1098136796], (available on O'Reilly), 2022
2. Dan Jurafsky, D. and James H. Martin, J., Speech and Language Processing Links to an external site. (3rd ed), 2019
3. Raaijmakers S. 2022. Deep Learning for Natural Language Processing Links to an external site. O'Reilly. [ISBN-13: 978-1617295447].

Web Resources

1. Hugging Face Transformers : https://huggingface.co/transformers/
2. The Illustrated Transformer by Jay Alammar: http://jalammar.github.io/illustrated-transformer/
3. NLTK – Natural Language Toolkit : https://www.nltk.org/

Mapping with Programme Outcomes

COs	**Program Outcomes(Pos)**						**Program Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	**Assessment Tools**	**Marks**
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL16	COMPUTER VISION ON EDGE COMPUTING	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

This course aims to provide foundational and advanced knowledge in computer vision techniques and their deployment on edge computing platforms. It introduces core concepts in image formation, processing, and recognition, while emphasizing real-time performance and optimization strategies for edge devices.

Prerequisite : Basic knowledge of image processing, programming, and computer architecture.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Demonstrate Knowledge Of Fundamentals Of Computer Vision And Image Formation Techniques	Explain
CO2	Apply Image Processing Methods For Feature Extraction And Optimization	Apply, Analyze
CO3	Implement Object Recognition And Classification Techniques Using Visual Data	Apply
CO4	Analyze Edge Computing Architecture, Components, And Application Domains	Analyze, Explore
CO5	Optimize And Deploy Computer Vision Models On Edge Devices Using Hardware-Aware Strategies And Case Studies	Analyze, Apply

Syllabus

UNIT–I Introduction to Computer Vision **9 Hours**

Introduction to Computer Vision, Image Formation: Geometric Primitives and Transformation, Photometric Image Formation, Color and Compression.

UNIT–II Image Processing **9 Hours**

Point Operators, Linear Filtering, Pyramids and Wavelets, Model Fitting and Optimization: Scattered Data Interpolation, Variational Methods and Regularization, Markov Random Fields.

UNIT–III Image Recognition **9 Hours**

Instance Recognition, Image Classification, Object Detection, Feature Detection and Matching: Points and Patches, Edges and Contours, Contour Tracking, Segmentation.

UNIT–IV Introduction to Edge Computing **9 Hours**

The Cloud and Edge Computing Paradigms, Edge Computing Architecture and Technology, Components of Edge Computing Systems, Trends in Edge Computing, Edge Computing Challenges and Applications.

UNIT–V Optimization Techniques for Edge Computing **9 Hours**

Techniques for Optimizing Computer Vision Algorithms, Model Compression and Quantization, Hardware-aware Optimization Strategies, Edge Devices for Computer Vision Applications, Case Studies.

TOTAL HOURS:45

Text Book

1. Richard Szeliski, Computer Vision: Algorithms and Applications 2nd Edition, The University of Washington, 2022.
2. 2. Ranjay Krishna, Computer Vision: Foundations and Applications, Ist Edition, Stanford

University, 2017.

Reference Book

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2022.
2. Simon Haykin, Neural Networks and Learning Machines, Pearson Education, 2016.
3. Joseph Redmon and Santosh Divvala, Deep Learning for Computer Vision, Packt Publishing, 2021.

Web Resources

1. A Comprehensive Review on Edge Computing- https://www.sciencedirect.com/science/article/pii/S23528648220 0024
2. Recent Advances in Edge AI- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9919555/pdf/sens ors-23-01279.pdf
3. Model Quantization Techniques - https://moschip.com/blog/ai/model-quantization-for-edge-ai/

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL17	SOCIAL NETWORK ANALYSIS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

This course is designed to introduce students to the fundamentals and applications of social networking technologies, focusing on semantic web development and the extraction of meaningful data from social platforms. It covers critical aspects of privacy, security, and access control in social networks, emphasizing the challenges and solutions in protecting user information.

Prerequisite : Basic understanding of web technologies, databases, and fundamentals of computer security.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Develop simple semantic web applications related to social networking.	Apply
CO2	Explain privacy and security issues prevalent in social networking platforms.	Understand
CO3	Extract and mine data effectively from social networks for analysis.	Analyze
CO4	Discuss techniques for predicting human behavior in social communities.	Understand
CO5	Describe and implement access control, privacy, and security management strategies in social networks.	Understand

Syllabus

UNIT–I Fundamentals of Social Networking **9 Hours**

Introduction to Semantic Web, Limitations of current Web, Development of Semantic Web, Emergence of the Social Web, Social Network Analysis, Development of Social Network Analysis, Key Concepts and Measures in Network Analysis, Historical Overview of Privacy and Security, Major Paradigms for Understanding Privacy and Security.

UNIT–II Security Issues in Social Networks **9 Hours**

The Evolution of Privacy and Security Concerns with Networked Technologies, Contextual Influences on Privacy Attitudes and Behaviors, Anonymity in a Networked World.

UNIT–III Extraction and Mining in Social Networking Data **9 Hours**

Extracting Evolution of Web Community from a Series of Web Archives, Detecting Communities in Social Networks, Definition of Community, Evaluating Communities, Methods for Community Detection and Mining, Applications of Community Mining Algorithms, Tools for Detecting Communities, Social Network Infrastructures and Communities, Big Data and Privacy.

UNIT–IV Predicting Human Behavior and Privacy Issues **9 Hours**

Understanding and Predicting Human Behavior for Social Communities, User Data Management, Inference and Distribution, Enabling New Human Experiences, Reality Mining, Context, Awareness, Privacy in Online Social Networks, Trust in Online Environment, What is Neo4j, Nodes, Relationships, Properties.

UNIT–V Access Control, Privacy and Identity Management **9 Hours**

Understanding the Access Control Requirements for Social Networks, Enforcing Access Control Strategies, Authentication and Authorization, Role-Based Access Control, Host, Storage and Network Access Control Options, Firewalls, Authentication and Authorization in Social Networks,

Identity & Access Management, Single Sign-On, Identity Federation, Identity Providers and Service Consumers, The Role of Identity Provisioning.

TOTAL HOURS:45

Text Book

1. Peter Mika, "Social Networks and the Semantic Web, First Edition, Springer 2007.
2. BorkoFurht, "Handbook of Social Network Technologies and Application, First Edition, Springer, 2010.
3. Learning Neo4j 3.x – Second Edition By Jérôme Baton, Rik Van Bruggen, Packt publishing
4. David Easley, Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning about a Highly Connected World‖, First Edition, Cambridge University Press, 2010.

Reference Book

1. Easley D. Kleinberg J., "Networks, Crowds, and Markets – Reasoning about a Highly Connected World‖, Cambridge University Press, 2010.
2. Jackson, Matthew O., "Social and Economic Networks", Princeton University Press, 2008. 3. GuandongXu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", First Edition, Springer, 2011.

Web Resources

1. **W3C Semantic Web Standards**
   https://www.w3.org/standards/semanticweb/
2. **Social Network Analysis Tools and Tutorials**
   https://www.social-networks.org/tutorials/

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	2	2	1	2	2	1	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL18	OPTIMIZATION TECHNIQUES	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

This course aims to equip students with the fundamental techniques of operations research, focusing on formulating and solving linear programming problems and various optimization models. Students will learn to analyze and solve integer programming, transportation, and assignment problems, as well as apply network analysis tools like CPM and PERT for project scheduling.

Prerequisite :

Basic knowledge of mathematics, including algebra and calculus, and fundamentals of probability and statistics.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Formulate and solve linear programming problems (LPP).	Analyze
CO2	Evaluate Integer Programming Problems, Transportation, and Assignment Problems.	Analyze
CO3	Obtain solutions to network problems using CPM and PERT techniques.	Apply
CO4	Optimize functions subject to constraints.	Apply
CO5	Identify and solve problems under Markovian queuing models.	Analyze, Apply

Syllabus

UNIT–I Linear Models **9 Hours**

Introduction to Operations Research, Mathematical Formulation of Linear Programming Problems (LPP), Graphical Methods to Solve LPP, Simplex Method, Two-Phase Method.

UNIT–II Integer Programming and Transportation Problems **9 Hours**

Integer Programming: Branch and Bound Method, Transportation and Assignment Problems, Traveling Salesman Problem.

UNIT–III Project Scheduling **9 Hours**

Project Network, Diagram Representation, Floats, Critical Path Method (CPM), PERT, Cost Considerations in PERT and CPM.

UNIT–IV Classical Optimization Theory **9 Hours**

Unconstrained Problems: Necessary and Sufficient Conditions, Newton-Raphson Method; Constrained Problems: Equality Constraints, Inequality Constraints, Kuhn-Tucker Conditions.

UNIT–V Queuing Models **9 Hours**

Introduction to Queuing Theory, Operating Characteristics of a Queuing System, Constituents of a Queuing System, Service Facility, Queue Discipline, Single Channel Models, Multiple Service Channels.

TOTAL HOURS:45

Text Book

1. Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2017.

Reference Book

1. ND Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 4th Edition, 2011.
2. J. K. Sharma, Operations Research Theory and Applications, Macmillan, 5th Edition, 2012.

3. Hiller F.S, Liberman G.J, Introduction to Operations Research, 10th Edition McGraw Hill, 2017.
4. Jit. S. Chandran, Mahendran P. Kawatra, KiHoKim, Essentials of Linear Programming, Vikas Publishing House Pvt.Ltd. New Delhi, 1994.
5. Ravindran A., Philip D.T., and Solberg J.J., Operations Research, John Wiley, 2nd Edition, 2007.

Web Resources

1. **Integer Programming and Branch and Bound Method**
   https://www.coursera.org/lecture/algorithms-part2/branch-and-bound-algorithm-JnHkX
2. **Project Scheduling - CPM and PERT**
   https://www.projectmanager.com/blog/cpm-and-pert-techniques
3. **Classical Optimization Theory**
   https://ocw.mit.edu/courses/18-335j-nonlinear-programming-spring-2003/

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL19	CYBER SECURITY OPERATIONS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

This course aims to provide foundational and advanced knowledge in computer vision techniques and their deployment on edge computing platforms. It introduces core concepts in image formation, processing, and recognition, while emphasizing real-time performance and optimization strategies for edge devices.

Prerequisite : Basic knowledge of computer networks, operating systems, and fundamentals of cybersecurity.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Apply the knowledge of security technologies.	Apply
CO2	Analyze the security operation capabilities.	Analyze
CO3	Evaluate the process of security events generation.	Evaluate
CO4	Analyze the preparation to operate in a security environment.	Analyze
CO5	Evaluate the types of events and incidents in security operations.	Evaluate

Syllabus

UNIT–I Introduction to Security Operations and the SOC Technologies 9 Hours

Cybersecurity Challenges, Introduction to Information Assurance, Introduction to Risk Management, Information Security Incident Response, SOC Generations, Characteristics of an Effective SOC, Introduction to Maturity Models, Applying Maturity Models to SOC, Phases of Building a SOC, Challenges and Obstacles, Data Collection and Analysis, Vulnerability Management, Threat Intelligence, Compliance, Ticketing and Case Management, Collaboration, SOC Conceptual Architecture**.**

UNIT–II Assessing Security Operations Capabilities 9 Hours

Assessment Methodology, Organization's Threat Landscape, SOC Sponsorship, Allocated Budget, Presenting Data Strategy Elements, SOC Model of Operation, SOC Services, SOC Capabilities Roadmap**.**

UNIT–III SOC Infrastructure and Security Events Generation, Collection & Vulnerability Management 9 Hours

Design Considerations, Model of Operation, Facilities, Active Infrastructure, Data Collection, Cloud Security, Intrusion Detection and Prevention System, Network Telemetry with Network Flow, Handling Vulnerabilities, Automating Vulnerability Management, Threat Intelligence.

UNIT–IV Technology and Preparing to Operate 9 Hours

Network, Security, Systems, Storage, Collaboration, Technologies to Consider During SOC Design, Breach Detection, Final SOC Architecture, Preparing to Operate, Key Challenges, Managing Challenges Through a Well-Managed Transition**.**

UNIT–V Reacting to Events and Incidents 9 Hours

Event Intake, Enrichment, Monitoring and Handling, Closing and Reporting on the Case, Review

and Assessing the SOC, Maintaining and Improving SOC. **TOTAL HOURS:45**
Text Book 1. Joseph Muniz, Gary McIntyre, Security Operations Center, Cisco press 2015 2. John Rittinghouse PhD CISM Captain, William M. Hancock PhD CISSP CISM, Digital Press, 2003
Reference Book 1. Russel C Hibler, Engineering Mechanics: Statics, Dynamics, Pearson,14th ed., 2015 2. Robert H. Deatherage, Jr., Security Operations an Introduction to planning and Conductive Private Security Details for High-Risk Areas **Web Resources** 1. Introduction to Security Operations & SOC Architecture- https://www.sans.org/white-papers/security-operations-center-soc/ 2. NIST Risk Management Framework- https://csrc.nist.gov/publications/detail/sp/800-37/rev-2/final 3. MITRE ATT&CK Framework- https://attack.mitre.org/

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	2	2	1	2	2	1	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL20	HUMAN COMPUTER INTERACTION	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

This course introduces the fundamental concepts of Human Computer Interaction, focusing on designing user-centered interfaces. Learners will explore usability principles, interaction design, evaluation methods, and emerging trends to develop effective and accessible computing systems.

Prerequisite : Basic knowledge of computer systems and programming fundamentals.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand the principles and theories of Human Computer Interaction.	Explain
CO2	Analyze user requirements and design user-centered interfaces.	Analyze
CO3	Apply usability evaluation techniques to improve interface design.	Apply
CO4	Design effective and accessible user interfaces.	Create
CO5	Evaluate emerging HCI technologies and their impact on user experience.	Evaluate

Syllabus

UNIT–I Introduction to Human Computer Interaction **9 Hours**

Definition, goals, and importance of HCI, models and theories of HCI, ergonomics and human factors, interaction styles and paradigms.

UNIT–II User Interface Design Principles **9 Hours**

Design process and principles, cognitive models and mental workload, human memory and attention, guidelines for screen design and interface metaphors.

UNIT–III Usability and Evaluation Methods **9 Hours**

Usability concepts and metrics, heuristic evaluation and cognitive walkthrough, user testing methods (surveys, interviews, focus groups), prototyping and iterative design.

UNIT–IV Interaction Devices and Technologies **9 Hours**

Input/output devices (keyboards, mice, touchscreens, voice, gestures), virtual reality (VR) and augmented reality (AR), mobile and ubiquitous computing, multimodal interaction.

UNIT–V Emerging Trends and Future Directions in HCI **9 Hours**

Social computing and collaborative systems, accessibility and inclusive design, affective computing, ethical issues and privacy in HCI.

TOTAL HOURS:45

Text Book

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, Human-Computer Interaction, 3rd Edition, Pearson Education, 2004.
2. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 5th Edition, Pearson, 2010.
3. Jenny Preece, Yvonne Rogers, Helen Sharp,

Interaction Design: Beyond Human-Computer Interaction, 4th Edition, Wiley, 2015.

Reference Book

1. Dix, Alan, et al. Human-Computer Interaction, 2nd Edition, Prentice Hall, 1998.
2. Rogers, Yvonne, Helen Sharp, and Jenny Preece,Interaction Design: Beyond Human-Computer Interaction, 2nd Edition, Wiley, 2007.
3. Preece, Jenny, Yvonne Rogers, and Helen Sharp,Interaction Design: Beyond Human-Computer Interaction, 3rd Edition, Wiley, 2015.
4. Shneiderman, Ben, et al.The New ABCs of Research: Achieving Breakthrough Collaborations, Oxford University Press, 2008.
5. Dix, Alan, et al.Human Computer Interaction, 3rd Edition, Pearson Education India, 2004.

Web Resources

1. **Interaction Design Foundation** – Comprehensive tutorials and articles on HCI concepts https://www.interaction-design.org/literature/topics/human-computer-interaction
2. **Usability.gov** – U.S. Government resource for user experience best practices and guidelines https://www.usability.gov/
3. **Nielsen Norman Group (NNG)** – Research-based articles and insights on usability and UX design https://www.nngroup.com/articles/
4. **Coursera: Human-Computer Interaction Courses** – Online courses from top universities https://www.coursera.org/courses?query=human%20computer%20interaction

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	2	2	1	2	2	1	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL21	DATA SCIENCE	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To equip students with a comprehensive understanding of data science methodologies and tools. The course enables learners to apply descriptive and inferential data analytics, visualize data effectively, and develop predictive models for various real-world applications.

Prerequisite

- Basic knowledge of Probability, Statistics, Linear Algebra, and Programming in Python.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Explain the data analytics pipeline.	Explain
CO2	Describe and visualize data.	Understand
CO3	Perform statistical inferences from data.	Apply
CO4	Analyze the variance in the data.	Analyze
CO5	Build models for predictive analytics.	Apply

Syllabus

UNIT- I Introduction To Data Science **9 Hours**

Need for Data Science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleansing, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications.

UNIT- II Descriptive Analytics **9 Hours**

Frequency distributions – Outliers –interpreting distributions – graphs – averages - describing variability – interquartile range – variability for qualitative and ranked data - Normal distributions – z scores –correlation – scatter plots – regression – regression line – least squares regression line – standard error of estimate – interpretation of r2 – multiple regression equations – regression toward the mean.

UNIT- III Inferential Statistics **9 Hours**

Populations – samples – random sampling – Sampling distribution- standard error of the mean - Hypothesis testing – z-test – z-test procedure –decision rule – calculations – decisions – interpretations - one-tailed and two-tailed tests – Estimation – point estimate – confidence interval – level of confidence – effect of sample size.

UNIT- IV Analysis Of Variance **9 Hours**

t-test for one sample – sampling distribution of t – t-test procedure – t-test for two independent samples – p-value – statistical significance – t-test for two related samples. F-test – ANOVA – Two-factor experiments – three f-tests – two-factor ANOVA –Introduction to chi-square tests.

UNIT- V Predictive Analytics **9 Hours**

Linear least squares – implementation – goodness of fit – testing a linear model – weighted resampling. Regression using StatsModels – multiple regression – nonlinear relationships – logistic regression – estimating parameters – Time series analysis – moving averages – missing values –

serial correlation – autocorrelation. Introduction to survival analysis.

TOTAL HOURS : 45

Text Book

4. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. (first two chapters for Unit I).
5. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
6. Joel Grus, "Data Science from Scratch: First Principles with Python", O’Reilly Media, 2nd Edition, 2019.

Reference Book

1. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press, 2014.
2. Wes McKinney, "Python for Data Analysis: Data Wrangling with pandas, NumPy, and IPython", O’Reilly Media, 2nd Edition, 2017.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2nd Edition, 2009.

Web Resources

1. https://nptel.ac.in/courses/106/106/106106179 – "Data Science for Engineers" – IIT Madras.
2. https://nptel.ac.in/courses/106107220 – "Python for Data Science" – IIT Roorkee.
3. https://nptel.ac.in/courses/106106202 – "Machine Learning for Engineering and Science Applications" – IIT Madras.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL22	ADVANCED MACHINE LEARNING ALGORITHMS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To provide students with a comprehensive understanding of human learning aspects and their application in advanced machine learning. The course enables learners to understand the fundamental primitives of computational learning, develop linear models and classification algorithms, implement clustering techniques, and apply tree-based learning methods for solving complex real-world problems.

Prerequisite

- Basic knowledge of Machine Learning, Probability and Statistics, Linear Algebra, and Programming in Python.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Demonstrate knowledge of learning algorithms and concept learning through implementation for sustainable solutions of applications.	Understand
CO2	Evaluation of different algorithms on well formulated problems along with stating valid conclusions that the evaluation supports.	Analyze
CO3	Apply a given problem within the Bayesian learning framework with focus on building lifelong learning ability.	Apply
CO4	Analyze research-based problems using machine learning techniques.	Analyze
CO5	Apply decision tree learning algorithms.	Apply

Syllabus

UNIT- I Introduction and Types of Learning **9 Hours**

Introduction: Machine Learning: What & Why? - Examples of Machine Learning applications, Training versus Testing, Positive and Negative Class, Cross-validation. Types of Learning: Supervised, Unsupervised and Semi-Supervised Learning. The Curse of dimensionality -Over fitting and under fitting - Bias and Variance tradeoff - Evaluation Metrics, Gradient Descent Curve - Error and noise-Parametric vs. non-parametric models-Linear Algebra for machine learning.

UNIT- II Design And Analysis of Machine Learning Algorithms **9 Hours**

Guidelines for machine learning experiments, Cross Validation (CV) and resampling – K-fold CV, measuring classifier performance, assessing a single classification algorithm and comparing two classification algorithms - K-fold CV Performance metrics-MSE, accuracy, confusion matrix, precision, recall, F1-score- Linear Regression - Logistic Regression with Binomial & Multi class classification.

UNIT- III Non-Parametric Model **9 Hours**

K nearest neighbor classification –Gaussian Naive Bayes Classification-Multinomial Naïve Bayes classification-Bernoulli Naïve Bayes Classification - Comparison of Gaussian, Multinomial, Bernoulli naive bayes classification -Support vector machine.

UNIT- IV Decision Tree and Ensembling Models **9 Hours**

Decision tree representation-Basic decision tree learning algorithm-Inductive bias in decision tree Decision tree construction-Issues in decision tree-Classification and regression trees (CART)-Random Forest-Random Forest with scikit-learn Minority Class, bootstrapping, Impurity Measures

– Gini Index and Entropy, Best Split -Multivariate adaptive regression trees (MART). Boosting TechniqueWorking of Adaboost, Gradient boost, Extreme Gradient Boost, Stacking and voting ensemble models.

UNIT- V Unsupervised Techniques **9 Hours**

Measuring (dis)similarity-Evaluating output of clustering methods-Spectral Clustering-Hierarchical Clustering-Agglomerative clustering-Divisive clustering-Choosing the number of clusters-Clustering data points and features-Bi-clustering-Multi-view clustering-K-Means clustering-K-medoids clustering, Principal component Analysis, Singular value decomposition (SVD).

TOTAL HOURS : 45

Text Book

1. Géron, “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow”, O'Reilly Media, Third Edition, 2022.
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

Reference Book

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education, 1997.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2nd Edition, 2009.
3. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Web Resources

1. https://nptel.ac.in/courses/106106202 – "Machine Learning for Engineering and Science Applications" – IIT Madras.
2. https://nptel.ac.in/courses/106106139 – "Deep Learning" – IIT Ropar.
3. https://nptel.ac.in/courses/106105152 – "Machine Learning" – IIT Kharagpur.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL23	VIRTUAL & AUGMENTED REALITY	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To impart fundamental knowledge of Virtual and Augmented Reality technologies. The course enables learners to understand the hardware and software components used in AR/VR systems, learn graphical processing architectures, gain insights into AR/VR application development, and explore various technologies involved in building immersive AR/VR-based solutions.

Prerequisite

- Basic knowledge of Computer Graphics, Programming in C/C++ or Python, and Linear Algebra.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand the basic concepts of AR and VR.	Understand, Explain
CO2	Understand the tools and technologies related to AR/VR.	Understand
CO3	Know the working principle of AR/VR related Sensor devices.	Analyze
CO4	Design of various models using modeling techniques.	Apply
CO5	Develop AR/VR applications in different domains.	Apply

Syllabus

UNIT- I Introduction To Virtual & Augmented Reality **9 Hours**

Introduction to VR and AR – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.

UNIT- II VR Modeling **9 Hours**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

UNIT- III VR Programming **9 Hours**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D.

UNIT- IV Applications **9 Hours**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

UNIT- V Augmented Reality **9 Hours**

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices.

TOTAL HOURS : 45

Text Book

1. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
2. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016.
3. Dieter Schmalstieg and Tobias Hollerer, "Augmented Reality: Principles and Practice", Addison-Wesley, 2016.

Reference Book

1. Jason Jerald, "The VR Book: Human-Centered Design for Virtual Reality", Morgan & Claypool Publishers, 2015.
2. Alan B. Craig, "Understanding Augmented Reality: Concepts and Applications", Morgan Kaufmann, 2013.

Web Resources

1. https://nptel.ac.in/courses/106106138 – "Introduction to Augmented Reality and Virtual Reality" – IIT Madras.
2. https://nptel.ac.in/courses/106105219 – "Computer Graphics" – IIT Kharagpur.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL24	DATABASE SYSTEMS DESIGN: RELATIONAL AND NOSQL	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To provide an understanding of database system fundamentals, architecture, and relational model design. The course enables learners to design schemas using relational algebra and SQL, apply normalization techniques, build real-world applications using NoSQL databases, and implement transactional NoSQL systems.

Prerequisite

- Basic knowledge of Data Structures, Programming in SQL and Python, and Fundamentals of Computer Systems.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand DBMS architecture, languages and Design of entire database.	Understand
CO2	Demonstrate Database design with SQL Queries.	Apply
CO3	Formulate removal of anomalies using Normalization concepts.	Apply
CO4	Analyze various real time applications of NoSQL.	Analyze
CO5	Implement Transactional NoSQL Database.	Apply

Syllabus

UNIT- I Introduction to DBMS **9 Hours**

Issues in File Processing System – Need for DBMS – Basic terminologies of Database – Database system Architecture – Various Data models – ER diagram basics and extensions – Keys – Constraints – Conversion of ER to Relational model – Tuple Relational calculus – Domain relational calculus.

UNIT- II SQL **9 Hours**

Relational Algebra – Fundamental Operators – SQL commands : DDL, DML, DCL – Integrity Constraints – Aggregate Functions – Joins – Types of Joins : Inner joins, Outer joins, Self-joins – Subqueries : Single row and multiple row subqueries – Views – PL – SQL – Triggers – Cursors.

UNIT- III Normalization **9 Hours**

Pitfalls in Relational database – Decomposing bad schema – Normalization – Need for Normalization – 1 NF – Functional Dependency – Closure of FD set – Closure of attributes – 2 NF – 3 NF – BCNF – Multi-valued dependency – 4 NF – Join dependency – 5 NF.

UNIT- IV NoSQL Fundamentals **9 Hours**

Overview and History of NoSQL Databases – Types of NoSQL Database – The Value of Relational Databases – Getting at Persistent Data – Concurrency – Integration – Impedance Mismatch – Application and Integration Databases – Attack of the Clusters – The Emergence of NoSQL – Comparison of relational databases to new NoSQL stores – MongoDB – Cassandra – HBASE – Challenges NoSQL approach – Key-Value and Document Data Models – Column-Family Stores – Aggregate-Oriented Databases – Replication and sharding – MapReduce on databases.

UNIT- V Transactions with NoSQL **9 Hours**

NoSQL Key-Value databases using MongoDB – Document Databases – Document oriented Database Features – Consistency – Transactions – Availability – Query Features – Scaling – Suitable Use Cases – Event Logging – Content Management Systems – Blogging Platforms – Web Analytics or Real-Time Analytics – Social media Applications – Column-oriented NoSQL databases using Apache HBASE.

TOTAL HOURS : 45

Text Book

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill Education, 7th Edition, 2020.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2017.
3. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley, 2013.
4. Shashank Tiwari, "Professional NoSQL", Wiley, 2011.

Reference Book

1. C.J. Date, "An Introduction to Database Systems", Pearson Education, 8th Edition, 2003.
2. Kristina Chodorow, "MongoDB: The Definitive Guide", O'Reilly Media, 3rd Edition, 2019.

Web Resources

1. https://nptel.ac.in/courses/106106220 – "Introduction to NoSQL Databases" – IIT Roorkee.
2. https://nptel.ac.in/courses/106105175 – "Database Management System" – IIT Kharagpur.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL25	AGENT BASED INTELLIGENT SYSTEM	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To introduce students to fundamental approaches in Artificial Intelligence. The course enables learners to develop problem-solving agents and apply logical and probabilistic reasoning in intelligent systems.

Prerequisite

- Basic knowledge of Artificial Intelligence, Data Structures, and Programming in Python or Java.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Describe the fundamental approaches and techniques in Artificial Intelligence.	Understand
CO2	Design intelligent agents for solving search and optimization problems.	Apply
CO3	Apply logic-based techniques for knowledge representation and reasoning.	Apply
CO4	Analyze and implement probabilistic reasoning models for uncertain environments.	Analyze
CO5	Develop multi-agent systems and evaluate their decision-making capabilities.	Apply

Syllabus

UNIT- I Introduction to Intelligent Agents **9 Hours**

Definition of agents – Types of agents – Agent vs. object – Rationality – Task environments – Agent structure – Simple reflex agents – Model-based reflex agents – Goal-based agents – Utility-based agents – Learning agents – Agent programming.

UNIT- II Problem Solving and Search Techniques **9 Hours**

Problem solving agents – Search problems – Uninformed search strategies: Breadth-first, Depth-first, Depth-limited, Iterative deepening – Informed search strategies: Greedy best-first, A* algorithm – Heuristic functions – Local search algorithms – Hill climbing – Simulated annealing – Genetic algorithms – Constraint satisfaction problems (CSPs).

UNIT- III Knowledge Representation and Reasoning **9 Hours**

Propositional logic – First-order logic – Syntax and semantics – Knowledge-based agents – Inference in first-order logic – Forward chaining – Backward chaining – Resolution – Unification – Ontologies – Description logics – Rule-based systems.

UNIT- IV Probabilistic Reasoning and Learning **9 Hours**

Uncertainty – Bayesian networks – Inference in Bayesian networks – D-separation – Exact and approximate inference – Temporal models – Hidden Markov Models (HMMs) – Dynamic Bayesian Networks (DBNs) – Decision theory – Utility theory – Basic learning models – Supervised vs. unsupervised learning – Naive Bayes – Expectation Maximization.

UNIT- V Multi-Agent Systems and Applications **9 Hours**

Introduction to multi-agent systems – Characteristics – Agent communication – Agent cooperation – Coordination and negotiation – Distributed problem solving – Multi-agent planning – Applications

in robotics, game AI, distributed systems – Case studies of intelligent agent applications.

TOTAL HOURS : 45

Text Book

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 4th Edition, 2020.
2. Michael Wooldridge, "An Introduction to MultiAgent Systems", Wiley, 2nd Edition, 2009.
3. Gerhard Weiss, "Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence", MIT Press, 2013.

Reference Book

1. Yoav Shoham and Kevin Leyton-Brown, "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations", Cambridge University Press, 2008.
2. Nils J. Nilsson, "The Quest for Artificial Intelligence", Cambridge University Press, 2010.

Web Resources

1. https://nptel.ac.in/courses/106106140 – "Artificial Intelligence" – IIT Madras.
2. https://nptel.ac.in/courses/106106220 – "Game Theory and Multi-Agent Systems" – IIT Bombay.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL26	MICROSERVICES AND SERVICE BASED ARCHITECTURES	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To introduce key concepts of Web services, SOA, and Microservices. The course enables learners to apply service design patterns, understand Microservices architecture and tools, and deploy Microservices on cloud platforms.

Prerequisite

- Basic knowledge of Web Technologies, XML, and Object-Oriented Programming.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Demonstrate knowledge of the basics of web services and protocols.	Explain
CO2	Comprehend the need for SOA and their systematic evolution.	Explain
CO3	Design and analyze various SOA patterns and techniques.	Apply
CO4	Apply knowledge of micro-services architecture and cloud services.	Apply
CO5	Implement micro-services using Python and deploy them on the cloud.	Apply

Syllabus

UNIT- I Introduction to Web Services **9 Hours**

Introduction to XML, Creating well-formed XML- Web services overview - Architecture– DOM and SAX Processors – SOAP – WSDL – UDDI – JSON – WS – Security -Web Services Standards – Java, .NET, Python Web Services – RESTful Web Services - Case studies - Payment Gateways, Social Plugins, Travel and Booking, Maps Services, E-commerce websites, Cloud-based storage providers etc.

UNIT- II SOA and MSA Basics **9 Hours**

Service Orientation in Daily Life – Evolution of SOA and MSA – Service-oriented Architecture and Micro-services architecture – Drivers for SOA – Dimensions of SOA – Conceptual Model of SOA – Standards and Guidelines for SOA – Emergence of MSA – Service-Oriented Architecture: Considerations for Enterprise-wide SOA – Strawman Architecture for Enterprise-wide SOA – Enterprise SOA Reference Architecture – Adopting Microservices in Practice – Service-oriented Analysis and Design (SOAD) Process.

UNIT- III Service-Oriented Applications **9 Hours**

Considerations for Service-oriented Applications – Patterns for SOA – Pattern-based Architecture for Service-oriented Applications – Composite Applications – Composite Application Programming Model – Service-Oriented Analysis and Design – Need for Models – Principles of Service Design – Non-functional Properties for Services – Design of Activity Services (or Business Services) – Design of Data Services – Design of Client Services – Design of Business Process Services – Case Study: SOA – Loan Management System (LMS) PoC.

UNIT- IV Micro-services Architecture **9 Hours**

Trend in SOA – Micro-services Architecture (MSA) – Services Model for Cloud and Mobile Solutions – API Adoption on the Rise – Challenges and Takeaways from SOA Implementations –

Architecture Trend – Micro-services Architecture – Micro-services Architecture in Action – Cloud and MSA – Cloud Services – Hybrid Cloud Service and its Considerations – Cloud Services and MSA – MSA for SMAC Solutions – MSA Platforms and Tools – Docker – Containers and Kubernetes – GraphQL Integration – CI/CD Pipeline for Micro-service.

UNIT- V Micro-service Based Applications **9 Hours**

Implementing Micro-services with Python – Micro-service Discovery Framework – Coding, Testing and Documenting Micro-services – Interacting with Other Services – Monitoring and Securing the Services – Containerized Services – Deploying on Cloud, Mobile and MSA: Mobile Technologies, Types of Mobile Applications, MSA for mobile solutions, Case study: MSA – APIary PoC, Building a scalable ecommerce platform or a cloud-native application.

TOTAL HOURS : 45

Text Book

1. Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005.
2. Eric Newcomer and Greg Lomow, "Understanding SOA with Web Services", Addison-Wesley, 2004.
3. Thomas Erl, "SOA Principles of Service Design", Prentice Hall, 2007.

Reference Book

1. Sandeep Chatterjee and James Webber, "Developing Enterprise Web Services: An Architect's Guide", Pearson Education, 2004.
2. Michael Rosen et al., "Applied SOA: Service-Oriented Architecture and Design Strategies", Wiley Publishing, 2008.

Web Resources

1. https://nptel.ac.in/courses/106105191 – "Service-Oriented Architecture" – IIT Kharagpur.
2. https://nptel.ac.in/courses/106105173 – "Web Services" – IIT Bombay.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL27	BUSINESS DATA ANALYTICS	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To introduce the role of data analytics in modern business environments. The course enables learners to collect, clean, and analyze data; apply statistical and machine learning methods to business problems; interpret and communicate insights effectively and evaluate ethical issues in data usage.

Prerequisite

- Basic knowledge of Statistics, Programming in Python or R, and Fundamentals of Data Analysis.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Apply data analytics techniques and tools across finance, supply chain, HR, healthcare, and customer domains.	Apply
CO2	Identify and solve complex business problems using data-driven approaches.	Understand
CO3	Design the Effectively communicate data-driven insights to diverse stakeholders.	Apply
CO4	Analyze the ethical and privacy implications of data collection and analysis.	Analyze
CO5	Collaborate with cross-functional teams to leverage data for business impact.	Apply

Syllabus

UNIT- I Marketing Analytics **9 Hours**

Resource Allocation – Cluster Analysis – Conjoint Analysis – Linear Regression – Customer Lifetime Value (CLTV) – Marketing Experiments – Paid Search Advertising – Text Analytics – Recommendation Systems – Automation of Marketing Models – Case Studies.

UNIT- II Workforce Analytics **9 Hours**

Workforce Analytics Fundamentals – Building a Workforce Analytics Function – Data Collection and Measurement – Analyzing Workforce Data – Linking to Business Outcomes – Implementing Solutions – Evaluating Success – Future Trends – Case Studies.

UNIT- III Supply Chain Analytics **9 Hours**

Introduction to Supply Chain Analytics – Data Management and Visualization – Forecasting and Demand Planning – Inventory Management – Warehousing and Transportation – Network Optimization – Supply Chain Risk Management – Sustainability and Social Responsibility.

UNIT- IV Financial Analytics **9 Hours**

Introduction and Overview of Financial Statements – Analysis of Financial Statements – Profitability Analysis – Credit Risk Analysis – Accounting Analysis and Adjustment – Forecasting and Valuation – Cost of Capital Estimation – Company Valuation.

UNIT- V Healthcare Analytics and Ethics **9 Hours**

Healthcare Data Sources and Basic Analytics – Various healthcare data sources and analytical techniques used in the processing and analysis of such data – Advanced Data Analytics for Healthcare – Advanced analytical methods including clinical prediction models – Temporal pattern mining methods – Visual analytics – Applications and Practical Systems for Healthcare –

Applications of data analytics to pervasive healthcare – Fraud detection – Drug discovery – Systems for medical imaging and decision support – Patient Privacy and Data Security (HIPAA) – Bias and Fairness in Healthcare Algorithms – Informed Consent and Data Sharing – Ethical Considerations in AI and Healthcare – Legal and Regulatory Compliance.

TOTAL HOURS : 45

Text Book

1. Umesh R Hodeghatta, Umesha Nayak, "Business Analytics Using R: A Practical Approach", Apress, 2017.
2. James R. Evans, "Business Analytics", Pearson Education, 3rd Edition, 2016.
3. Galit Shmueli, Peter C. Bruce, Nitin R. Patel, "Data Mining for Business Analytics: Concepts, Techniques, and Applications in R", Wiley, 3rd Edition, 2016.

Reference Book

1. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley, 2014.
2. Foster Provost, Tom Fawcett, "Data Science for Business", O'Reilly Media, 2013.

Web Resources

1. https://nptel.ac.in/courses/110106072 – "Business Analytics and Data Mining Modeling Using R" – IIT Roorkee.
2. https://nptel.ac.in/courses/110106064 – "Business Analytics & Text Mining Modeling Using Python" – IIT Roorkee.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL28	ETHICAL HACKING	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To provide a foundational understanding of ethical hacking techniques. The course enables learners to gather information and identify targets, use vulnerability assessment tools, study network attacks and their countermeasures, and explore wireless and web hacking through real-world examples.

Prerequisite

- Basic knowledge of Computer Networks, Operating Systems, and Programming in C/Python.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Explain the fundamental concepts, terminologies, and methodologies of penetration testing, vulnerability assessment, and risk analysis, including the use of Kali Linux for ethical hacking.	Explain
CO2	Apply active and passive information gathering techniques, network scanning, and target enumeration methods to identify system vulnerabilities.	Apply
CO3	Evaluate and utilize vulnerability assessment tools such as Nmap, Nessus, and Exploit-db to detect and analyze security weaknesses.	Evaluate
CO4	Implement various sniffing tools to exploit over networks.	Apply
CO5	Implement wireless network attacks and web application exploitation techniques, including SQL injection, XSS, CSRF, and brute force attacks, for security testing and hardening.	Apply

Syllabus

UNIT- I Introduction to Hacking **9 Hours**

Important Terminologies- Categories of Penetration Testing – Writing Reports and its structure- Vulnerability assessment summary – Risk Assessment Methodology – File Structure in Linux- Scheduler- Users – Applications – Kali Linux– Services.

UNIT- II Information Gathering and Target Enumeration **9 Hours**

Active Information Gathering – Passive Information Gathering – What Web – Net craft – Xcode Exploit Scanner – Intercepting a Response – Interacting with DNS Servers – Nslookup – Forward and Reverse DNS LookupSNMP – SMTP Enumeration- Intelligence Gathering Using Shodan – Host Discovery – Scanning for Open Ports and Services – Types of Port Scanning – TCP Three-Way Handshake – Scanning for a Vulnerable HostPort Status Types – OS Fingerprinting – Advanced Firewall/IDS Evading Techniques – Using Wireshark – Decoys – ZENMAP.

UNIT- III Vulnerability Assessment **9 Hours**

Vulnerability Scanners – Pros and Cons – Vulnerability Assessment with Nmap – Scanning netapi – Testing SCADA Environments with Nmap – Nessus Vulnerability Scanner – Installing Nessus on Kali Linux – Nessus Integration with Metasploit – Using Exploit-db with Kali Linux.

UNIT- IV Network Sniffing **9 Hours**

Types of Sniffing – ARP Attacks – Denial of Service Attacks – Using ARP Spoof to Perform MITM Attacks – Sniffing the Traffic with Dsniff – Sniffing Pictures with Drifnet – Urlsnarf and Webspy – Sniffing with Wireshark – Hijacking Session with MITM Attack – ARP Poisoning with Cain and Abel – Sniffing Session Cookies with Wireshark – Hijacking the Session – SSL Strip:

Stripping HTTPS Traffic – DNS Spoofing – DHCP Spoofing.

UNIT- V Wireless and Web Hacking **9 Hours**

Introducing Aircrack-ng – Uncovering Hidden SSIDs – Monitoring Beacon Frames on Wireshark – Monitoring with Airodump-ng – Determining the Target with Airodump-ng – Cracking a WPA/WPA2 Wireless Network Using Aircrack-ng – Evil Twin Attack – Scanning the Neighbors – Spoofing the MAC – Setting Up a Fake Access Point – Causing Denial of Service on the Original AP – Attacking the Authentication – Brute Force and Dictionary Attacks – Types of Authentication – Brute Force Attack – SQL Injection Attacks – Testing for SQL Injection – XSS (Cross-Site Scripting) – Cross-Site Request Forgery (CSRF) – Real-World Example on Web Hacking.

TOTAL HOURS : 45

Text Book

1. Michael T. Simpson, Kent Backman, James Corley, "Hands-On Ethical Hacking and Network Defense", Cengage Learning, 3rd Edition, 2019.
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing", Syngress, 2nd Edition, 2013.
3. Jon Erickson, "Hacking: The Art of Exploitation", No Starch Press, 2nd Edition, 2008.
4. Dafydd Stuttard, Marcus Pinto, "The Web Application Hacker's Handbook", Wiley, 2nd Edition, 2011.

Reference Book

1. Georgia Weidman, "Penetration Testing: A Hands-On Introduction to Hacking", No Starch Press, 2014.
2. Stuart McClure, Joel Scambray, George Kurtz, "Hacking Exposed: Network Security Secrets and Solutions", McGraw-Hill, 7th Edition, 2012.

Web Resources

1. https://nptel.ac.in/courses/106105217 – "Computer Systems Security" – IIT Madras.
2. https://nptel.ac.in/courses/106106129 – "Network Security" – IIT Kharagpur.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL29	DATA VISUALIZATION TECHNIQUES	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To develop the ability to design and evaluate effective visualizations. The course enables learners to understand visual perception, core analytical skills, technological advancements, and various techniques and methodologies for visualizing large data sets.

Prerequisite

- Basic knowledge of Data Analytics, Statistics, and Programming using Python or R.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Visualize the objects in different dimensions.	Explain
CO2	Design and process the data for Visualization.	Apply
CO3	Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences.	Apply
CO4	Apply the virtualization techniques for research projects.	Apply
CO5	Design appropriate data visualization techniques given particular requirements imposed by the data.	Apply

Syllabus

UNIT- I Introduction and Data Foundation **9 Hours**

Basics - Relationship between Visualization and Other Fields -The Visualization Process - Pseudo code Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets.

UNIT- II Foundations for Visualization **9 Hours**

Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson‘s Affordance theory – A Model of Perceptual Processing.

UNIT- III Visualization Techniques **9 Hours**

Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Geospatial Data : Visualizing Spatial Data - Visualization of Point Data, Line Data, Area Data – Other Issues in Geospatial Data Visualization Multivariate Data : Point-Based Techniques - LineBased Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Displaying Arbitrary Graphs/Networks.

UNIT- IV Interaction Concepts and Techniques **9 Hours**

Text and Document Visualization: Introduction - Levels of Text Representations - The Vector Space Model - Single Document Visualizations -Document Collection Visualizations – Extended Text Visualizations Interaction Concepts: Interaction Operators - Interaction Operands and Spaces - A Unified Framework. Interaction Techniques: Screen Space - Object-Space –Data Space - Attribute Space- Data Structure Space - Visualization Structure – Animating Transformations - Interaction Control.

UNIT- V Research Directions in Visualizations **9 Hours**

Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data.

Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation , Hardware and Applications.

TOTAL HOURS : 45

Text Book

1. Claus O. Wilke, "Fundamentals of Data Visualization", O'Reilly Media, 2019.
2. Alberto Cairo, "The Functional Art: An Introduction to Information Graphics and Visualization", New Riders, 2012.
3. Tamara Munzner, "Visualization Analysis and Design", CRC Press, 1st Edition, 2014.

Reference Book

1. Ben Fry, "Visualizing Data: Exploring and Explaining Data with the Processing Environment", O'Reilly Media, 2007.
2. Colin Ware, "Information Visualization: Perception for Design", Morgan Kaufmann, 4th Edition, 2020.
3. Julie Steele, Noah Iliinsky, "Beautiful Visualization: Looking at Data through the Eyes of Experts", O'Reilly Media, 2010.

Web Resources

1. https://nptel.ac.in/courses/106103224 – "Data Visualization" – IIT Madras.
2. https://nptel.ac.in/courses/106108100 – "Information Visualization" – IIT Roorkee.
3. https://nptel.ac.in/courses/106106221 – "Data Analytics with Python" – IIT Roorkee.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSL30	STATISTICAL MACHINE LEARNING	Category	L	T	P	Credit	Total Hours
		PEC	3	0	0	3	45

Course Objective

- To provide a strong mathematical foundation for machine learning. The course enables learners to handle data for machine learning tasks, apply supervised and unsupervised learning algorithms, and understand the fundamental concepts of neural networks.

Prerequisite

- Basic knowledge of Probability, Statistics, Linear Algebra, and Programming in Python.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Apply suitable mathematical concepts to carry out machine learning.	Apply
CO2	Acquire and process data for performing machine learning tasks.	Understand
CO3	Apply appropriate supervised learning model.	Apply
CO4	Determine the suitable type of unsupervised learning for the given problem.	Understand
CO5	Implement Neural network algorithms on applications.	Apply

Syllabus

UNIT- I Fundamentals of Machine Learning **9 Hours**

Linear Algebra – Matrix vector operations – Eigen Values – Eigen Vectors – Orthogonality – Gaussian distribution – Gradient Descent – Prior probability – Bayes rule – Gaussian normal distribution – Role of Machine Learning in Computer Science and problem solving – Problem formulation – Role of Loss Functions and Optimization – Types of Machine Learning.

UNIT- II Data Management **9 Hours**

Acquisition – Representation – Pre-processing – Transformation – Principal Component Analysis – Autoencoders – Overfitting – Underfitting – Data Management using NumPy.

UNIT- III Supervised Learning **9 Hours**

Regression – Linear – Logistic – Ridge – Decision Tree Classifiers – Support Vector Machines – Naïve Bayes Classifier – Random Forest – AdaBoost – Gradient Boost – Multi-Layer Perceptron – Exploring Supervised Learning using Pandas and Sci-kit Learn.

UNIT- IV Unsupervised Learning **9 Hours**

Clustering – k-means, Hierarchical, DBSCAN – Association – Apriori, FP-growth – Applications – Exploring Unsupervised Learning using Pandas and Sci-kit Learn.

UNIT- V Neural Networks **9 Hours**

Types of Network Architectures – Feed Forward Networks – Activation Functions – Linear Separability Problem – Back Error Backpropagation – Case Studies in Machine Learning.

TOTAL HOURS : 45

Text Book

1. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2nd Edition, 2009.
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, "An Introduction to

Statistical Learning", Springer, 2nd Edition, 2021.

Reference Book

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. David Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 2012.

Web Resources

1. https://nptel.ac.in/courses/106106202 – "Statistical Machine Learning" – IIT Madras.
2. https://nptel.ac.in/courses/106104197 – "Machine Learning" – IIT Roorkee.
3. https://nptel.ac.in/courses/106106198 – "Deep Learning" – IIT Ropar.

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	2	3	3
CO3	2	3	3	1	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

OPEN ELECTIVE COURSES

25PCSO01	EMBEDDED AUTOMATION	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

- This course introduces the fundamentals of Embedded C programming and microcontroller-based system design. It equips students with skills to interface hardware components and develop real-time embedded applications. Emphasis is also placed on vision systems and home automation for intelligent control solutions.

Prerequisite

- Microprocessors and Microcontrollers
- Digital Electronics
- Basic Programming in C/C++
- Computer Architecture.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand the architecture and programming of modern embedded systems.	Understand
CO2	Design real-time embedded automation solutions using advanced microcontrollers.	Apply
CO3	Interface sensors, actuators, and display systems with microcontrollers for real-time embedded applications.	Apply
CO4	Apply image processing techniques for object detection and automation in embedded vision systems.	Apply
CO5	Design and implement embedded systems for smart home automation using microcontrollers and vision systems.	Create

Syllabus

UNIT - I: Introduction To Embedded C Programming **9 Hours**

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers and Arrays - FIFO and LIFO - C Structures - Development Tools.

UNIT - II: AVR Microcontroller **9 Hours**

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features: Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters.

UNIT – III: Hardware And Software Interfacing With 8-Bit Series Controller

9 Hours

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Converters - Interfacing Digital To Analog Converters - LED Displays: Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools.

UNIT – IV: Vision System **9 Hours**

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction.

UNIT – V: Home Automation **9 Hours**

Home Automation Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System.

TOTAL HOURS:45

Text Book

1. **Tammy Noergaard**, *Embedded System Architecture: A Comprehensive Guide for Engineers and Programmers*, 2nd Edition, Elsevier, 2013.
2. **Peckol**, *Embedded System Design*, John Wiley & Sons, 2010.

Reference Book

1. Lyla B. Das, *Embedded Systems – An Integrated Approach*, Pearson, 2013.
2. Wolf Wayne Hendrix, *Computers as Components: Principles of Embedded Computing System Design*, 3rd Edition, Morgan Kaufmann, 2012.
3. Raj Kamal, *Embedded System Architecture, Programming, and Design*, McGraw-Hill, 2013.
4. Elicia White, *Making Embedded Systems*, O'Reilly (SPD), 2011.

Web Resources

1. Real-Time Embedded Systems Specialization- https://www.coursera.org/specializations/real-time-embedded-systems
2. Embedded Systems - https://www.skyfilabs.com/embedded-online-courses

Mapping with Programme Outcomes

COs	Program Outcomes(Pos)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	-	3	3
CO3	2	3	3	3	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO02	ROBOTICS AND AUTOMATION	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

- Understand the fundamentals of robotics design, kinematics, and control.
- Gain practical skills in robot programming, simulation, and integration.
- Develop intelligent automation solutions using AI, vision, and IoT.

Prerequisite

Microprocessors and Microcontrollers, Digital Electronics, Basic Programming in C/C++, and Computer Architecture.

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand the fundamentals of robotics, automation concepts, and system components.	Understand
CO2	Analyze and design robotic mechanisms and automation processes for industrial applications.	Analyze
CO3	Develop control algorithms for robotic manipulators and automated systems.	Apply
CO4	Integrate sensors, actuators, and controllers to build autonomous robotic systems.	Apply
CO5	Design and implement complex robotic automation projects incorporating path planning and AI.	Create

Syllabus

UNIT I: Kinematics & Dynamics Of Robots **9 Hours**

Robot architecture - Denavit–Hartenberg notation - Forward/inverse kinematics - Jacobian analysis - Trajectory planning - Lagrangian & Newton–Euler dynamics - Workspace & dexterity evaluation.

UNIT II: Sensors, Drives & Actuators **9 Hours**

Encoders - Force/vision/LIDAR sensors - DC/servo/stepper motors - H-bridge circuits - Pneumatic/hydraulic systems - Signal conditioning - Feedback control loops.

UNIT III: Control & Industrial Automation **9 Hours**

PID tuning - Stability and frequency domain analysis - PLC programming - SCADA and DCS systems - CNC and flexible manufacturing - Lean automation principles.

UNIT IV: Machine Vision & Autonomous Robotics **9 Hours**

Image processing - Object detection - Pose estimation for robotic guidance - SLAM - AI/ML-based decision-making - A*/Dijkstra algorithm - ROS integration for mobile robots.

UNIT V: Advanced Robotics & Industry 4.0 **9 Hours**

Swarm intelligence - Multi-robot coordination - Cloud/edge robotics with ROS2 - Digital twins - Predictive analytics in automation - Emerging designs (soft robots, humanoids, modular systems).

TOTAL HOURS:45

Text Book

1. S. K. Saha, *Introduction to Robotics*, Tata McGraw-Hill Education, 2024.
2. R. K. Mittal & I. J. Nagrath, *Robotics and Control*, Tata McGraw-Hill Publishing, 2023.
3. J. J. Craig, *Introduction to Robotics: Mechanics and Control*, 3rd Ed., Pearson, 2020.

Reference Book

1. Steven M. LaValle, *Planning Algorithms*, Cambridge University Press, 2006.
2. Roland Siegwart, Illah R. Nourbakhsh & Davide Scaramuzza, *Introduction to Autonomous Mobile Robots*, 2nd Ed., MIT Press, 2011.
3. Mark W. Spong, Seth Hutchinson & M. Vidyasagar, *Robot Modeling and Control*, 2nd Ed.,

Wiley, 2020. (Fundamental control theory)
4. Diego Rodrigues, *Automation and Robotics in Industry 4.0*, Academic Press, 2024. (Digital twins & predictive maintenance)

Web Resources

1. Modern Robotics: Mechanics, Planning, and Control Specialization - https://www.coursera.org/specializations/modernrobotics
2. Robotics- https://onlinecourses.nptel.ac.in/noc19_me74/preview

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	2	-	1	2	-	3	3
CO2	1	2	2	2	2	-	3	3
CO3	2	3	3	3	3	3	3	3
CO4	2	3	3	1	3	3	3	3
CO5	2	3	3	1	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO03	NUMERICAL METHODS	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

1. Provide mastery in numerical algorithms for solving algebraic problems.
2. Develop expertise in numerical methods for differential equations.
3. Teach optimization problem-solving techniques.
4. Emphasize algorithm design principles.
5. Focus on error analysis in numerical computations.

Prerequisite : Undergraduate-level calculus, linear algebra, programming basics (Python or MATLAB).

Course Outcome : On the successful completion of the course, students will be able to

CO1	Understand fundamental numerical algorithms for solving algebraic equations.	Understand
CO2	Apply numerical methods to solve ordinary and partial differential equations.	Apply
CO3	Implement optimization techniques for various mathematical problems.	Apply
CO4	Analyze and design efficient numerical algorithms considering error propagation.	Analyze
CO5	Evaluate the accuracy and stability of numerical solutions in computational problems.	Evaluate

Syllabus

UNIT I: Errors, Approximations & Linear Systems **9 Hours**

Modeling and propagation of truncation and round-off errors - Floating-point representation - Direct methods such as Gaussian elimination, LU decomposition - Iterative approaches including Gauss-Seidel, Successive Over Relaxation - Eigenvalue computations including Power method.

UNIT II: Nonlinear Equations & Root Finding **9 Hours**

ARM Cortex-M architecture - Instruction sets - Peripheral interfacing - Timer modules - PWM, ADC, DAC - GPIO, UART, SPI, I2C, DMA - Memory management - RTOS fundamentals (task scheduling, synchronization, memory management) - Device drivers - Debugging tools.

UNIT III: Interpolation, Regression & Numerical Integration **9 Hours**

Polynomial interpolation - Newton's divided differences - Cubic splines - Least squares regression, total least squares - Numerical quadrature using trapezoidal, Simpson's, Richardson extrapolation, and Gauss quadrature methods.

UNIT IV: Initial And Boundary Value Problems **9 Hours**

Industrial and IoT protocols: CAN, LIN, Modbus, BLE, Zigbee, LoRa, Wi-Fi - Constrained application protocols (MQTT, CoAP) - Gateway design - Cloud interfacing - Data security - Edge ML deployment - TinyML applications - Firmware upgrade mechanisms.

UNIT V: Pdes, Scientific Computing & Optimization **9 Hours**

Numerical methods for parabolic and elliptic PDEs: Crank–Nicolson, upwind and Lax schemes - Finite difference and finite element methods - Conjugate gradient and SOR for sparse systems - Gradient-based optimization and simple neural-network solvers.

TOTAL HOURS:45

Text Book

1. Chapra, S. C. & Canale, R. P., *Numerical Methods for Engineers*, 5th Edition, McGraw Hill Education.
2. Suli, E. & Mayers, D., *An Introduction to Numerical Analysis*, Cambridge University Press.

Reference Book

1. J. D. Hoffman, *Numerical Methods for Engineers and Scientists*.
2. P. Knabner & L. Angermann, *Numerical Methods for Elliptic and Parabolic Partial Differential Equations*.
3. Press, W. H. et al., *Numerical Recipes: The Art of Scientific Computing*, Cambridge University Press.
4. Kong, Q., Siauw, T. & Bayen, A., *Python Programming and Numerical Methods for Engineers and Scientists*, Academic Press, 2020.

Web Resources

1. Numerical Methods - https://onlinecourses.nptel.ac.in/noc22_ma39/preview
2. Numerical Methods for Engineers- https://onlinecourses.nptel.ac.in/noc19_ge30/preview
3. Applied Numerical Methods- https://onlinecourses.nptel.ac.in/noc23_me135/preview

Mapping with Programme Outcomes

COs	Program Outcomes (POs)							
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	-	-	2	2	-	3	2
CO2	3	-	1	2	2	-	3	2
CO3	2	-	3	3	3	-	3	3
CO4	2	-	1	3	2	-	3	3
CO5	2	1	3	3	3	2	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO04	HUMAN VALUES AND ETHICS	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

1. To develop awareness and sensitivity toward human values and ethical responsibilities in personal and professional life.
2. To understand harmony in the self, family, society, and nature.
3. To cultivate ethical decision-making and socially responsible behavior.
4. To promote sustainable development through value-based leadership and global citizenship.

Prerequisite:

None (Open to all undergraduate students regardless of discipline)

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand and analyze the concept of value education and its relevance in life.	Analyze
CO2	Apply the principles of harmony in self, family, and society to real-life situations.	Apply, Analyze
CO3	Evaluate ethical conduct in professional and personal spheres based on universal human values.	Evaluate
CO4	Develop sustainable, inclusive, and ethically sound models for leadership and enterprise.	Apply, Create
CO5	Reflect critically on personal beliefs and societal norms to foster ethical decision-making and responsible citizenship.	Evaluate, Reflect, Apply

Syllabus

UNIT I: Introduction to Value Education **9 Hours**

Definition and need - Content and process - Self-exploration - Happiness & prosperity.

UNIT II: Harmony in the Human Being **9 Hours**

Concept of the self beyond the body - Harmony between body and self - Fulfilling inner versus physical needs.

UNIT III: Harmony in Family, Society & Nature **9 Hours**

Values in human relationships - Trust, respect - Comprehensive human goals - Universal order.

UNIT IV: Social & Ethical Conduct **9 Hours**

Foundations of ethical human behavior - Flaws in conduct - Universal ethical values - Holistic alternative frameworks.

UNIT V: Professional Ethics & Global Citizenship **9 Hours**

Value-based life and profession - Professional integrity - Ethical issues in technology and management - Sustainable models.

TOTAL HOURS:45

Text Book

1. Human Values and Professional Ethics" by R.R. Gaur, R. Sangal, G.P. Bagaria
2. Ethics in Engineering" by Mike W. Martin and Roland Schinzinger
3. Values and Ethics for Organizations: Theory and Practice" by Patrick Doherty

Web Resources:

1. An Introduction To Values And Ethics- https://onlinecourses.nptel.ac.in/noc23_hs89/preview

Ethics Unwrapped – University of Texas at Austin- https://ethicsunwrapped.utexas.edu/

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	-	2	1	1	3	2	2
CO2	2	-	2	2	1	3	2	2
CO3	2	-	2	2	1	3	2	2
CO4	2	-	3	3	1	3	3	3
CO5	2	-	3	3	1	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO05	VLSI DESIGN FUNDAMENTALS	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

1. Provide a deep understanding of CMOS-based VLSI design, from device physics to system integration.
2. Teach modern VLSI design flow including synthesis and physical layout.
3. Emphasize low-power and high-performance chip design techniques.
4. Introduce emerging AI-assisted methods in VLSI design and optimization.

Prerequisite : Digital Logic Design, Semiconductor Physics, Basic Programming (C/Verilog), Electronic Devices.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand CMOS device physics and fundamentals of VLSI design from device to system integration.	Understand
CO2	Apply modern VLSI design flow techniques including synthesis and physical layout design.	Apply
CO3	Analyze low-power and high-performance design strategies for VLSI circuits.	Analyze
CO4	Evaluate emerging AI-assisted methods in VLSI design and optimization.	Evaluate
CO5	Design and implement optimized VLSI circuits considering power, performance, and area constraints.	Create

Syllabus

UNIT I: Basics Of Cmos & Logic Design **9 Hour**

Modeling and propagation of truncation and round-off errors - Floating-point representation - Direct methods such as Gaussian elimination, LU decomposition - Iterative approaches including Gauss-Seidel, Successive Over Relaxation - Eigenvalue computations including Power method.

UNIT II: HDL & RTL Design Methodology **9Hour**

ARM Cortex-M architecture - Instruction sets - Peripheral interfacing - Timer modules - PWM, ADC, DAC - GPIO, UART, SPI, I2C, DMA - Memory management - RTOS fundamentals (task scheduling, synchronization, memory management) - Device drivers - Debugging tools.

UNIT III: Low Power & High Performance VLSI **9Hour**

Polynomial interpolation - Newton's divided differences - Cubic splines - Least squares regression, total least squares - Numerical quadrature using trapezoidal, Simpson's, Richardson extrapolation, and Gauss quadrature methods.

UNIT IV: Physical Design Flow & Verification **9 Hour**

Industrial and IoT protocols: CAN, LIN, Modbus, BLE, Zigbee, LoRa, Wi-Fi - Constrained application protocols (MQTT, CoAP) - Gateway design - Cloud interfacing - Data security - Edge ML deployment - TinyML applications - Firmware upgrade mechanisms.

UNIT V: Emerging Trends & Ai Assisted **9 Hour**

Numerical methods for parabolic and elliptic PDEs: Crank–Nicolson, upwind and Lax schemes -

Finite difference and finite element methods - Conjugate gradient and SOR for sparse systems - Gradient-based optimization and simple neural-network solvers.

TOTAL HOURS:45

Text Book

1. Neil H. E. Weste & David Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, 4th Edition, Pearson, 2015 — industry-standard for CMOS logic, layout, timing and power optimization
2. Jan M. Rabaey, Anantha Chandrakasan & Borivoje Nikolic, *Digital Integrated Circuits: A Design Perspective*, 2nd Edition, Wiley, 2003 — advanced logic design methodology and architecture planning

Reference Book

1. Low Power Designs in Nanodevices and Circuits for Emerging Applications, edited by Shilpi Birla, Shashi Kant Dargar, Neha Singh & P. Sivakumar, CRC Press, 2023 — a research-oriented guide covering cutting-edge ultra-low-power circuits with FinFETs, TFETs, CNTFETs, QCA, and IoT-focused VLSI applications.
2. Optimizing VLSI Physical Design: From Fundamentals to High-Performance, Debasis Mukherjee, 2023 — a focused exploration of physical design challenges and optimization methods for high-performance VLSI systems.

Web Resources

1. VLSI Design Flow- https://onlinecourses.nptel.ac.in/noc25_ee106/preview
2. Lab Workshop VLSI Fundamentals- https://www.nielit.gov.in/calicut/content/lab-workshop-vlsi-fundamentals

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	3	2	2	2	-	3	3
CO2	2	3	3	3	3	-	3	3
CO3	2	3	3	2	3	-	3	3
CO4	2	3	3	3	3	2	3	3
CO5	2	3	3	3	3	2	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO06	ELECTRIC VEHICLE TECHNOLOGY	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

1. Equip students with comprehensive knowledge of electric vehicle (EV) propulsion systems.
2. Teach fundamentals of battery systems and energy management in EVs.
3. Cover power electronics and charging infrastructure for EVs.
4. Focus on both theory and hands-on application for sustainable, high-performance EV design.

Prerequisite : Power Electronics, Electric Drives, Control Systems, Battery Technology & Embedded Systems.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand the principles and components of electric vehicle propulsion systems.	Understand
CO2	Apply knowledge of battery systems and energy management techniques in electric vehicles.	Apply
CO3	Analyze power electronics and charging infrastructure used in electric vehicles.	Analyze
CO4	Evaluate performance and sustainability aspects of electric vehicle design.	Evaluate
CO5	Design and develop electric vehicle systems integrating propulsion, battery, and control technologies.	Create

Syllabus

UNIT I: Need For Electric Vehicles **9Hour**

History and need for electric and hybrid vehicles - Social and environmental importance of hybrid and electric vehicles - Impact of modern drive-trains on energy supplies - Comparison of diesel, petrol, electric and hybrid vehicles - Limitations - Technical challenges.

UNIT II: Electric Vehicle Architecture **9 Hour**

Electric vehicle types - Layout and power delivery - Performance: traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption - Concepts of hybrid electric drive train - Architecture of series and parallel hybrid electric drive train - Merits and demerits - Mild and full hybrids - Plug-in hybrid electric vehicles and range extended hybrid electric vehicles - Fuel cell vehicles.

UNIT III: Energy Storage **9Hour**

Batteries – types: lead acid batteries, nickel based batteries, and lithium based batteries - Electrochemical reactions - Thermodynamic voltage - Specific energy - Specific power - Energy efficiency - Battery modeling and equivalent circuit - Battery charging and types - Battery cooling - Ultra-capacitors - Flywheel technology - Hydrogen fuel cell - Thermal Management of the PEM fuel cell.

UNIT IV: Electric Drives And Control **9Hour**

Types of electric motors - Working principle of AC and DC motors - Advantages and limitations - DC motor drives and control - Induction motor drives and control - PMSM and brushless DC motor

drives and control - AC and Switch reluctance motor drives and control - Drive system efficiency - Inverters - DC and AC motor speed controllers.

UNIT V: Design Of Electric Vehicles **9Hour**

Materials and types of production - Chassis skateboard design - Motor sizing - Power pack sizing - Component matching - Ideal gear box – Gear ratio - Torque–speed characteristics - Dynamic equation of vehicle motion - Maximum tractive effort – Power train tractive effort - Acceleration performance - Rated vehicle velocity – Maximum gradability - Brake performance - Electronic control system - Safety and challenges in electric vehicles - Case study of Nissan Leaf, Toyota Prius, Tesla Model 3, and Renault Zoe cars.

TOTAL HOURS:45

Text Book

1. C.C. Chan & K.T. Chau, *Modern Electric Vehicle Technology*, Oxford University Press, 2001 (revised versions preferred)
2. Francisco Díaz-González, Andreas Sumper & Oriol Gomis-Bellmunt, *Energy Storage in Power Systems*, Wiley, 2016
3. Nil Patel, *Electric Vehicles: Modern Technologies and Trends*, Springer, 2024 — covers HEV/BEV/FCEV and optimization methodology

Reference Book

1. Iqbal Husain, *Electric and Hybrid Vehicle Design Fundamentals*, CRC Press, 2021
2. Ali Emadi, *Advanced Electric Drive Vehicles*, CRC Press, 2015
3. Mehrdad Ehsani, Yimi Gao, Sebastian Gay & Ali Emadi, *Modern Electric, Hybrid, and Fuel Cell Vehicles*, CRC Press, 2004

Web Resources

1. https://elearn.nptel.ac.in/shop/completed-courses/short-term-programs-completed/e-mobility-and-electric-vehicle-engineering/?v=c86ee0d9d7ed
2. https://onlinecourses.nptel.ac.in/noc25_ee33/preview

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	3	2	2	-	3	3
CO2	2	3	2	2	2	-	3	3
CO3	2	3	3	2	3	-	3	3
CO4	2	2	3	3	3	2	3	3
CO5	2	3	2	3	2	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO07	BIOINFORMATICS	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

1. Integrate biological sciences with computational methods.
2. Enable analysis of high-throughput biological data.
3. Teach design of algorithms for sequence and structural analysis.
4. Apply machine learning and systems biology tools for genomics, proteomics, and drug design.

Prerequisite : Basic Molecular Biology, Genetics, Programming (Perl, Python), Statistics, and Data Structures.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand the integration of biological sciences with computational methods.	Understand
CO2	Apply computational techniques to analyze high-throughput biological data.	Apply
CO3	Design algorithms for sequence alignment and structural bioinformatics analysis.	Create
CO4	Utilize machine learning and systems biology tools for genomics and proteomics applications.	Apply
CO5	Evaluate computational approaches for drug design and biological data interpretation.	Evaluate

Syllabus

UNIT I: Introduction **9Hour**

Need for Bioinformatics technologies – Overview of Bioinformatics technologies – Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics – Biological Data Integration System.

UNIT II: Data Warehousing And Data Mining In Bioinformatics **9Hour**

Bioinformatics data – Data warehousing architecture – Data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architecture and applications in bioinformatics.

UNIT III: Modeling For Bioinformatics **9 Hour**

Hidden Markov modeling for biological data analysis – Sequence identification – Sequence classification – Multiple alignment generation – Comparative modeling – Protein modeling – Genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks – Molecular modeling – Computer programs for molecular modeling.

UNIT IV: Pattern Matching And Visualization **9 Hour**

Gene regulation – Motif recognition – Motif detection – Strategies for motif detection – Visualization – Fractal analysis – DNA walk models (one dimension, two dimension, higher dimension) – Game representation of biological sequences – DNA, Protein, Amino acid sequences.

UNIT V: Microarray Analysis **9Hour**

Microarray technology for genome expression study – Image analysis for data extraction – Preprocessing – Segmentation – Gridding – Spot extraction – Normalization – Filtering – Cluster analysis – Gene network analysis – Compared Evaluation of Scientific Data Management Systems – Cost Matrix – Evaluation model – Benchmark – Tradeoffs.

TOTAL HOURS:45

Text Book

1. Rastogi, S. C., Rastogi, P. & Mishra, M., *Bioinformatics: Concepts, Skills & Applications*, 2nd Edition, CBS Publishers, 2009.
2. Durbin, R., Eddy, S. R., Krogh, A. & Mitchison, G., *Biological Sequence Analysis: Probabilistic Models of Proteins & Nucleic Acids*, Cambridge University Press. (Classic reference for HMMs and sequence modeling)

Reference Book

1. Wunschiers, R., *Computational Biology*, Springer, 2004.
2. Gentleman, R. et al., *Bioinformatics and Computational Biology Solutions Using R and Bioconductor*, Springer, 2005.
3. Pevzner, P., *Computational Molecular Biology: An Algorithmic Approach*, 2nd Edition, MIT Press, 2000.
4. Karim, M. R. et al., *Explainable AI for Bioinformatics: Methods, Tools & Applications*, 2022 – essential for transparency in ML models used in sensitive bio-data contexts.

Web Resources

1. **Bio-Informatics: Algorithms and Applications** (Prof. Michael Gromiha, IIT Madras, via NPTEL)- https://onlinecourses.nptel.ac.in/noc25_bt06/preview
2. **Fundamentals of Bioinformatics** (Dr. Vivek P J, via SWAYAM)- https://onlinecourses.swayam2.ac.in/cec23_bt02/preview

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	2	2	2	-	3	2
CO2	2	3	2	2	3	-	3	3
CO3	2	2	3	2	3	-	3	3
CO4	2	3	2	3	3	2	3	3
CO5	2	3	3	3	3	2	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO08	ENTREPRENEURSHIP DEVELOPMENT	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

1. Learn transform-domain methods, image restoration, and compression techniques and Study image segmentation and feature extraction methods.

Prerequisite : Linear Algebra, Signals & Systems, Programming (MATLAB/Python), basic probability and calculus.

Course Outcome: On the successful completion of the course, students will be able to

CO1	Understand the fundamental concepts and importance of entrepreneurship in economic development.	Understand
CO2	Apply tools and techniques for identifying and evaluating business opportunities.	Apply
CO3	Develop effective business plans and marketing strategies for new ventures.	Create
CO4	Analyze financial management and funding options for startups and small businesses.	Analyze
CO5	Evaluate entrepreneurial challenges and ethical considerations in business development.	Evaluate

Syllabus

UNIT I: FUNDAMENTALS & ENHANCEMENT **9Hours**

Digital image formation - Sampling - Quantization - Pixel relationships - Visual perception - Spatial domain processing: gray-level transformations, histogram equalization, smoothing and sharpening - Frequency domain filters and homomorphic filtering.

UNIT II: RESTORATION & COLOR PROCESSING **9 Hours**

Image degradation models - Noise modeling - Inverse filtering - Wiener and constrained least-squares filtering - Spatial filtering in restoration - Fundamentals of color processing and color space conversions.

UNIT III: COMPRESSION & MORPHOLOGY **9 Hours**

Redundancy types - Information theory basics - Lossless and lossy compression - DCT, vector quantization, entropy coding - JPEG, JPEG 2000, MPEG standards - Basics of binary and gray scale morphological operations for processing shapes.

UNIT IV: SEGMENTATION, REPRESENTATION & FEATURE EXTRACTION **9Hours**

Edge detection - Thresholding - Region based segmentation - Watershed - Morphological segmentation - Boundary and region representation - Feature extraction - Object recognition - Classification approaches.

UNIT V: ADVANCED METHODS & EMERGING TOPICS **9Hours**

Multiresolution (pyramids, wavelets) - SVD - Radon transform - Sparse and dictionary-based methods - Introduction to deep learning–based segmentation and recognition (e.g., CNNs, encoder–decoder architectures) - Real-time image super resolution.

TOTAL HOURS:45

Text Book

1. Rafael C. Gonzalez & Richard E. Woods, *Digital Image Processing*, 3rd Edition, Pearson Education, 2009.
2. Rafael C. Gonzalez, Richard E. Woods & Steven L. Eddins, *Digital Image Processing Using MATLAB*, 2nd Edition, Gatesmark Publishing, 2011

Reference Book

1. V. Kishore Ayyadevara & Yeshwanth Reddy, *Modern Computer Vision with PyTorch (2nd Ed., 2024)*.
2. David A. Forsyth & Jean Ponce, *Computer Vision: A Modern Approach*, 2nd Edition, Pearson, 2015.
3. Sanjiban Sekhar Roy, Ching-Hsien Hsu & Venkateshwara Kagita (eds.), *Deep Learning Applications in Image Analysis* (Springer, 2023/24).

Web Resources

1. Digital Image Processing – NPTEL (IIT Madras/IIT Prof. P.K. Biswas)- https://onlinecourses.nptel.ac.in/noc25_ee126/preview .
2. Computer Vision & Image Processing – NPTEL / Swayam (covering fundamentals and applications)- https://onlinecourses.nptel.ac.in/noc24_ee38/preview

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	2	2	2	2	-	3	2
CO2	2	3	3	2	3	-	3	3
CO3	2	2	3	2	3	-	3	3
CO4	2	3	2	3	3	2	3	3
CO5	2	3	3	3	3	2	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO09	FINANCIAL MANAGEMENT FOR ENGINEERS	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Preamble/ Course Objective

1. Understand key financial statements and their analysis in engineering projects.
2. Develop skills to assess project viability using financial tools like ratio analysis and break-even methods.
3. Learn time value of money concepts and apply methods like NPV, IRR, and payback period for investment decisions.

Prerequisite : Fundamentals of Engineering Economics, Basic Accounting, Linear Algebra.

Course Outcome: On the successful completion of the course, students will be able to

Course Outcome (CO)	Description	Cognitive Level(s)
CO1	Understand key financial statements and perform financial analysis for engineering projects.	Understand
CO2	Apply financial tools such as ratio analysis and break-even methods to assess project viability.	Apply
CO3	Analyze time value of money concepts and use NPV, IRR, and payback period for investment decisions.	Analyze
CO4	Develop strategies for effective financial planning and control in engineering projects.	Create
CO5	Evaluate financial risks and make informed decisions to optimize engineering project outcomes.	Evaluate

Syllabus

UNIT I: FUNDAMENTALS & FINANCIAL STATEMENT ANALYSIS 9 Hours

Overview of financial management tailored for engineers; structure and interpretation of balance sheet, income statement, and cash flow; ratio analysis to assess financial health; break-even analysis and applications.

UNIT II: TIME VALUE OF MONEY & VALUATION TECHNIQUES 9 Hours

Concepts of present and future value; discounting and compounding; annuities and perpetuities; valuation fundamentals; introduction to risk and return trade-offs.

UNIT III: CAPITAL BUDGETING & PROJECT EVALUATION 9 Hours

Capital budgeting techniques: NPV, IRR, benefit-cost ratio, payback period, accounting rate of return; estimation of project cash flows and incorporation of risk; case studies in project appraisals.

UNIT IV: WORKING CAPITAL & COST MANAGEMENT 9 Hours

Working capital components; cash and inventory management; receivables and payables; cost controls and short-term financing; budgeting considerations.

UNIT V: FINANCING DECISIONS & RISK ANALYSIS 9 Hours

Sources of capital (equity, debt, hybrid instruments); capital structure strategies; cost of capital; break-even and sensitivity analysis; risk management tools.

TOTAL HOURS:45

Text Book

1. Van Horne, J. C. & Wachowicz, J. M., *Fundamentals of Financial Management*, Prentice

Hall India, latest edition

2. Prasanna Chandra, *Financial Management: Theory and Practice*, Tata McGraw-Hill, latest edition

Reference Book

1. Pandey, I. M., *Financial Management – Theory and Practice*, Vikas Publishing, latest edition
2. Rostogi, R., *Fundamentals of Financial Management*, Taxmann Publications, latest edition
3. Sharma, S. K. & Gupta, S., *Fundamentals of Financial Management*, Kalyani Publishers, latest edition
4. Bhalla, V. K., *Financial Management*, S. Chand, latest edition

Web Resources

1. Financial Management for Engineers – https://onlinecourses.swayam2.ac.in/cec25_mg06/preview
2. Financial Engineering and Risk Management- https://www.coursera.org/specializations/financialengineering

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	2	-	2	1	2	2	2	2
CO2	2	-	3	1	3	2	2	2
CO3	2	-	3	2	3	2	3	2
CO4	2	-	3	3	3	3	3	3
CO5	2	-	3	3	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**

25PCSO10	MICRO AND SMALL BUSINESS MANAGEMENT	Category	L	T	P	Credit	Total Hours
		OEC	3	0	0	3	45

Course Objective

1. Understand the dynamics of MSMEs, including their ecosystem and finance.
2. Learn about digital transformation and sustainability in MSMEs.
3. Explore entrepreneurship and policy mechanisms supporting MSMEs.
4. Prepare students to launch, manage, and scale micro and small enterprises in India and global markets.

Prerequisite

- Fundamentals of Engineering Economics, Basic Accounting.

Course Outcome: On the successful completion of the course, students will be able to

Course Outcome (CO)	Description	Cognitive Level(s)
CO1	Understand the dynamics of micro, small, and medium enterprises (MSMEs) including their ecosystem and financing.	Understand
CO2	Analyze the impact of digital transformation and sustainability practices on MSMEs.	Analyze
CO3	Apply entrepreneurship principles and government policy mechanisms to support MSMEs.	Apply
CO4	Develop strategies for launching, managing, and scaling micro and small businesses.	Create
CO5	Evaluate challenges and opportunities in MSME growth in Indian and global markets.	Evaluate

Syllabus

UNIT I: FUNDAMENTALS & FINANCIAL STATEMENT ANALYSIS 9 Hours

Overview of financial management tailored for engineers; structure and interpretation of balance sheet, income statement, and cash flow; ratio analysis to assess financial health; break-even analysis and applications.

UNIT II: TIME VALUE OF MONEY & VALUATION TECHNIQUES 9 Hours

Concepts of present and future value; discounting and compounding; annuities and perpetuities; valuation fundamentals; introduction to risk and return trade-offs.

UNIT III: CAPITAL BUDGETING & PROJECT EVALUATION 9 Hours

Capital budgeting techniques: NPV, IRR, benefit-cost ratio, payback period, accounting rate of return; estimation of project cash flows and incorporation of risk; case studies in project appraisals.

UNIT IV: WORKING CAPITAL & COST MANAGEMENT 9 Hours

Working capital components; cash and inventory management; receivables and payables; cost controls and short-term financing; budgeting considerations.

UNIT V: FINANCING DECISIONS & RISK ANALYSIS 9 Hours

Sources of capital (equity, debt, hybrid instruments); capital structure strategies; cost of capital; break-even and sensitivity analysis; risk management tools.

TOTAL HOURS:45

Text Book

1. Poornima M. Charanthimath, *Entrepreneurship Development and Small Business Enterprises*, 3rd Ed., Pearson, 2020.
2. Robert D. Hisrich, Michael Peters & Dean A. Shepherd, *Entrepreneurship*, 8th Ed., Tata McGraw Hill, 2013.

Reference Book

1. Government of India, *MSME Policy Framework*, including Udyam Registration and CGTMSE Guidelines.
2. Industry Reports: *Emerging Trends in MSME Sector*, covering digital adoption, fintech,

sustainability, and human-centered entrepreneurship.

3. Social & Inclusive Entrepreneurship Texts, highlighting value-based business models and empowerment.

Web Resources

1. Micro Small Enterprise Management – https://onlinecourses.swayam2.ac.in/ntr24_ed51/preview
2. Digital Tools & MSME Finance – https://onlinecourses.swayam2.ac.in/ntr25_ed39/preview
3. Sustainable & Social Enterprise – https://elearn.nptel.ac.in/shop/completed-courses/execedu-closed/sustainability-for-indian-businesses-cohort-2/?v=c86ee0d9d7ed

Mapping with Programme Outcomes

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CO1	3	-	2	2	2	2	2	2
CO2	2	-	3	2	3	2	2	2
CO3	2	-	3	2	3	2	3	2
CO4	2	-	3	3	3	3	3	3
CO5	2	-	3	3	3	3	3	3

Assessment Methodology	Assessment Tools	Marks
Test		25
Problem based Assignment	Moodle / Google form	5
Project-based Assignment	Demo & Viva	5
Attendance		5
Total		**40**