LORDS INSTITUTE OF ENGINEERING AND TECHNOLOGY
(An Autonomous Institution)
DEPARTMENT OF CSE-DATA SCIENCE
SCHEME OF INSTRUCTION & EXAMINATION [LR-24]
(With effect from the Academic Year 2026-27)
B.E. V-Semester

S. No.	Course Code	Course Category	Course Title	Scheme of Instructions				Scheme of Examination			CREDITS
				L	T	P/D	Contact Hrs/Week	CIE	SEE	Duration in Hours	
Theory Course											
1	U24CD501	PCC	Artificial Intelligence	3	-	-	3	40	60	3	3
2	U24CD502	PCC	Full Stack Web Development	3	-	-	3	40	60	3	3
3	U24CD503	PCC	Discrete Mathematics	3	-	-	3	40	60	3	3
4	U24CS501	PCC	Computer Networks	3	-	-	3	40	60	3	3
5	-	PEC	Professional Elective-I	3	-	-	3	40	60	3	3
Practical / Laboratory Course											
6	U24CD5L1	PCC	Artificial Intelligence Lab	-	-	3	3	25	50	3	1.5
7	U24CD5L2	PCC	Full Stack Web Development Lab	-	-	3	3	25	50	3	1.5
Project											
8	U24CD5P1	PROJ	Internship (During vacation period after 4Sem.)	-	-	3	3	50	-	-	2
Total				**15**	**-**	**9**	**24**	**300**	**400**	-	**20**

L: Lecture *(Hrs/Wk/Sem)* **T**: Tutorial *(Hrs/Wk/Sem)* **P**: Practical **D**: Drawing *(Hrs/Wk/Sem)*
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination **BSC**: Basic Science Course
ESC: Engineering Science Course **PCC:** Program core course
HSMC: Humanities & Social Science Including Management Course
CM: CSE-AIML **CD**: CSE-Data Science **PEC:** Professional Elective Course
OEC: Open Elective Course **PROJ:** Project **CS**: Computer Science and Engineering

Note:
1. Each contact hour is a Clock Hour.
2. The duration of the practical class is three hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

PEC 1	U24CD505	Ethical Hacking
	U24CD506	Software Engineering
	U24CD507	Computer Graphics
	U24CD508	Information Retrieval Systems

***Term Work:** assignments/seminars/micro projects/industrial visits/any other student activities

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(With effect from the Academic Year 2026-27)
B. E. VI-Semester (Tentative)

S. No.	Course Code	Course Category	Course Title	Scheme of Instructions				Scheme of Examination			CREDITS
				L	T	P/ D	Contact Hrs/Week	CIE	SEE	Duration in Hours	
Theory Course											
1	U24CD601	PCC	Data Engineering	3	-	-	3	40	60	3	3
2	U24CM608	PCC	Machine Learning	3	-	-	3	40	60	3	3
3	U24MB601	HSMC	Business Economics and Financial Analysis	3	-	-	3	40	60	3	3
4	-	PEC	Professional Elective-II	3	-	-	3	40	60	3	3
5	-	OEC	Open Elective-I	3	-	-	3	40	60	3	3
Practical / Laboratory Course											
6	U24CD6L1	PCC	Data Engineering Lab	-	-	3	3	25	50	3	1.5
7	U24CM6L4	PCC	Machine Learning Lab	-	-	3	3	25	50	3	1.5
Project											
8	U24CD6P1	PROJ	Mini Project	-	-	6	6	50	50	-	2
Skill Development Course											
9	U24MA6L1	BSC	Aptitude and Reasoning Skills Lab	-	-	2	2	25	50	2	1
Total				**15**	**-**	**14**	**29**	**325**	**500**	**-**	**21**

L: Lecture *(Hrs/Wk/Sem)* **T**: Tutorial *(Hrs/Wk/Sem)* ***P*:** Practical **D**: Drawing *(Hrs/Wk/Sem)*
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination **BSC**: Basic Science Course
ESC: Engineering Science Course **PCC:** Program core course **MA**: Mathematics **MB:** Management Studies **HSMC:** Humanities & Social Sciences Including Management Course **PEC:** Professional Elective Course **CM:** CSE-AIML
CD: CSE-Data Science **OEC:** Open Elective Course **PROJ:** Project

Note:
1. Each contact hour is a Clock Hour.
2. The duration of the practical class is three hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

PEC 2	U24CD602	Distributed Systems
	U24CD603	Software Project Management
	U24CD604	Image Processing
	U24CD605	Data Mining

Any NPTEL course of 12 weeks is equivalent to 3 credits of Professional electives

Course Code	Course Title						Core/Elective
U24CD501	ARTIFICIAL INTELLIGENCE						Core
Prerequisite	Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Data Structures, Basics of probability	3	-	_	_	40	60	3

Course Objectives:

The course will introduce the students to

1. To understand the various characteristics of Intelligent agents
2. To learn the different search strategies in AI
3. To learn to represent knowledge in solving AI problems
4. To understand the different ways of designing software agents
5. To know about the various applications of AI.

Course Outcomes:

At the end of the course, student would be able to

1. Use appropriate search algorithms for any AI problem
2. Represent a problem using first order and predicate logic
3. Provide the apt agent strategy to solve a given problem
4. Design software agents to solve a problem
5. Design applications for NLP that use Artificial Intelligence.

Unit-1:

Introduction to Artificial Intelligence and Intelligent Agents: Introduction to Artificial Intelligence, History and Evolution of AI, Intelligent Systems, Characteristics of Intelligent Systems, Applications of AI, Intelligent Agents, Agent Architectures, Rational Agents, PEAS Representation, Environment Types, State Space Representation.

Unit-2:

Problem Solving and Search Techniques: Uninformed Search Strategies -Breadth First Search, Depth First Search, Uniform Cost Search, Iterative Deepening Search. Informed Search Strategies- Best First Search, Hill Climbing, A* Algorithm, Beam Search. Adversarial Search – Minimax Algorithm, Alpha-Beta Pruning, Constraint Satisfaction Problems

Unit-3:

Knowledge Representation and Reasoning: Knowledge Representation, Knowledge-Based Systems, Propositional Logic, Predicate Logic, Inference Mechanisms, Forward Chaining, Backward Chaining, Semantic Networks, Frames, Ontologies, Expert Systems, Uncertainty in Knowledge Representation, Bayesian Reasoning

Unit-4:

Planning and Natural Language Processing: Introduction to Planning in AI, Planning Languages, State Space Planning, and Automated Planning. Fundamentals of Natural Language Processing, Text Processing, Syntax and Semantics, Information Extraction, Question Answering Systems, Conversational Agents, and Chatbots.

Unit-5:

Generative AI, Ethics and Emerging Trends: Introduction to Generative AI, Large Language Models (LLMs), Prompt Engineering, Retrieval-Augmented Generation (RAG), Autonomous Systems, Explainable AI (XAI), Responsible AI, AI Ethics and Fairness, Privacy and Security Issues in AI, Applications of Generative AI, and Future Trends in Artificial Intelligence.

SUGGESTED READINGS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, **Fourth Edition, 2020**

2. M. Tim Jones, ―Artificial Intelligence: A Systems Approach (Computer Science) ‖, Jones and Bartlett Publishers, Inc.; First Edition, 2008

Course Code	Course Title						Core/Elective
U24CD502	Full Stack Web Development						Core
	Hours Per Week				CIE	SEE	Credits
Prerequisite	L	T	D	P			
Java	3	2	–	–	40	60	3

Course Objectives:

The course will introduce the students to

1. To provide a fundamental understanding of web technologies and how the web works.
2. To implement the structure and design of web pages using HTML and CSS.
3. To apply client-side scripting using JavaScript to create dynamic web applications.
4. To develop server-side scripting concepts with technologies such as Python or Ruby.
5. To familiarize students with database integration for web-based applications.

Course Outcomes:

At the end of the course, student would be able to

1. Explain how the World Wide Web works, including web browsers and web servers.
2. Design responsive and structured web pages using HTML, CSS, Flexbox, and Grid.
3. Use JavaScript to add interactivity, form validation, and DOM manipulation to web pages.
4. Create dynamic web applications using server-side scripts with Python or Ruby.
5. Connect web pages with databases to build interactive and data-driven websites.

UNIT – I

HTML – What is HTML, Basic Structure of HTML Page, Basic Tags, Types of Tags, Lists, Tables, Images, Forms, Frames, Buttons, and Moving Images. **Cascading Style Sheet** – Introduction, A Simple Specification, Types of Style Sheets, Style Classes, Font Properties, Background properties, Border properties, text properties, margin properties, padding properties, table properties, line/marker properties.

UNIT – II

JAVA SCRIPT – Introduction, Usage of variables, operations, control structures, looping structures, predefined keywords, arrays, predefined functions, arrays and functions, mathematical functions, string functions, expressions, pattern matching using RegEXp Class, String Class, Exception Handling, Bgcolor/Fgcolor , Date Object, Form Validation, DOM Manipulation.

UNIT – III

Front-end Frameworks/Libraries- Introduction- React, Angular. Jquery and Vue, Angular- Features and Benefits, Components, Angular CLI, Data Binding, Angular application, **Jquery :** String, Numbers, Boolean, Objects, Arrays, Functions, Arguments, Scope, Jquery Effect Methods, Hide and Show, jQuery Toggle, jQuery Slide – slideDown, slideUp, slideToggle.

UNIT – IV

Server-Side Languages- Introduction- Node js, Python and Ruby on Rails, Node JS Features and Drawbacks, Setup Environment for Node.js, Node JS Program architecture, Node JS Web Server, Node JS Global Objects, Node JS Error Handling, Node JS Event Loop, Node JS File System, Connecting with Database, Handling CRUD Operations,

UNIT – V

Databases: Introduction on MySQL, PostgreSQL, MangoDB and **MangoDB-** MongoDB, Configuring Server and Client, MongoDB Compass, Creating Database, MongoDB Commands, MongoDB CRUD Operations, **REST API –** Introduction to REST API,REST Architecture, GraphQL.

SUGGESTED READINGS:

1. Mayur Ramgir, "Full Stack Java Development with Spring MVC, Hibernate, jQuery, and Bootstrap", Packt Publishing, First Edition, 2020.
2. Ketan Agnihotri, Pranali Dahale, " React Development using Typescript: Modern web app development using advanced React techniques ", English Edition, First Edition, 2024.
3. Nabendu Biswas, "Ultimate Full-Stack Web Development with MERN: Design, Build, Test and Deploy Production-Grade Web Applications with MongoDB, Express, React and NodeJS", 1st Edition, 2023.

Course Code	Course Title						Core/Elective
U24CD503	DISCRETE MATHEMATICS						Core
Pre requisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Basic Mathematics	3	0	-	-	40	60	03

Course Objectives

The course will introduce the students to

1. To Learn mathematical concepts as applied in computer science for solving logical problems.
2. To model relationships, analyses data, apply probability concepts and use functions to solveproblems.
3. To develop the mathematical skills needed for advanced quantitative courses.
4. Apply Important problems design and methods of analysis
5. Synthesize efficient problems in common engineering design situations

Course Outcomes

After completing this course, the student will be able to:

1. Apply Propositional and Predicate logic for a variety of problems in various domains.
2. Understand Set Theory, Venn Diagrams, relations, functions and apply them to Real-worldscenarios.
3. Model and solve the real-world problems using Generating Functions and Recurrence Relations.
4. To identify the basic properties of graphs and trees and use these concepts to model simpleapplications.
5. Understand General properties of Algebraic systems and study lattices as partially ordered sets and their applications

UNIT – I

Logic – Sets and Functions – Logic, Propositional equivalences – Predicates and quantifiers – Nested Quantifiers Sets-Operations, Functions.

Algorithms- Integers – Matrices: Algorithms, Complexity of Algorithms. The Integers and Division, Integers and Algorithms, Applications of Number Theory, Matrices.

UNIT – II

Mathematical Reasoning, Induction, and Recursion: Proof Strategy, Sequence and Summation,

Counting – Basics, Pigeonhole principle, Permutations and combinations – Binomial Coefficients, Generalized Permutations combinations, Generating permutations and combinations.

UNIT – III

Discrete Probability: An Introduction to Discrete Probability theory, Expected Value and Variance.

Advanced Counting Techniques: Recurrence relations – Solving Recurrence Relations, - Divide and conquer relations – Recurrence Relations, Generating function – Inclusion – Exclusion – Applications of Inclusion – Exclusion.

UNIT – IV

Relations: Relations & their properties, n-ray relations and applications, Representing relations – Closures, equivalence rel ations, partial orderings.

Graphs: Introduction, Graph terminology, representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamiltonian, shortest path problems, Planar graphs, Graph coloring.

UNIT – V

Trees: Introduction to Trees, Application of Trees, Spanning Trees, Minimum Spanning Trees.

Boolean Algebra: Boolean function, Representing Boolean functions, Logic Gates

SUGGESTED READINGS:

1. Kenneth H. Rosen – Discrete Mathematics and its Application – 5th Edition, McGraw Hill, 2003.
2. J. K. Sharma, Discrete Mathematics, Second Edition, Macmillan, 2005
3. J.P. Tremblay, R. Manohar, Discrete Mathematical Structure with Application to Computer Science,McGraw Hill – 2nd Edition1987.
4. Joel. Mott. Abraham Kandel, T.P. Baker, Discrete Mathematics for Computer Scientist &Mathematicians, Prentice Hail N.J., 2nd Edition, 1986.

Course Code	Course Title						Core / Elective
U24CS501	COMPUTER NETWORKS						Professional Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PPS	3	-	-	-	40	60	3

Course Objectives

The course will introduce the students to

1. Become familiar with layered communication architectures (OSI and TCP/IP)
2. Familiarize with flow control and error control mechanisms in data link layer.
3. Study the design issues in network layer and various routing algorithms.
4. Learn Sockets programming and how to implement client/server programs.
5. Understand the concepts of reliable data transfer and how TCP implements these concepts.

Course Outcomes:

At the end of the course, student would be able to

1. Explain the function of each layer of OSI and trace the flow of information from one Node to another node in the network.
2. Familiarize the Transmission Media, Flow Control and Error Detection and Correction
3. Understand the principles of IP addressing and internet routing.
4. Describe the working of various networked applications such as DNS, mail, file transfer and www.
5. Implement client-server socket-based networked applications

UNIT-I

Overview: Data communication, Networks, The Internet, Protocols and standards, layered tasks OSI Model and layers in OSI model, TCP /IP protocol suite, Addressing, Transmission Modes

Techniques for Bandwidth utilization: Multiplexing-Frequency Division, Wavelength division, Synchronous and Statistical Time division multiplexing.

UNIT-II

The Data Link Layer and Medium Access Sub layer: Error detection and Error correction, Introduction to Error detection and Error correction, Block coding, CRC

Data Link Control: Framing, Flow Control and Error Control, Protocols-Simplest Protocol, Stop and Wait Protocol, Stop and Wait ARQ, Go-Hack-N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking

Multiple Access: Random Access-Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA.

UNIT-III

Network Layer- Switching Techniques: Circuit switching networks, Packet Switching networks, Virtual Circuit networks, Logical addressing, Internetworking, IPV4, IPV6, Tunneling.

Internet Control Protocols: Address Mapping- ARP, RARP, BOOTP and DHCP, ICMP, IGMP, Delivery, Forwarding, Unicast Routing protocol.

UNIT-IV

Transport Layer: Process to Process Delivery, UDP, TCP, Data Traffic, Congestion, Congestion Control, Congestion Control in TCP, Quality of Service, Techniques to improve QoS.

UNIT-V

Socket Programming: Socket address, Elementary socket system calls, Advanced socket system calls

The Application Layer: Domain Name System (DNS), EMAIL, SNMP and Multimedia.

SUGGESTED READINGS:

1. Computer Networks, Andrew S. Tanenbaum, 6th Edition, 2021, Pearson Education.
2. Data Communication and Networking, 4th Edition, Behrouz. A. Forouzan,Mc Graw Hill
3. Unix Network Programming‖, W. Richard Stevens, Prentice Hall/Pearson Education, 2009.
4. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
5. W. Richard Stevens, Unix Network Programming, , Prentice Hall/Pearson Education, 2009.

Course Code	Course Title						Core/Elective
U24CD505	**ETHICAL HACKING**						**PROFESSIONAL ELECTIVE**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-		**40**	**60**	**3**

Course Objectives

The course will introduce the students to

1. The methodologies, frameworks, and best practices of ethical hacking for enhancing organizational and information security.
2. The impacts of hacking, various types of hackers, and key information security models.
3. The components of an information security program from a business perspective.
4. The planning and execution of controlled attacks using a structured framework, including reconnaissance, enumeration, vulnerability analysis, exploitation, deliverables, and integration

Course Outcomes:

After successful completion of the course, student will be able to:

1. Demonstrate knowledge of tools, techniques, and resources available to support ethical hacking activities.
2. Analyze and interpret the results of controlled attacks to assess system vulnerabilities effectively
3. Understand the influence of organizational politics, inherent and imposed limitations, and metrics in planning and executing penetration tests.
4. Apply structured frameworks for planning and executing penetration tests, including reconnaissance, enumeration, vulnerability analysis, exploitation, and reporting.
5. Evaluate the role of organizational policies, limitations, and metrics in planning and conducting ethical hacking exercises.

UNIT – I: INTRODUCTION TO ETHICAL HACKING

Introduction: Hacking Impacts, The Hacker Framework: Planning the test, Sound Operations, Reconnaissance, Enumeration, Vulnerability Analysis, Exploitation, Final Analysis, Deliverable, Integration. Information Security Models: Computer Security, Network Security, Service Security, Application Security, Security Architecture Information Security Program: The Process of Information Security, Component Parts of Information Security Program, Risk Analysis and Ethical Hacking

UNIT – II: THE BUSINESS PERSPECTIVE

The Business Perspective: Business Objectives, Security Policy, Previous Test Results, Business Challenges Planning for a Controlled Attack: Inherent Limitations, Imposed Limitations, timing is Everything, Attack Type, Source Point, Required Knowledge, Multi-Phased Attacks, Teaming and Attack Structure, Engagement Planner, The Right Security Consultant, The Tester, Logistics, Intermediates, Law Enforcement

UNIT – III: PREPARING FOR HACK

Preparing for a Hack: Technical Preparation, Managing the Engagement Reconnaissance: Social Engineering, Physical Security, Internet Reconnaissance. Rules of Engagement (scope, objectives, permissions, legal considerations), penetration testing planning and target prioritization, passive and active reconnaissance techniques, OSINT gathering, footprinting and target profiling, DNS and WHOIS analysis, network and service discovery.

UNIT – IV: ENUMERATION AND EXPLOITATION

Enumeration: Enumeration Techniques, Soft Objective, Looking Around or Attack, Elements of Enumeration, Preparing for the Next Phase. Exploitation: Intuitive Testing, Evasion, Threads and Groups, Operating Systems, Password Crackers, RootKits, applications, Wardialing, Network, Services and Areas of Concern

UNIT – V: DELIVERABLE

Deliverable: The Deliverable, The Document, Overall Structure, Aligning Findings, Presentation Integration: Integrating the Results, Integration Summary, Mitigation, Defense Planning, Incident Management, Security Policy, Conclusion

TEXTBOOKS:

1. James S. Tiller, “The Ethical Hack: A Framework for Business Value Penetration Testing”, Auerbach Publications, CRC Press.
2. EC-Council, “Ethical Hacking and Countermeasures Attack Phases”, Cengage Learning.
3. Michael Simpson, Kent Backman, James Corley, “Hands-On Ethical Hacking and Network Defense”, Cengage Learning.

Course Code	Course Title						Core/Elective
U24CD506	**SOFTWARE ENGINEERING**						**Professional Elective**
	Hours Per Week						
Prerequisite	**L**	**T**	**D**	**P**	**CIE**	**SEE**	**Credits**
OS	**3**	**-**	**-**	**-**	**40**	**60**	**3**

Course Objectives:

1. To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product.
2. To impart knowledge on various phases, methodologies and practices of software development.
3. To understand the importance of testing in software development and study various testing strategies and software quality metrics.
4. To impart knowledge on various phases, methodologies and practices of software development
5. To understand the importance of testing in software development, study various testing strategies along with its relationship with software quality and metrics

Course Outcomes:

At the end of the course, student would be able to

1. Describe and compare alternative approaches and techniques used across various phases of the software development lifecycle.
2. Develop a complete software project independently by applying appropriate design principles, tools, and methodologies.
3. Identify and analyze the real-world challenges involved in developing large-scale software systems.
4. Design and construct software architecture independently or in a team by recognizing recurring problems and applying relevant design patterns.
5. Evaluate software product quality using appropriate metrics while addressing practical development challenges.

UNIT-I

Introduction to Software Engineering: The evolving role of software, changing nature of software, software myths. A Generic view of process: Software engineering- a layered technology, a process framework, the capability maturity model integration (CMMI). Process models: The waterfall model, Spiral model and Agile methodology

UNIT – II

Software Requirements: Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document. Requirements engineering process: Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management.

UNIT – III

Design Engineering: Design process and design quality, design concepts, the design model. Creating an architectural design: software architecture, data design, architectural styles and patterns, architectural design, conceptual model of UML, basic structural modeling, class diagrams, sequence diagrams, collaboration diagrams, use case diagrams, component diagrams.

UNIT – IV Testing Strategies: A strategic approach to software testing, test strategies for conventional software, black-box and white-box testing, validation testing, system testing, the art of debugging. Metrics for Process and Products: Software measurement, metrics for software quality.

UNIT – V

Risk management: Reactive Vs proactive risk strategies, software risks, risk identification, risk projection, risk refinement, RMMM. Quality Management: Quality concepts, software quality assurance, software reviews, formal technical reviews, statistical software quality assurance, software reliability, the ISO 9000 quality standards

SUGGESTED READINGS:

1. Software Engineering, A practitioner's Approach- Roger S. Pressman, 9th Edition, 2023, McGraw Hill International Edition.
2. Software Engineering- Sommerville, 10th Edition, 2015, Pearson Education.

Course Code	Course Title						Core/Elective
U24CD507	Computer Graphics						PROFESSIONAL ELECTIVE
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Data Structures	3	-	-	-	40	60	3

Course Objectives

1. To comprehend graphs as modeling and analysis tool
2. To introduce various data structures with graph theory
3. To learn a variety of different problems in graph theory
4. To understand and analyze various graphs
5. To know various supervised and unsupervised graphs.

Course Outcomes

Upon completion of the course, the students will be able to:

1. Write mathematical definitions involving basic graphs
2. Differentiate the potential use of directed and undirected graphs
3. Develop algorithms based on diverse applications of graphs in different domains.
4. Validate and critically assess a mathematical proof related with graphs
5. Illustrate graph theorems and its types.

UNIT-I

BASICS OF GRAPHS AND TREES: Graphs – Introduction – Isomorphism – Sub Graphs– Walks, Paths, Circuits – Connectedness– Components – Euler Graphs – Hamiltonian paths and circuits – Trees – Properties of Trees– Distance and Centers in Tree – Rooted and Binary Trees.

UNIT-II

TREES, CONNECTIVITY & PLANARITY: Spanning Trees – Fundamental Circuits – Spanning Trees in a Weighted Graph – Cut Sets – Properties of Cut Set – All Cut Sets – Fundamental Circuits and Cut Sets – Connectivity and Separability – Combinational and Geometric Graphs – Planer Graphs – Different Representation of a Planer Graph.

UNIT-III

COLOURING AND DIRECTED GRAPH: Chromatic Number – Chromatic Partitioning – Chromatic Polynomial – Edge Coloring & Vertex Coloring –Vizing's Theorem – Directed Graphs – Types of Directed Graphs – Digraphs and Binary Relations – Directed Paths and Connectedness – Euler Graphs.

UNIT-IV

MATCHINGS & COVERS: Matchings– Matchings& Coverings in Bipartite Graphs – Perfect Matching – Maximum Matching – Hall's Theorem & Consequences – Min – Max Theorems – Independent Sets & Edge Covers – Cuts & connectivity

UNIT-V

PLANAR GRAPHS: Plane & Planar graphs – Dual Graphs – Euler Formula – Kuratowski's Theorem – The five- color theorem and four-color conjecture.

SUGGESTED READINGS:

1. Introduction to Graph Theory, Douglas B. West, 2nd Edition, Prentice Hall ofIndia,2015.
2. Graph Theory: With Application to Engineering and Computer Science, Narsingh Deo, 2nd Edition, Prentice Hallof India, 2003.
3. Graph Theory, Narosa Publications, F. Harry, 2001.
4. Discrete Mathematics and Its Applications, Rosen K.H., — McGraw Hill, 2007.

Course Code	Course Title						Core / Elective
U24CD508	Information Retrieval systems						Professional Elective
	Hours Per Week						
Prerequisite	L	T	D	P	CIE	SEE	Credits
Operating Systems	3	-	-	-	40	60	3

Course Objectives:

1. To learn about the relationships to data base management systems and libraries.
2. To understand the important concepts, algorithms, and data/file structures
3. To learn about clusters, searching techniques and visualization.
4. To expose the students to find the searching algorithms and Evaluation systems.
5. To facilitate design, and implementation of Information Retrieval (IR) systems.

Course Outcomes:

1. Analyze the retrieval information systems and its capabilities.
2. Analyze and apply appropriate data structures and indexing concepts.
3. Use the various searching techniques for improving the information visualization.
4. Apply the searching algorithms to evaluate information systems.
5. Use the multimedia information retrieval of query languages

UNIT-I:

Introduction to Information Retrieval Systems: Definition of Information Retrieval System, Objectives of Information Retrieval Systems, Functional Overview: Item Normalization, Selective Dissemination of Information, Document, Index and Multimedia Database Search, Information Retrieval System Capabilities: Search Capabilities, Browse Capabilities, Miscellaneous Capabilities, Z39.50 and WAIS Standards

UNIT – II:

Cataloging and Indexing: History and Objectives of Indexing, Indexing Process, Scope of Indexing, Linkages and Pre coordination, Automatic Indexing: Classes of Automatic Indexing, Statistical Indexing, Natural Language, Concept Indexing, Hypertext Linkages, Information Extraction, Index Compression: Dictionary Compression, Posting File Compression

UNIT – III:

User Search Techniques and Scoring: Search Statements and Binding, Similarity Measures and Ranking, Relevance Feedback, Selective Dissemination of Information Search, Weighted Searches of Boolean Systems, Searching the INTERNET and Hypertext, Computing Scores in a Complete Search System: Efficient Scoring and Ranking, Components of an Information Retrieval System

UNIT – IV:

Evaluation and Information Visualization: Evaluation in Information Retrieval, Standard Test Collections, Evaluation of Unranked Retrieval Sets, Evaluation of Ranked Retrieval Results, Assessing Relevance, System Quality and User Utility, Information Visualization: Cognition and Perception, Aspects of Visualization Process, Information Visualization Technologies.

UNIT – V:

Multimedia Information Retrieval: Introduction to Text Search Techniques, Software Text Search Algorithms, Hardware Text Search Systems, Spoken Language Audio Retrieval, Non-Speech Audio Retrieval, Graph Retrieval, Image Retrieval, Video Retrieval, Challenges in Multimedia IR, Applications and Future Trends

SUGGESTED READINGS:

1. Information Retrieval: Data Structures and Algorithms, W.B. Frakes, Ricardo Baeza-Yates, Prentice Hall, 1st Edition, 1992.
2. Information Storage & Retrieval, Robert Korfhage, John Wiley & Sons.
3. Modern Information Retrieval, Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Pearson Education

Course Code	Course Title						Core/Elective
U24CD5L1	Artificial Intelligence Lab						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Data Structures	3	-	-	-	25	50	1.5

Course Objectives:

The objective of this lab is to get an overview of the various Artificial Intelligence techniques and can able to demonstrate those using python.

1. Apply intelligent agent concepts and search algorithms to solve AI problems.
2. Implement knowledge representation and reasoning techniques for intelligent systems.
3. Analyse game-playing, planning, and constraint satisfaction problems using AI methods.
4. Utilize NLP techniques for text processing and conversational AI applications.
5. Design AI solutions using LLMs, AI agents, and responsible AI.

Course Outcomes:

After the completion of the course the student can able to:

1. Able to design and implement AI solutions searching techniques using AI.
2. Able to know about facts of querying.
3. Be capable of confidently applying tree mechanism using AI with Neural Network
4. Be capable of performing experiments in Machine Learning using real-world data.
5. Be capable to implement classifiers and Regression algorithm.

List of Experiments:

WEEK 1:

1. Design PEAS representations for real-world intelligent systems such as Autonomous Taxi, Smart Home, Medical Diagnosis System, and Robot Vacuum Cleaner.

WEEK 2:

1. Develop a simple reflex agent for a Vacuum Cleaner World environment.
2. Implement state space representation for Water Jug Problem.

WEEK 3:

1. Implement Breadth First Search (BFS) and Depth First Search (DFS) algorithms.
2. Implement Uniform Cost Search and Iterative Deepening Search algorithms

WEEK 4:

1. Implement Best First Search and A* Search algorithms for path finding problems.
2. Implement Hill Climbing and Beam Search algorithms.

WEEK 5:

1. Implement Minimax Algorithm with Alpha-Beta Pruning for Tic-Tac-Toe or similar game.
2. Solve Constraint Satisfaction Problems such as N-Queens or Graph Colouring.

WEEK 6:

1. Implement Propositional Logic using Python.
2. Develop a Predicate Logic representation for a real-world problem.
3. Implement Forward Chaining and Backward Chaining inference mechanisms.

WEEK 7:

1. Construct Semantic Networks and Frame-based knowledge representations.
2. Implement Bayesian Reasoning for decision-making under uncertainty.

WEEK 8:

1. Implement Goal-Based Planning for a simple problem-solving task.
2. Develop a State Space Planning model using suitable planning operators.
3. Perform text preprocessing including tokenization, stop-word removal, stemming, and lemmatization.

WEEK 9:

1. Implement Information Extraction from textual data.
2. Develop a Question Answering System using NLP techniques.
3. Design and implement a rule-based conversational chatbot.

WEEK 10:

1. Build a simple AI Agent for task automation.

WEEK 11:

1. Analyse Explainable AI (XAI) techniques for interpreting AI outputs.

Experiments Beyond Syllabus

1. Develop applications using Large Language Models (LLMs) through APIs or open-source frameworks.
2. Implement a Retrieval-Augmented Generation (RAG) system using document retrieval and response generation.
3. Case Study on Responsible AI, Fairness, Privacy, and Security in AI Systems.
4. Mini Project: Development of an AI-based application integrating concepts from Intelligent Agents, Search, Knowledge Representation, NLP, or Generative AI.

Course Code	Course Title						Core/Elective
U24CD5L2	Full Stack Web Development Lab						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Data Structures	3	-	-	-	25	50	1.5

Course Objectives:

1. To understand the structure and syntax of HTML and CSS for designing static web pages.
2. To apply styling using CSS properties such as layout, positioning, typography, and responsiveness.
3. To gain knowledge of JavaScript and jQuery for adding interactivity and client-side logic to web pages.
4. To explore form handling and validation techniques using JavaScript.
5. To practice full-stack web application development and deployment using modern tools and frameworks.

Course Outcomes:

At the end of the course, student would be able to

1. Develop well-structured HTML web pages with embedded CSS styles.
2. Apply various CSS properties to create visually appealing and responsive layouts.
3. Write JavaScript programs to add dynamic behavior to web pages.
4. Validate forms using client-side JavaScript and handle user input efficiently.
5. Deploy web applications and demonstrate the ability to build full-stack web solutions.

Lab Experiments

1. Create a basic HTML page with a title, headings, paragraphs, a horizontal line, and a line break. Use <html>,
2. <head>, <body>, <h1> to <h6>, <p>, <hr>, and
 tags. This experiment helps in understanding the structure of an HTML page.
3. Design an HTML form using various input types such as text boxes, radio buttons, checkboxes, submit and reset buttons. Implement labels and organize the form layout using tables or divs for better structure.
4. Create an HTML table with appropriate headings and data. Use rowspan and colspan to merge cells. Apply CSS styling to enhance table appearance like border, background-color, and text alignment.
5. Use internal or external CSS to apply properties such as font size, font family, background color, border thickness, margin, padding, and text alignment to a basic HTML page with content elements.
6. Style an HTML page using Inline CSS, Internal CSS, and External CSS.
7. Write a JavaScript program that uses variables, arithmetic operators, comparison operators, and logical operators.
8. Implement JavaScript control structures such as if-else and switch-case. Also, include looping structures like for, while, and do-while to print series or patterns based on conditions.
9. Create a registration or login form and apply JavaScript form validation to check email format, password strength, phone number length, and required fields before submission.
10. Show date and time using the Date object.
11. Perform pattern matching using RegExp class.
12. Use jQuery to show, hide, and toggle visibility of elements such as paragraphs, divs, and images on button click. Use $(selector).hide(), show(), and toggle() methods.
13. Implement slide animations using jQuery on different elements. Use slideDown(), slideUp(), and slideToggle() to demonstrate UI effects like drop-down menus or slide panels.
14. Install Node.js and write a basic Node.js program using console.log() and process object. Execute it using the command line and display output.

SUGGESTED READINGS:

1. Mayur Ramgir, “Full Stack Java Development with Spring MVC, Hibernate, jQuery, and Bootstrap”, Packt Publishing, 2020.
2. Ketan Agnihotri, Pranali Dahale, " React Development using Typescript: Modern web app development using advanced React techniques ", English Edition, 2024.
3. Nabendu Biswas, “Ultimate Full-Stack Web Development with MERN: Design, Build, Test and Deploy Production-Grade Web Applications with MongoDB, Express, React and NodeJS”, 1st Edition, 2023.

Course Code	Course Title						Core/Elective
U24CD5P1	**INTERNSHIP**						**Core**
	Contact Hours per Week						
Prerequisite	**L**	**T**	**D**	**P**	**CIE**	**SEE**	**Credits**
-	**-**	**-**	**-**	**3**	**50**	**-**	**2**

Course Objectives:

This course enables students to:

1. Produce an accurate record of work performed during the Internship/Co-op
2. Apply engineering knowledge to a problem in industry
3. Produce a technical report
4. Discuss work in a team environment, if relevant to the project
5. Conduct herself/himself responsibly, safely, and ethically in a professional environment

Course Outcomes:

After completing the course, the student will be able to:

1. Design/develop a small and simple product in hardware or software.
2. Complete the task or realize a pre specified target, with limited scope, rather than taking up a complex task and leave it.
3. Learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to pre specified criteria.
4. Implement the selected solution and document the same.

Guidelines:

Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organizations /Computer Industry/Software Companies/R&D Organization for a period of 4 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co- ordinate (person from industry). The course schedule will depend on the specific internship/training experience.

The typical time per topic will vary depending on the internship

Documents to be submitted:

1. Overview of company/project
2. Safety training
3. Discussions with project teams
4. Background research, review of documents, white papers, and scientific papers
5. Planning, designing, and reviewing the planned work
6. Executing the plans
7. Documenting progress, experiments, and other technical documentation
8. Further team discussions to discuss results

Final report writing and presentation

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Note:

Students have to undergo summer internship of 4 weeks at the end of semester IV and credits will be awarded after evaluation in V semester.

Course Code	Course Title						Core/Elective
U24CD601	Data Engineering						Core
Prerequisite	Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Basic Programming	3	_	_	_	40	60	3

Course Objectives:

1. To understand the fundamental concepts of data engineering and its lifecycle.
2. To leverage Python for ingesting, transforming, and managing structured and unstructured data.
3. To work with databases and data warehouses using Python.
4. To implement data pipelines using modern data engineering tools.
5. To develop skills to manage, monitor, and optimize data workflows in real-world scenarios.

Course Outcomes:

At the end of the course, student would be able to:

1. Understand the data engineering lifecycle and ecosystem.
2. Use Python libraries and tools to perform ETL processes.
3. Work with different data storage and retrieval systems (SQL, NoSQL, file formats).
4. Build and deploy end-to-end data pipelines using Python.
5. Optimize, monitor, and debug data pipelines effectively.

UNIT I:

Introduction to Data Engineering and Python Basics: Introduction to Data Engineering, Data vs Software Engineering, Data Engineering lifecycle: Ingestion, Storage, Processing, Orchestration, Python for Data Engineering: File handling, Exception handling, OOP Basics, Pandas, NumPy, OS, Logging

UNIT II:

Data Ingestion and Transformation: File formats: CSV, JSON, XML, Parquet, Avro, Reading/Writing structured and semi-structured data using Python, APIs and Web scraping for data ingestion, Data cleaning with Pandas, Data transformation techniques, Data validation methods

UNIT III:

Working with Databases and Data Warehousing: SQL and Python: sqlite3, SQLAlchemy, working with MySQL, PostgreSQL, NoSQL using MongoDB and PyMongo, Introduction to Data Warehousing, Dimensional Modeling concepts, Connecting Python to data warehouses: BigQuery, Redshift

UNIT IV:

Building Data Pipelines: ETL vs ELT, Modular and reusable pipeline design, Apache Airflow basics: DAGs, Task scheduling, Airflow Python operators, Custom operators, Batch data processing, Introduction to Kafka, Streaming data concepts

UNIT V:

Data Workflow Management and Deployment: Pipeline testing strategies, Logging best practices, Monitoring and alerting using Airflow UI and retries, Performance optimization techniques, Introduction to Docker for deployment, Case Study: Building and deploying a complete data pipeline.

SUGGESTED READINGS:

1. **Data Engineering with Python** by Paul Crickard — Covers Python tools and techniques for building data pipelines, ETL, and data workflows.
2. **Designing Data-Intensive Applications** by Martin Kleppmann — Provides deep insights into scalable data systems, storage, processing, and architectures.

Course Code	Course Title						Core/Elective
U24CM608	MACHINE LEARNING						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Artificial Intelligence	3	1	-	-	40	60	3

Course Objectives:

This course will enable students to

1. To introduce students to the basic concepts of Data Science and techniques of Machine Learning.
2. To develop skills of using recent machine learning software for solving practical problems.
3. To gain experience of doing independent study and research.
4. To develop an understanding of the role of machine learning in massive scale automation.
5. To design and implement various machine learning algorithms in the range of real-world applications

Course Outcomes:

On completion of this course, the students are able to :

1. Design and implement machine learning solutions of classification, regression problems.
2. Evaluate and interpret the results of the machine learning algorithms.
3. Evaluate exploratory data analysis and Data preparation and preprocessing on different datasets.
4. Calculate Statistical measurements of the given data.
5. Analyze and identify the best algorithm matches for a given dataset.

UNIT – I

Introduction: What is Machine Learning, Use Machine Learning, and Types of Machine Learning Systems: supervised, unsupervised, semi-supervised, Reinforcement Learning, Batch and Online Learning, Main Challenges of Machine Learning.

UNIT – II

Descriptive Statistics: Data representation, types of data- nominal, ordinal, interval and continuous, central tendency- calculating mean mode median, mean vs median, variability, variance, standard deviation, Mean Absolute Deviation using sample dataset, finding the percentile, interquartile range, Box Plot, Outlier, whisker, calculating correlation, covariance, causation. Exploratory data analysis, Data preparation and preprocessing, Data visualization.

UNIT – III

Regression: Introduction to Regression analysis, measure of linear relationship, Regression with stats models, Determining coefficient, meaning and significance of coefficients, coefficient calculation with least square method, Types of regression, Simple Linear Regression, Using Multiple features, Polynomial Regression, Metrics for Regression: MSE, RMSE, MAE.

UNIT – IV

Classification: Classification problem, Probability based approach, Logistic Regression- log-odd, sigmoid transformation, Metrics: Confusion Matrix, Accuracy, Error Rate, Precision, Recall, ROC curve, F1 score, and introduction to gradient descent.

UNIT – V

Non-Parametric & SVM classification: About Non parametric classification, Decision Trees: Entropy, Gain ratio, Information Gain, Splitting criteria.
Ensemble Method: Introduction to Random Forest, Accuracy measure & performance
Instance based learning- Introduction, KNN algorithm, Distance measures, model building, locally weighted regression, radial basis functions, SVM classifier, hyper-plane, slack variables, geometric transformation kernel trick, kernel transformation.

SUGGESTED READINGS:

1. Machine Learning in Action, Peter Harrington, Dream Tech Press India Pvt. Ltd, 1st Edition,2012.
2. The Field Guide to Data Science, Booz, Allen, Hamilton, Manning Publications 2nd Edition,2018.
3. Hands-On Machine Learning with Scikit-Learn and TensorFlow Aurelian Géron, O'Reilly Media, 3rd Edition,2017.

Course Code	Course Title						Core/Elective
U24MB601	BUSINESS ECONOMICS AND FINANCIAL ANALYSIS						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Basic Economics	3	-	-	-	40	60	3

Course Objectives:

This course will enable students to

1. Understand the concepts of Business and Economics
2. Comprehend the concepts of market dynamics namely elasticity of demand and pricing in different market structures.
3. Gain the knowledge on the production theories and cost analysis while dealing with the production and the concept of breakeven analysis.
4. To acquire the in-depth knowledge on Financial Accounting concepts and principles and preparation of final accounts.
5. To understand the financial statements through ration analysis and cash flow techniques.

Course Outcomes:

On completion of this course, the students are able to

1. Apply the concepts of business and economics during his/her professional and personal life.
2. Understand the elasticity of the demand of the product, different types, and measurement of elasticity of demand and factors influencing on elasticity of demand.
3. Recognize the Production function, features of Iso-Quants and Iso-Costs, different types of internal economies, external economies and law of returns with appropriate examples.
4. Prepare the financial statements of the firm.
5. Analyze the financial statements using ratio analysis and cash flow techniques.

UNIT – I

Introduction to Business and Economics: Business: Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance. Economics: Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply in Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

UNIT – II

Demand and Supply Analysis: Elasticity of Demand: Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting. Supply Analysis: Determinants of Supply, Supply Function & Law of Supply.

UNIT- III

Production, Cost, and Market Structures & Pricing: Production Analysis: Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions. Cost analysis: Types of Costs, Short run and Long run Cost Functions. Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, and Monopolistic Competition. Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, & Cost Volume Profit Analysis

UNIT – IV

Financial Accounting: Accounting concepts and Conventions, Accounting Equation, Double Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, and Preparation of Final Accounts.

UNIT – V

Financial Analysis through Ratios: Concept of Ratio Analysis, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios (simple problems), Introduction to Cash Flow Analysis (simple problems).

SUGGESTED READINGS:

1. "Managerial Economics and Financial Analysis" A.R. Aryasri, TMH Publications, 3rd Edition, 2007.
2. "Managerial Economics", D.N. Dwivedi, Vikas Publication House Pvt. Ltd, 2nd Edition, 2012.
3. "Financial Accounting", S.N. Maheshwari & S.K. Maheshwari, Vikas Publication House Pvt.Ltd, 4th Edition, 2012

Course Code	Course Title						Core/Elective
U24CD602	DISTRIBUTED SYSTEMS						Professional Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
OS, Java Programming	3	-	-	-	40	60	3

Course Objectives:

The objectives of this course are

1. To acquire an understanding of the issues in distributed systems.
2. To learn about Naming and synchronization with different algorithms.
3. To study architectures and working of Distributed file systems, Distributed web-based system
4. To expose the students to distributed transaction management, security issues and replication.
5. To introduce Emerging trends in distributed computing

Course Outcomes:

On Successful completion of this course, student will be able to

1. List the principles of distributed systems and describe the problems and challenges associatedwith these principles
2. To know about interposes communication and remote communication.
3. Understand Distributed Computing techniques, Synchronous and Processes.
4. Understand Distributed File Systems Apply Distributed web-based system. Understand theimportance of security in distributed systems
5. Student will be able to know distributed service-oriented architecture.

UNIT – I

Introduction: Characteristics & Properties of Distributes Systems – Taxonomy – Types of DistributedSystems Design goals – Transparency Issues.

Architectures: Architectural Styles, System Architectures, Architectures versus Middleware, and Self- Management in Distributed Systems.

Processes: Threads, Virtualization, Software Agents, Clients, Servers, and Code Migration. **Communication:** Inter process communication Mechanisms, Remote Procedure Call, Remote Method Invocation, Message-Oriented Communication, Stream-Oriented Communication, andMulticast Communication.

UNIT – II

Naming: Names, Identifiers and Addresses, Flat Naming, Structured Naming and Attribute-BasedNaming. **Synchronization:** Clock Synchronization, Logical Clocks, Mutual Exclusion, Global Positioning of Nodes, and Election Algorithms.

Consistency and Replication: Introduction, Data-Centric Consistency Models, Client-CentricConsistency Models, Replica Management, and Consistency Protocols.

UNIT-III

Fault Tolerance: Introduction to Fault Tolerance, Process Resilience, Reliable Client- Server Communication, Reliable Group Communication, Distributed Commit, and Recovery.

Distributed Object-Based Systems: CORBA, DCOM, GLOBE -Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, andSecurity

UNIT-IV

Distributed File Systems: File system, DFS- definition, Characteristics, Goals, SUN NFS-NFS Architecture, NFS Implementation, Protocols, The CODA file system-Design Overview, An Example,Design Rational, Implementation, The GOOGLE file system-Definition, Architectures, GFS

Distributed Web-Based Systems: Traditional Web-Based Systems, Web Services Fundamentals, The Apache Web Server, Web Server Clusters, Communication, HTTP Fundamentals, Simple Object Access Protocol SOAP, Web Proxy Caching, Replication for Web Hosting Systems-CDN'S**,** Service-Oriented Architectures, REST and Web Services

UNIT -V

Distributed Coordination-Based Systems – Architecture, Naming and Security

Emerging Trends in Distributed Systems – Emerging Trends Introduction, Grid Computing, Cloud Computing and its roots in distributed systems mechanisms and self-management of distributed systems, Virtualization, Service Oriented Architecture, The Future of Emerging Trends.**Map-Reduce**: Example, Scaling, Programming Model, Apache Hadoop, Amazon Elastic Map Reduce, Mapreduce.net, Pig and Hive.

SUGGESTED READINGS:

1. Andrew S. Tanenbaum and Maarten Van Steen, *Distributed Systems*, PHI 2nd Edition, 2009.
2. Distributed Computing, Sunita Mahajan and Seema Shah, Oxford University, 2nd Edition, 2013.
3. R. Hill, L. Hirsch, P. Lake, S. Moshiri, *Guide to Cloud Computing*, Principles andPractical, Springer, 2013.
4. R. Buyya, J. Borberg, A. Goscinski, *Cloud Computing-Principles and Paradigms*, Wiley, 2013.

Course Code	Course Title						Core/ Elective
U24CD603	SOFTWARE PROJECT MANAGEMENT						PROFESSIONAL ELECTIVE
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Software Engineering	3	-	-	-	40	60	3

Course Objectives

The course will introduce the students to

1. To understand the fundamental principles of software project management.
2. To have a good knowledge of responsibilities of project manager.
3. To be familiar with the different methods and techniques used for project
4. To be Familiar with the different activities involved in Software Project Management.
5. Explain the quality management & different types of metrics used in software development.

Course Outcomes

Upon completion of the course, the students will be able to:

1. Identify the different project contexts and suggest an appropriate management strategy.
2. Practice the role of professional ethics in successful software development.
3. Identify and describe the key phases of project management.
4. Determine an appropriate project management approach through an evaluation of the business context and scope of the project.
5. Understand the importance of risk. Define the questions a decision maker needs to ask.

UNIT – I

SOFTWARE MANAGEMENT & ECONOMICS: The Waterfall Model, Conventional Software Management Performance; Evolution of Software Economics – Software economics, Pragmatic software cost estimation, Reducing software product size, Improving software processes.

UNIT – II

THE OLD AND THE NEW WAY OF PROJECT MANAGEMENT: Improving team effectiveness, Improving automation through software environment, Achieving required quality; Peer inspections – A pragmatic view, The principles of conventional software engineering, Principles of modern software management, Transitioning to an iterative process.

UNIT – III

SOFTWARE MANAGEMENT PROCESS FRAMEWORK: Life cycle phases, The artifact sets, Management artifacts, Engineering artifacts, Pragmatic artifacts; Model Based Software Architectures – A management perspective and A technical perspective.

UNIT – IV

PROJECT ORGANIZATION AND PLANNING: Work breakdown structures, Planning guidelines, The cost and schedule estimating process, The iteration planning process, Pragmatic planning, Line-of-Business organizations, Project organizations, Evolution of organizations; Process automation – Automation building blocks, The project environment.

UNIT – V

PROJECT CONTROL AND PROCESS INSTRUMENTATION: The Seven-Core metrics, Management indicators, Quality indicators, Life-Cycle expectations, Pragmatic software metrics, Metrics automation, Modern project profiles, Next generation software economics, Modern process transitions.

SUGGESTED READINGS:

1. Walker Royce, “Software Project Management”, 1st Edition, Pearson Education, 2006.
2. Bob Hughes and Mike Cotterell, “Software Project Management”, 3rd Edition, Tata McGraw Hill Edition, 2005.
3. Joel Henry, “Software Project Management”, 1st Edition, Pearson Education, 2006. 3. Pankaj Jalote, “Software Project Management in practice”, 1st Edition, Pearson Education, 2005.

Course Code	Course Title						Core/ Elective
U24CD604	Image Processing						ELECTIVE
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Software Engineering	3	-	-	-	40	60	3

Course Objectives

The course will introduce the students to

1. Explain the components of a digital image processing system and describe image models, relationships between pixels, and geometric transformations.
2. Apply frequency domain techniques, including Fourier, Discrete Cosine, Walsh, Haar, and Hadamard transforms for image filtering.
3. Enhance images using techniques such as histogram equalization, smoothing, sharpening, and homomorphic filtering.
4. Restore degraded images using methods like inverse filtering, Wiener filtering, and constrained least mean square techniques.
5. Implement image compression methods, including lossless and lossy compression techniques such as LZW, transform coding, and wavelet coding.

Course Outcomes

Upon completion of the course, the students will be able to:

1. The fundamental concepts and mathematical models of digital image processing, including image representation, perception, and geometry.
2. The techniques for image enhancement, restoration, and transformation, using both spatial and frequency domain methods.
3. The image compression and segmentation techniques, applicable in real-world image analysis and computer vision applications.
4. Apply image segmentation techniques, including edge detection, thresholding, region-based segmentation, and texture analysis.
5. Improve images by applying methods like histogram equalization, smoothing, sharpening, and homomorphic filtering.

UNIT-I:

FUNDAMENTALS OF IMAGE PROCESSING

Introduction to digital image processing, Elements of Digital Image Processing system, Visual perception and properties of human eye, Image representation, A simple image model, Some basic relationship between pixels, Some basic relationship between pixels, Image geometry

UNIT-II:

FILTERING IN THE FREQUENCY DOMAIN

Introduction to Fourier Transform, DFT & FFT, Properties of 2D Fourier Transform, Separable Image Transforms –Walsh, Hadamard Transform, Hadamard Transform (Problem), Discrete Cosine Transform, Discrete Cosine Transform, Discrete Cosine Transform (Problem), Haar Transform

UNIT-III:

IMAGE ENHANCEMENT

Image Enhancement – Histogram Modelling, Image Enhancement – Histogram Modelling, Equalization, Equalization and modification, Image smoothing, Image sharpening, Spatial Filtering, Homomorphic filtering for image enhancement, Homomorphic filtering for image enhancement.

UNIT-IV:

IMAGE RESTORATION

Model of Image Degradation/Restoration process, Model of Image Degradation/Restoration process, Inverse filtering, Inverse filtering, Least Mean Square (Wiener) filtering, Least Mean Square (Wiener), filtering, constrained least mean square restoration, constrained least mean square restoration, Constrained least mean square restoration, Singular value decomposition, Recursive filtering

UNIT-V:

IMAGE SEGMENTATION

Image compression models, Lossless compression: Variable length coding, LZW coding, Lossy Compression: Transform coding, Wavelet coding, Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding-Region oriented segmentation and Texture.

SUGGESTED READINGS:

1. Rafael C Gonzalez, Richard E Woods, "Digital Image Processing", 4th Edition, Pearson Education, 2018.
2. Jain A.K., "Fundamentals of Digital Image Processing", Pearson education, 4th Edition, Pearson Education, 2018.

Course Code	Course Title						Core/Elective
U24CD605	DATA MINING						Professional Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
DBMS, P&S	3	-	-	-	40	60	3

Course Objectives

The course will introduce the students to

1. The scope and essentiality of data mining and warehousing.
2. The analysis of data, choosing relevant models and algorithms for respective applications.
3. The process and mining of complex data types such as streams, spatial, web and multimedia
4. The research perspectives towards advances in data mining
5. Examine data mining algorithms for solving real world problems

Course Outcomes

On completion of the course, students will be able to

1. Relate knowledge discovery in databases (KDD) process with the help of data warehouse fundamentals and data mining functionalities
2. Summarize data mining concepts and preprocessing techniques for knowledge discovery
3. Apply Apriori and FP growth methods on transaction data for frequent pattern mining
4. Choose classification or clustering algorithm for building a classification or prediction model
5. Infer complex data models with respect to multimedia, streams, spatial and web mining.

UNIT-I: DATAWAREHOUSING

Introduction to Data warehouse, Differences between OLAP and OLTP, A Multi-dimensional data model- Star, Snow flake and Fact constellation schemas, Measures, Concept hierarchy, OLAP operations in multi-dimensional data model, Data warehouse architecture- A three tier Data ware house architecture, types of OLAP servers, Data warehouse Implementation, Data warehouse models

UNIT -II: DATA MINING

Introduction, what is Data Mining, Definition, Knowledge Discovery in Data (KDD), Kinds of data bases, Data mining functionalities, Classification of data mining systems, Data mining task primitives, data objects. Data Preprocessing: Data cleaning, Data integration and transformation, Data reduction, Data discretization and Concept hierarchy.

UNIT -III: ASSOCIATION RULE MINING

Association Rules: Problem Definition, Frequent item set generation, The APRIORI Principle, support and confidence measures, association rule generation; APRIORI algorithm. FP-Growth Algorithm, Compact Representation of Frequent item Set-Maximal Frequent item set, close frequent itemset.

UNIT -IV: CLASSIFICATION AND PREDICTION

Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back propagation, Classification Based on Concepts from Association Rule Mining, Other Classification Methods, Prediction, Classifier Accuracy

UNIT -V: CLUSTERING

Types of data, categorization of major clustering methods, K-means partitioning methods, hierarchical methods, density-based methods, grid-based methods, model-based clustering methods, outlier analysis. Mining Complex

Types of Data: Multidimensional Analysis and Descriptive Mining of Complex, Data Objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Time-Series and Sequence Data, Mining Text Databases, Mining the World Wide Web.

SUGGESTED READINGS:

1. Jiawei Han, Jian Pei, and Hang hang Tong, "Data Mining: Concepts and Techniques", Elsevier (Morgan Kaufmann Publishers), 4th Edition,2022.

2. Parteek Bhatia, "Data Mining and Data Warehousing: Principles and Practical Techniques", Cambridge University Press, 1st Edition ,2019

3. Ralph Kimball, "The Data Warehouse Life Cycle Toolkit", Wiley, Student Edition, 2006

Course Code	Course Title						Core/Elective
U24CD6L1	Data Engineering Lab						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Python	-	-	-	3	25	50	1.5

Course Objectives

1. To understand the fundamental concepts of data engineering and its lifecycle.
2. To leverage Python for ingesting, transforming, and managing structured and unstructured data.
3. To work with databases and data warehouses using Python.
4. To implement data pipelines using modern data engineering tools.
5. To develop skills to manage, monitor, and optimize data workflows in real-world scenarios.

Course Outcomes:

At the end of the course, student would be able to:

1. Understand the data engineering lifecycle and ecosystem.
2. Use Python libraries and tools to perform ETL processes.
3. Work with different data storage and retrieval systems (SQL, NoSQL, file formats).
4. Build and deploy end-to-end data pipelines using Python.
5. Optimize, monitor, and debug data pipelines effectively.

1. Write programs to parse text files, CSV, HTML, XML and JSON documents and extract relevant data. After retrieving data check any anomalies in the data, missing values etc.

2. Write programs for reading and writing binary files

3. Write programs for searching, splitting, and replacing strings based on pattern matching using regular expressions

4. Design a relational database for a small application and populate the database. Using SQL do the CRUD (create, read, update and delete) operations.

5. Create a Python MongoDB client using the Python module pymongo. Using a collection object practice functions for inserting, searching, removing, updating, replacing, and aggregating documents, as well as for creating indexes

6. Write programs to create numpy, arrays of different shapes and from different sources, reshape and slice arrays, add array indexes, and apply arithmetic, logic, and aggregation functions to some or all array elements

7. Write programs to use the panda's data structures: Frames and series as storage containers and for a variety of data-wrangling operations, such as:

   a) Single-level and hierarchical indexing
   b) Handling missing data
   c) Arithmetic and Boolean operations on entire columns and tables
   d) Database-type operations (such as merging and aggregation)
   e) Plotting individual columns and whole tables
   f) Reading data from files and writing data to files

Course Code	Course Title						Core/Elective
U24CM6L4	MACHINE LEARNING LAB						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Python Programming	-	-	3	3	25	50	1.5

Course Objectives:

This course enables students to:

1. To introduce students to the basic concepts of Data Science and techniques of Machine Learning.
2. To develop skills of using recent machine learning software for solving practical problems.
3. To gain experience of doing independent study and research.
4. Be capable of confidently applying common Machine Learning algorithms in practice and implementing their own
5. Be capable of performing experiments in Machine Learning using real-world data.

Course Outcomes:

On completion of this course, the students are able to:

1. The student must be able to design and implement machine learning solutions to classification, regression problems.
2. Understand complexity of Machine Learning algorithms and their limitations
3. Able to evaluate and interpret the results of the algorithms.
4. Implement Decision trees and various algorithms
5. Implement and analyze various random forest techniques.

1. Implement a program to demonstrate the following
   a) Operation of data types in Python.
   b) Different Arithmetic Operations on numbers in Python.
   c) Create, concatenate and print a string and access substring from a given string.
   d) Append, and remove lists in python.
   e) Demonstrate working with tuples in python.
   f) Demonstrate working with dictionaries in python.

2. Using python write a NumPy program to compute the
   a) Expected Value
   b) Mean
   c) Standard deviation
   d) Variance
   e) Covariance
   f) Covariance Matrix of two given arrays.

3. For a given set of training data examples stored in a .CSV file, demonstrate Data Preprocessing in Machine learning with the following steps
   a) Getting the dataset.
   b) Importing libraries.
   c) Importing datasets.
   d) Finding Missing Data.
   e) Encoding Categorical Data.
   f) Splitting dataset into training and test set.
   g) Feature scaling.

4. Build a linear regression model using python for a particular data set by
   a) Splitting Training data and Test data.
   b) Evaluate the model (intercept and slope).
   c) Visualize the training set and testing set
   d) predicting the test set result
   e) compare actual output values with predicted value
   f) The dataset contains information of users from a company's database. It contains information about UserID, Gender, Age, EstimatedSalary, and Purchased. Use this dataset for predicting that a user will purchase the company's newly launched product or not by Logistic Regression model.

5. Implement a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

6. Implement k-nearest neighbor's classification to classify the iris data set using python.

User ID	Gender	Age	EstimatedSalary	Purchased
15624510	Male	19	19000	0
15810944	Male	35	20000	0
15668575	Female	26	43000	0
15603246	Female	27	57000	0
15804002	Male	19	76000	0
15728773	Male	27	58000	0
15598044	Female	27	84000	0
15694829	Female	32	150000	1
15600575	Male	25	33000	0
15727311	Female	35	65000	0
15570769	Female	26	80000	0
15606274	Female	26	52000	0
15746139	Male	20	86000	0
15704987	Male	32	18000	0
15628972	Male	18	82000	0
15697686	Male	29	80000	0
15733883	Male	47	25000	1
15617482	Male	45	26000	1
15704583	Male	46	28000	1

7. Given the following data, which specify classifications for nine combinations of VAR1 and VAR2 predict a classification for a case where VAR1=0.906 and VAR2=0.606, using the result of k-means clustering with 3 means (i.e., 3 centroids)

VAR1	**VAR2**	**CLASS**
1.713	1.586	0
0.180	1.786	1
0.353	1.240	1
0.940	1.566	0
1.486	0.759	1
1.266	1.106	0
1.540	0.419	1
0.459	1.799	1
0.773	0.186	1

8. Evaluate the metrics for all types of machine learning algorithms using sample data.

9. Implement an algorithm to demonstrate the significance of SVM.

SUGGESTED READINGS:

1. The Field Guide to Data Science, Booz, Allen, Hamilton, Manning Publications 2nd Edition,2018.
2. Hands-On Machine Learning with Scikit-Learn and TensorFlow, Aurelien Géron, O'Reilly Media, 1st Edition,2017.
3. Machine Learning in Action, Peter Harrington, Manning Publications.2012.

Course Code	Course Title						Core/Elective
U24CD6P1	MINI PROJECT						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	6	6	50	50	2

Course Objectives:

The objective of the course is to:

1. Enhance practical and professional skills.
2. Familiarize tools and techniques of systematic literature survey and documentation
3. Expose the students to industry practices and team work.
4. Encourage students to work with innovative and entrepreneurial ideas.
5. Make students evaluate different solutions based on economic and technical feasibility

Course Outcomes:

After completing the course, the student will be able to:

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained
5. Write the documentation in standard format

Guidelines:

1. As part of the curriculum in the VI- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
2. Four students will be allotted to one faculty supervisor for mentoring.
3. Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
4. Mini projects shall have inter-disciplinary/ industry relevance.
5. The students can select a mathematical modelling based/Experimental investigations or Numerical modelling
6. All the investigations should be clearly stated and documented with the reasons/explanations.
7. The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference.
8. The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
9. The preliminary results (if available) of the problem may also be discussed in the report.
10. The work has to be presented in front of the PRC committee which consists of one Supervisor and a minimum of two faculty members from the respective Department of the Institute.

Course Code	Course Title						Core/Elective
U24MA6L1	APTITUDE AND REASONING SKILLS LAB						Core
	Contact Hours per Week						
Prerequisite	L	T	D	P	CIE	SEE	Credits
-	-	-	2	2	25	50	1

Course Objectives

This course enables students to:

1. Acquire the concepts of mathematical aptitude and reasoning.
2. Develop the innovative and creative thinking through basic mathematical concepts.
3. Improve analytical and problems solving skills.
4. Enhance logical thinking and mathematical ability.
5. Empower with the basic tools of mathematical aptitude.

Course Outcomes

After completing this course, the student will be able to:

1. Build proficiency in quantitative reasoning
2. Improve critical thinking skills
3. Enhance analytical skills
4. Demonstrate quantitative aptitude concepts
5. Adapt principles of quantitative aptitude to achieve qualitative results.

Guidelines

1) **Basic concepts**: combined mean, average principles, wrong values taken, number added or deleted, average speed.

2) **Percentages** -Basic Concepts, conversions, finding percentages from given numbers, quantity increases or decreases by given percentage, population increase by given percentage, comparisons, consumption when a commodity price increase or decrease and applications.

3) **Data Interpretation** - Introduction to Data Interpretation, quantitative and qualitative data, Tabular Data, Line Graphs, Bar Chart, Pie Charts, X-Y Charts.

4) Number Series, Letter Series, Series completion and correction, Coding and Decoding. Word analogy-Applied analogy, Classifications, verbal classification.

5) **Reasoning Logical Diagrams** - Simple diagrammatic relationship, Multi diagrammatic relationship, Venn- diagrams, Analytical reasoning.

Reasoning Ability - Blood Relations, Seating arrangements, Directions, Decision making. Number Systems: Basic Concepts,

6) **Number Systems**: Natural numbers, whole numbers, integers, fractions, Rational Numbers, Irrational Numbers, Real Numbers, Divisibility Rules, Logic Equations, Remainder theorem, Unit digit calculation.

Progressions & Inequalities: Basic Concepts, Types: arithmetic, geometric, harmonic progression and applications.

7) **Profit and Loss**: Basic Concepts, discounts, marked price and list price, dishonest shopkeeper with manipulated weights, successive discounts etc.

Interest (Simple and Compound): Basic Concepts, Yearly, Half-yearly, and quarterly calculations, multiples, differences between simple and compound interest.

8) **Ratio and Proportion**: Basic Concepts of ratio and proportion, continued or equal proportions, mean proportions, invest proportion, alternative proportion, division proportion, compound proportion, duplication of ratio, finding values, coins and currencies, etc.

9) **Speed, Time and Distance**: Basic Concepts, Single train problems, two train problems: some point same side, some point opposite sides, relative speed, different points meeting at common points, different points same side (different timings vs. same timings), ratios, number of stoppages, average speed, etc.

10) **Time and Work**: Basic Concepts, comparative work, mixed work, alternative work, middle leave and middle join, ratio efficiency.

11) **Permutations and combinations**: Basic Concepts, differences between permutations and combinations, alternative arrangement, fixed positions, items drawing from a single group, items drawing from a multiple group, total ways of arrangement with repetitions and without repetitions, handshakes or line joining between two points or number of matches,

sides and diagonals, etc.

12) **Clocks and Calendars**: Basic Concepts, Angle between minute hand and hour hand, reflex angle, hours hand angle, time gap between minute hand and hour hand, relative time: coincide, opposite sides and right angle, mirror images, faulty clock (slow/fast), miscellaneous, calendar.

13) **Geometry and Mensuration**: Basic concepts, types of angles.

Plane figures: rectangles, squares, triangles, quadrilateral, areas, perimeters, etc.

Solid figures: cubes, cuboids, cylinders-area (total surface area and lateral surface area), volumes, perimeters.

Others: Parallelogram, Rhombus, Trapezium, Circle, Sector, Segment, Cone, Sphere, Hemisphere, etc.

SUGGESTED READINGS:

1. Aptitude and reasoning skills lab Manual, LIET, HYD.