



MUFFAKHAM JAH COLLEGE OF ENGINEERING & TECHNOLOGY
(SULTAN-UL-ULOOM EDUCATION SOCIETY)
ACCREDITED BY NBA and NAAC WITH 'A+' GRADE
(An Autonomous Institution)
CSE(DATA SCIENCE) DEPARTMENT
SCHEME AND SYLLABUS FOR B.E. III - IV SEMESTER
SCHEME AND SYLLABUS FOR B.E. III-SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	D/P	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	25BS211MT	Probability & Statistics	3	-	-	3	40	60	3	3
2	25PC212CS	Data Structures	3	1	-	4	40	60	3	4
3	25PC213CS	Discrete Mathematics	3	-	-	3	40	60	3	3
4	25PC214CS	Object Oriented Programming using Java	3	-	-	3	40	60	3	3
5	25PC215DS	Foundation of Data Science	3	-	-	3	40	60	3	3
Practical / Laboratory Courses										
6	25PC251DS	Data Science Lab	-	-	2	2	40	60	3	1
7	25PC252CS	Data Structures Lab	-	-	2	2	40	60	3	1
8	25PC253CS	Object Oriented Programming using Java Lab	-	-	2	2	40	60	3	1
9	25ES254EC	Skill Development Course-1 (IOT)	-	-	2	2	50	-	-	1
Total			15	1	8	24	370	480	24	20



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w.e.f: 2026-2027

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(UGC Autonomous Institution)

Course Code	Course Title					Core/Elective	
25BS211MT	PROBABILITY AND STATISTICS					Core	
	Branches: B.E. (CSE (DS), CSE (AI) & CSE (AI&ML))						
Prerequisite	Contact hours per week				CIE	SEE	Credits
MDC, DENM	L	T	D	P			
	3	0	0	0	40	60	3

Course Objectives: To learn

1. Understand fundamental concepts of probability theory and random variables.
2. Apply discrete and continuous probability distributions in engineering problems.
3. Analyze statistical data using sampling distributions.
4. Perform hypothesis testing for means, proportions and variances.
5. Apply correlation, regression and basic statistical tools in real-life engineering applications.

Course Outcomes: After learning the contents of this course, the student must be able to

1. Solve problems involving probability axioms, conditional probability and Bayes' theorem
2. Evaluate statistical parameters of discrete probability distribution.
3. Evaluate statistical parameters of continuous probability distribution.
4. Perform regression analysis to compute the coefficient of correlation to interpret data.
5. Testing of hypothesis of few unknown statistical parameters using types of sampling, Sampling distribution of means, Sampling distribution of variance.

Unit-I: Probability: Introduction, Conditional Probability, Baye's Theorem (Without proof), Random variable, Discrete Probability Distribution, Continuous Probability Distribution, Probability Mass Function, Probability Density Function, Expectation, Variance.

Unit-II: Discrete Probability Distributions: Binomial Distribution and Poisson Distributions- Evaluation of Statistical Parameters for these Distributions- Mean, Variance and Moment Generating Function.

Unit-III: Continuous Probability Distributions: Uniform Distribution, Exponential Distribution and Normal Distribution- Evaluation of Statistical Parameters for these Distributions-Mean, Variance and Moment Generating Function.

Unit-IV: Curve Fitting: Curve Fitting by the Method of Least Squares-Fitting of Straight Line, Fitting of Parabola, Fitting of other Curves ($y = ae^{bx}$, $y = ax^b$, $y = ab^x$), Coefficient of Correlation, Regression Coefficient, Lines of Regression, Rank Correlation Coefficient.

Kphaneendra
25/7/26.

Dr. K. PHANEENDRA
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Unit-V: Test of Significance -Large samples- Test for single mean, difference of means, single proportion, difference of proportions -Test of significance for small samples- chi-square test for goodness of fit and independence of attributes, student's t-test, F -test for ratio of variances.

Suggested Reading:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publication 43rd Edition, 2014.
2. R. K Jain, S.R.K Iyengar, Advanced Engineering Mathematics, Narosa Publication. 4Th Edition, 2014.
3. S.C Gupta and V.K Kapoor, Fundamental of Mathematical Statistics, Sultan Chand & sons, New Delhi, 2014.

K. Phaneendra

Dr. K. PHANEENDRA
Professor
Department of Mathematics
Osmania University
Hyderabad-500 007.

CO-PO and CO-PSO mapping for CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	2	-	-	-	-	-	-	-	3	1
CO2	3	3	-	2	1	-	-	-	-	-	-	3	2
CO3	3	3	-	2	1	-	-	-	-	-	-	3	2
CO4	3	3	2	3	2	-	-	-	-	1	-	3	2
CO5	3	3	2	3	2	-	-	-	-	1	-	3	2



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DATA STRUCTURES		
L:T:P (Hrs./week):3:1:0	SEE Marks : 60	Course Code : 25PC212CS
Credits : 4	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
	On completion of the course,the students will be able to
1. Develop the ability to analyze algorithm efficiency and implement Abstract Data Types using appropriate Data Structures.	CO1. Analyze algorithm efficiency using asymptotic notations and implement array-based data structures and string processing techniques.
2. Understand and implement linear and non-linear data structures for solving computational problems.	CO2. Implement linked list and hashing techniques for efficient storage, retrieval, and manipulation of data.
3. Apply tree-based and hashing techniques for efficient storage, retrieval and manipulation of data.	CO3. Apply stack and queue data structures to solve computational problems involving expression evaluation and scheduling applications.
4. Analyze and implement searching, sorting and graph based algorithms using appropriate data structures.	CO4. Construct and analyze tree-based data structures including BSTs, AVL trees, and heaps for efficient searching and sorting. CO5. Apply graph algorithms, sorting, and searching techniques to solve real-world computational problems.

CO-PO and CO-PSO mapping -For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	2	2	-	1	-		1	2	3	2
CO2	3	3	3	2	2	-	1	-	1	1	2	3	2
CO3	3	3	3	2	2	-	1	-	1	1	2	2	3
CO4	3	3	3	2	2	-	1	-	1	1	2	3	2
CO5	3	3	3	3	2	-	1	-	1	1	2	1	2



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UNIT-I

Algorithms: Introduction, Algorithm Specifications, Recursive Algorithms, Performance Analysis of an algorithm- Time and Space Complexity, Asymptotic Notations.

Arrays: Arrays ADT, Polynomials, Sparse matrices, Strings-ADT, Pattern Matching.

UNIT-II

Linked Lists: Singly Linked Lists and Chains, Polynomials, Operations for Circularly linked lists, Equivalence Classes, Sparse matrices, Doubly Linked Lists.

UNIT-III

Stacks and Queues: Stacks, Stacks using Arrays, and Stacks using dynamic arrays, Evaluation of Expressions, Evaluating Postfix Expression, Infix to Postfix. Linked Stacks.

Queues: Queues ADT, operations, Circular Queues, Linked Queues.

Hashing: Static Hashing, Hash Tables, Hash Functions, Overflow Handling.

UNIT-IV

Trees: Introduction, Binary Trees, Binary Tree Traversals, Heaps.

Binary Search trees (BST): Definition, Searching an element, Insertion into a BST, Deletion from a BST.

Efficient Binary Search Trees: AVL Trees: Definition, Searching an element, Insertion into an AVL Tree.

UNIT-V

Graphs: Graph Abstract Data Type, Elementary Graph operations (DFS and BFS), Minimum Cost Spanning Trees (Prim's and Kruskal's Algorithms).

Sorting and Searching: Insertion sort, Quick sort, Merge sort, Heap sort, Shell sort, Sorting on Several Keys, List and Table Sorts, Summary of Internal Sorting, Linear and Binary Search algorithms.

Suggested Reading:

1. Horowitz E, Sahni S and Susan Anderson-Freed, Fundamentals of Data structures in C, 2nd Edition (Reprint 2024), Universities Press.
2. Tanenbaum A. M, Langsam Y. Augenstein M. J, Data Structures using C, Second Edition (2008), Pearson.
3. Gilberg R. F and Forouzan B. A, Data structures: A Pseudocode Approach with C, Second Edition (2007), Cengage Learning.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein, Introduction to Algorithms, Fourth Edition (2022), MIT Press.
5. Kushwaha D. S and Misra A.K, Data structures A Programming Approach with C, Second Edition (2014), PHI.



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DISCRETE MATHEMATICS		
L:T:P (Hrs./week):3:0:0	SEE Marks : 60	Course Code : 25PC213CS
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
- Understand the fundamental concepts of mathematical logic, predicate logic, and proof techniques used in discrete mathematics. - Apply the principles of set theory, relations, functions, lattices, and partial ordering to solve mathematical and computational problems. - Analyze graph-theoretic concepts, trees, and their applications in computer science, including graph traversal, graph coloring, and spanning trees. - Develop problem-solving skills using combinatorial techniques, counting principles, permutations, combinations, binomial theorem, inclusion-exclusion principle, and pigeonhole principle. - Solve recurrence relations and utilize generating functions to analyze algorithms and discrete structures.	CO1. Apply propositional and predicate logic, normal forms, quantifiers, and proof techniques to formulate and validate logical arguments. CO2. Analyze and solve problems involving sets, relations, functions, lattices, equivalence relations, partial orders, and Hasse diagrams. CO3. Model and solve real-world problems using graph theory and trees, including graph traversal, connectivity, graph coloring, Euler and Hamilton paths, and minimum spanning trees. CO4. Employ combinatorial methods, including counting principles, permutations, combinations, binomial theorem, inclusion-exclusion principle, and pigeonhole principle, to solve discrete mathematical problems. CO5. Formulate and solve linear recurrence relations and apply generating functions and divide-and-conquer techniques in algorithm analysis.

CO-PO and CO-PSO mapping- For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	1	-	-	-	-	-	-	1	3	2
CO2	3	3	1	1	-	-	-	-	-	-	1	3	2
CO3	3	3	2	2	1	-	-	1	-	-	1	3	2
CO4	3	3	1	2		-	-	-	-	-	1	3	2
CO5	3	3	2	2	1	-	1	-	-	-	2	3	2



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UNIT-I

Mathematical Logic: Statements and Notations, Connectives, Well-Formed Formulas, Truth Tables, Tautology, Equivalence, Implication, Normal Forms, Quantifiers, Universal Quantifiers.

Predicates: Predicate Logic, Free & Bound Variables, Rules of Inference, Consistency, Proof of Contradiction.

UNIT-II

Set Theory and Relations: Basic Concepts of Set Theory, Relations and Ordering, Properties of Binary Relations, Equivalence, Transitive Closure, Compatibility and Partial Ordering Relations, Hasse Diagram.

Functions: Composition of Functions, Inverse Functions, Recursive Functions, Lattice and Its Properties.

UNIT-III

Graphs: Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Subgraphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Euler Circuits, Planar Graphs, Graph Coloring, Chromatic Numbers.

Trees: Introduction to Trees, Properties, Applications of Trees, Tree Traversal, Minimal Spanning Trees.

UNIT-IV

Elementary Combinatorics: Basics of counting, Combinations & Permutations with and without Repetitions and Constrained Repetitions.

Binomial Theorem: Binomial Coefficients, Binomial and Multinomial theorems, The Principle of Inclusion- Exclusion and Its Applications, Pigeon Hole Principle and Its Applications.

UNIT-V

Recurrence Relations: Recurrence Relations, Solving Linear Homogenous Recurrence Relations, Solving Linear Non-Homogenous Recurrence Relations, Divide and Conquer Algorithms and Recurrence Relations, Generating Functions

Suggested Reading:

1. Discrete Mathematics and its Applications, Kenneth H. Rosen, VIII Edition, McGraw Hill Education, 2019.
2. Elements of Discrete Mathematics- A Computer Oriented Approach- C. L. Liu, D. P. Mohapatra, III Edition, Tata Mc Graw Hill, 2017.
3. Discrete Mathematics for Computer Scientists & Mathematicians, Joe L. Mott, A. Kandel, T. P. Baker, II Edition, PHI, 2015.
4. Discrete Mathematical Structures Theory and Application- Malik & Sen, I Edition, Cengage Learning, 2012.
5. Discrete Mathematics with Applications, Thomas Koshy, I Edition, Elsevier, 2005.



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OBJECT ORIENTED PROGRAMMING USING JAVA		
L:T:P (Hrs./week):3:0:0	SEE Marks : 60	Course Code : 25PC214CS
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course,the students will be able to
1. To understand object-oriented programming principles. 2. To develop Java programs using core and advanced OOP concepts. 3. To implement data handling using Collections and file processing. 4. To apply multithreading concepts in Java applications. 5. To develop simple database-driven applications using JDBC.	CO1. Explain OOP principles and Java program structure. CO2. Develop Java programs using classes, inheritance, interfaces and exception handling. CO3. Implement data structures using Java Collections and Generics. CO4. Demonstrate multithreading and file handling concepts. CO5. Build simple database applications using JDBC.

CO-PO and CO-PSO mapping- For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	1	2	3	2
CO2	3	3	3	2	2	-	-	-	1	1	2	2	2
CO3	3	3	3	2	2	-	-	-	1	1	2	3	2
CO4	3	3	3	2	2	-	-	-	1	1	2	3	3
CO5	3	3	3	3	2	-	-	-	1	1	2	3	3



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UNIT-I

Java Fundamentals & OOP : OOP principles (Abstraction, Encapsulation, Inheritance, Polymorphism), Java Architecture (JVM, JRE, JDK) , Structure of Java Program, Data Types, Variables, Type Casting, Operators & Control Statements, Arrays, Classes and Objects, Constructors, Methods & Overloading, this, static, final, String and StringBuilder classes.

UNIT-II

Advanced OOP & Exception Handling : Inheritance & Method overriding, super keyword, Abstract Classes, Interfaces (including Functional Interfaces), Packages & Access Modifiers, Exception Handling: try-catch-finally-throw-throws, Custom Exceptions, **Introduction to Lambda Expressions** (Basic syntax only)

UNIT-III

Collections & Generics : Generics, Overview of Java Collections Framework, List, Set, Map Interfaces, ArrayList, LinkedList, HashSet, TreeSet, HashMap classes, Comparable & Comparator, Iterators, **Basic Stream API (filter, map – intro level).**

UNIT-IV

Multithreading & File Handling : Java Thread Model, Creating Threads (Thread class & Runnable), Thread Lifecycle, Synchronization, Inter-thread Communication, AutoBoxing, Java Input/Output: exploring java.io, Java I/O classes and interfaces, File Handling: File class, Byte Streams, Character Streams, Serialization .

UNIT-V

JDBC & Mini Application : JDBC Architecture, Types of JDBC Drivers, steps to Connect to Database, Statement vs PreparedStatement, CRUD Operations, Basic Transaction Handling, **Mini Case Study: Student Management / Employee Record System.**

Suggested Reading:

1. The Complete Reference Java, 12th Edition - Herbert Scheldt
2. JDBC: Practical Guide for Java Programmers, 2nd Edition Gregory D. Speegle
3. Head First Java, 3rd Edition - Kathy Sierra & Bert Bates
4. Core Java, Volume I: Fundamentals, 12th Edition - Cay S. Horstmann
5. Database Programming with JDBC and Java, 2nd Edition - George

Online resources:

6. <https://docs.oracle.com/javase/tutorial/java>
7. https://spoken-tutorial.org/tutorial-search/?search_foss=Java&search_language=English
8. <https://docs.oracle.com/javase/tutorial/jdbc/basics/index.html>



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FOUNDATION OF DATA SCIENCE		
L:T:P (Hrs./week):3:0:0	SEE Marks : 60	Course Code : 25PC215DS
Credits :	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course,the students will be able to
1. Understand the fundamental concepts, principles, lifecycle, and interdisciplinary applications of Data Science. 2. Acquire knowledge of data collection, preprocessing, transformation, and statistical techniques for preparing data for analysis. 3. Develop proficiency in using Python-based data science libraries such as NumPy and Pandas for data manipulation, storage, and analysis. 4. Apply exploratory data analysis (EDA) and visualization techniques to summarize, interpret, and derive meaningful insights from datasets. 5. Understand the fundamentals of hypothesis testing, regression, and the machine learning workflow for building data-driven solutions.	CO1. Explain the concepts, workflow, tools, and real-world applications of Data Science. CO2. Perform data preprocessing, transformation, and descriptive statistical analysis on structured datasets. CO3: Utilize Python libraries to effectively manipulate, analyze, and manage datasets. CO4: Conduct exploratory data analysis and visualization to identify patterns and relationships in data. CO5: Apply hypothesis testing, basic regression analysis, and the machine learning workflow to formulate and evaluate data-driven solutions.

CO-PO and CO-PSO mapping- For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	2	2	-	1	-	1	1	2	3	3
CO2	3	3	3	2	3	1	-	-	-	1	2	3	1
CO3	2	3	2	3	2	-	-	-	1	1	2	2	2
CO4	3	3	3	3	3	1	-	-	1	1	2	3	3
CO5	2	3	3	3	3	1	1	-	1	1	3	3	3



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UNIT-I

Introduction: Data Science, Computational Thinking, Skills for Data Science, Tools for Data Science.

Data science in practice: Finance, Public Policy, Politics, Healthcare, Urban Planning, Education, Libraries. Relevance of Data Science to Other Fields, The Relationship between Data Science and Information Science: Information vs. Data Users in Information Science.

Data: Introduction, Data Types and Data Collections: Open Data, Social Media Data, Multimodal Data, Data Storage and Presentation. Data Pre-processing: Data Cleaning, Data Integration, Data Transformation, Data Reduction, Data Discretization. (*Hands-on Introduction to Data Science – Chirag Shah*)

UNIT-II

Data Science Tools and Techniques: Introduction: Data Analysis and Data Analytics, Descriptive Analysis, Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics, Exploratory Analysis, Mechanistic Analysis.

Statistics: Understanding attributes and their types, Types of attributes, Discrete and continuous attributes, measuring central tendency: Mean, Mode, Median, measuring dispersion, Skewness and kurtosis, understanding relationships using covariance and correlation coefficients.

Descriptive Statistics: Understanding statistics, distribution functions uniform distribution, normal distribution, exponential distribution, binomial distribution. Cumulative distribution function, descriptive statistics.

UNIT-III

Python Libraries for Data Science: Numpy and Pandas: Arithmetic with Numpy Arrays, Pseudorandom Number Generators, Universal Functions, Array-oriented programming with arrays, File input/output with arrays, Linear Algebra, Introduction to Pandas data structures, DataFrame, Indexing, Sorting and Ranking, Summarization and computing descriptive Statistics.

Data Loading, Storage, and File Formats: reading and writing data in text formats, Binary Data Format, Interacting with Web APIs and Databases.

UNIT-IV

The Fundamentals of Exploratory Data Analysis: Significance of EDA, Comparison of EDA with Classical and Bayesian Analysis, Getting Started with EDA, Visual Aids for EDA, Case Study: EDA with Personal Email.

Data Transformation: Transformation Techniques - data deduplication, Replacing Values, Handling Missing Data, Outlier Detection and Filtering, Renaming Axis Indexes, Outlier detection and filtering, Benefits of Data Transformation.

Correlation: Introduction, types of analysis: Univariate, Bivariate, and Multivariate analysis, Multivariate Analysis using Titanic Dataset, Simpson's Paradox.



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UNIT-V

Hypothesis Testing and Regression: Hypothesis Testing, understanding Regression, Model Development and Evaluation, Types of Machine Learning: Understanding Supervised Learning, Unsupervised Learning, Reinforcement Learning, Unified Machine Learning Workflow.

Suggested Reading:

1. Shah, Chirag. *A hands-on introduction to data science*. Cambridge University Press, 2020.
2. Mukhiya, Suresh Kumar, and Usman Ahmed. *Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data*. Packt Publishing Ltd, 2020.
3. Wes, McKinney. *Python for data analysis*. O'Reilly Media, Inc., 2012.



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DATA STRUCTURES LABORATORY		
L:T:P (Hrs./week):0:0:2	SEE Marks : 60	Course Code : 25PC252CS
Credits : 1	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
	On completion of the course, the students will be able to
1. To develop skills to design and analyse simple linear and nonlinear data structures.	CO1. Implement linear data structures such as arrays, stacks, queues, and their variations to perform basic operations like insertion, deletion, and traversal.
2. To gain programming skills to implement sorting and searching algorithms	CO2. Apply linked lists (singly, doubly, and circular) for dynamic memory management and use them to implement linear data structures such as stacks and queues.
3. To Strengthen the ability to identify and apply the suitable data structures for the given real world problem	CO3. Use standard searching (linear and binary) and sorting techniques (selection, insertion, merge, quick, heap) to process and organize data efficiently.
4. To Gain knowledge in practical applications of data structures	CO4. Construct tree structures such as binary trees, binary search trees, and AVL trees, and apply recursive traversal techniques.
	CO5. Apply graph traversal (DFS and BFS), hashing techniques, and minimum spanning tree algorithms (Prim's and Kruskal's) for solving computing problems.

CO-PO and CO-PSO mapping-For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	-	-	-	-	1	-	1	2	2
CO2	3	2	2	2	-	-	-	-	1	-	3	3	2
CO3	3	3	3		-	-	-	-	1	-	2	3	3
CO4	3	3	2	2	1	-	-	-	1	-	2	3	2
CO5	3	3	3	3	1	2	-	-	2	-	2	2	3



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List of Experiments:

1. Write a program to represent arrays for the following:
 - a. To check whether the given matrix is sparse or not and display triplet representation.
 - b. To add two given polynomials.
2. Write a program to apply arrays to perform operations on the following linear data structures:
 - a. Stacks
 - b. Queues
 - c. Circular Queue
3. Write a program to implement following stack applications:
 - a. String Reversal.
 - b. Infix to Postfix Conversion.
 - c. Postfix Expression Evaluation.
 - d. Balanced Parenthesis
4. Write a program to implement the operations of Singly Linked List
5. Write a program to implement the operations of Doubly Linked List.
6. Write a program to implement the operations of Circular Linked List.
7. Write a program to apply linked list to perform operations on the following data structures:
 - a. Stacks
 - b. Queues
8. Write a program to search for an element given in an array using following search techniques:
 - a. Linear search
 - b. Binary search
9. Write a program to build a hash table using linear probing and search for a given element
10. Write a program to construct a Binary Tree and implement display in-order, pre-order and post-order traversal.
11. Write a program to construct a Binary Search Tree and implement insertion, deletion and search operations on it.
12. Write a program to construct a AVL tree and implement insertion, deletion and search operations on it.
13. Write a program to connect a graph and traverse the graph using DFS and BFS.
14. Write a program to design a minimum spanning tree from a given graph using Prims and Kruskal's Algorithm.
15. Write a program to sort given set of elements using following sorting techniques:
 - a. Selection sort
 - b. Insertion sort
 - c. Merge sort
 - d. Quick sort
 - e. Heap sort



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OBJECT ORIENTED PROGRAMMING USING JAVA LABORATORY		
L:T:P(Hrs./Week) 0:0:2	SEE Marks : 60	Course Code : 25PC253CS
Credits : 1	CIE Marks : 40	Duration of the SEE : 03 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
1. Develop Java programs using core object-oriented principles.	CO1. Apply object-oriented programming concepts such as classes, inheritance, polymorphism, abstract classes, and interfaces in Java programs.
2. Handle exceptions and implement basic multithreaded applications.	CO2. Develop programs using exception handling and multithreading with proper synchronization mechanisms.
3. Perform file operations including reading, writing, and serialization.	CO3. Perform file handling operations using Java I/O streams, including serialization and deserialization.
4. Use collections effectively for data storage and manipulation.	CO4. Utilize Java Collection Framework components (List, Set, Map) and implement object comparison techniques.
5. Apply advanced Java features for efficient problem-solving.	CO5. Apply modern Java features such as lambda expressions, Stream API, and regular expressions for efficient data processing.

CO-PO and CO-PSO mapping- For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	1	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	-	-	-	-	-	-	2	3	2
CO3	2	2	3	1	-	-	-	-	-	-	1	2	2
CO4	2	3	3	2	-	-	-	-	-	-	2	1	3
CO5	2	2	3	2	1	-	-	-	1	-	2	2	3

List of Experiments:

1. Write a Java program to illustrate Command Line Arguments.
2. Write a Java program to illustrate java.util.Scanner class for input.
3. Write a Java program to illustrate the concept of classes with methods (Box class).
4. Write a Java program to illustrate the concept of constructor Overloading (Box class).



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5. Write a Java program to illustrate the concept of method Overloading (Test class).
6. Write a Java Program that reads a line of integers, and then displays each integer, and the sum of all the integers Use java.util.StringTokenizer class
7. Write a Java program to illustrate the concept of Single level and Multi level Inheritance.
8. Write a Java program to illustrate the concept of Method Overriding (Figure, Triangle, Rectangle class). (demonstrate Runtime polymorphism – Dynamic method dispatch).
9. Write a Java program to illustrate the concept of Abstract Classes (Method Overriding).
10. Write a Java program to demonstrate the Interfaces.
11. Write a Java Program to implement Lambda Functions.
12. Write a Java Program to implement Regular Expressions.
13. Write a Java program to demonstrate checked and unchecked Exceptions.
14. Write a Java Program to demonstrate user defined Exceptions.
15. Write a Java program to illustrate collection classes like Array List, Linked List, using Iterator interface and List Iterator interface.
16. Write a Java program to illustrate the concept of Hashmap (key-value).
17. Write a Java Program to implement Stream API.
18. Write a Java program to illustrate the concept of threading using Thread Class and runnable Interface.
19. Write a Java program to illustrate the concept of Thread synchronization.
20. Write a Java program that reads a file name from the user, and then displays information about whether the file exists, whether the file is readable, whether the file is writable, the type of file and the length of the file in bytes.
21. Write a Java program to illustrate the concept of I/O Streams (FileInputStream, FileReader, FileOutputStream, FileWriter).
22. A program to demonstrate the usage of Filter Stream (DataInputStream and DataOutputStream) and Buffered I/O streams.
23. Write a Java program to implement the Serialization / De-serialization concept.
24. Write a Java program to illustrate CRUD Operations on a database using JDBC.
25. Write a Java program to illustrate PreparedStatement with ResultSet.



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DATA SCIENCE LABORATORY		
L:T:P (Hrs./week):0:0:2	SEE Marks : 60	Course Code : 25PC251DS
Credits : 1	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course,the students will be able to
1. Develop proficiency in Python programming and utilize fundamental programming constructs, data structures, file handling, and exception handling. 2. Apply Python-based data science libraries such as NumPy and Pandas for data manipulation, preprocessing, transformation, and statistical analysis. 3. Perform exploratory data analysis, data visualization, and statistical interpretation using real-world datasets to identify patterns, trends, and relationships. 4. Implement data preprocessing techniques, including handling missing values, outlier detection, feature transformation, and normalization for preparing datasets for analysis. 5. Develop and evaluate supervised and unsupervised machine learning models using appropriate algorithms and performance measures for solving real-world data-driven problems.	CO1: Develop Python programs using essential programming constructs, file handling, and exception handling techniques for data science applications. CO2: Apply NumPy and Pandas libraries for data manipulation, preprocessing, transformation, and statistical analysis of structured datasets. CO3: Perform exploratory data analysis and visualization using appropriate Python libraries to extract meaningful insight from datasets. CO4: Apply statistical techniques and data preprocessing methods and feature transformation for effective data analysis. CO5: Develop and evaluate supervised and unsupervised machine learning models using appropriate algorithms and performance metrics to derive data-driven solutions.

CO-PO and CO-PSO mapping- For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	2	-	-	-	-	1	2	2	2
CO2	3	3	3	3	2	-	-	-	1	1	2	2	2
CO3	3	2	3	3	3	-	-	-	1	1	3	2	3
CO4	3	3	3	3	2	-	-	-	1	1	2	3	3
CO5	3	3	3	3	3	-	-	-	1	1	3	3	3



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List of Experiments:

1. Write Python programs to demonstrate the use of variables, data types, operators, control structures, functions, strings, lists, tuples, dictionaries, sets, file handling, and exception handling.
2. Develop Python programs using **NumPy** to perform array creation, indexing, slicing, reshaping, broadcasting, vectorized arithmetic operations, random number generation, matrix operations, and basic linear algebra computations.
3. Develop Python programs using **Pandas** to create Series and DataFrames, perform indexing, filtering, sorting, grouping, aggregation, merging, concatenation, and descriptive statistical analysis on the **Students Performance Dataset**.
4. Load the **Titanic Dataset (Kaggle)** from CSV, Excel, JSON, and SQLite database formats using Pandas, perform data import/export operations.
5. Perform data cleaning and preprocessing on the **Titanic Dataset (Kaggle)** by handling missing values, removing duplicate records, encoding categorical attributes, normalizing numerical features, and transforming the dataset for analysis.
6. Compute descriptive statistical measures including mean, median, mode, variance, standard deviation, skewness, kurtosis, covariance, and correlation for the **Wine Quality Dataset (UCI/Kaggle)** using Python.
7. Generate line plots, bar charts, histograms, scatter plots, box plots, violin plots, heat maps, and pair plots for the **Iris Dataset** using Matplotlib and Seaborn, and interpret the visualizations.
8. Perform Exploratory Data Analysis (EDA) on the **Titanic Dataset (Kaggle)** by generating summary statistics, identifying missing values and outliers, analyzing feature distributions, and visualizing relationships among variables.
9. Perform univariate, bivariate, and multivariate analysis on the **Heart Disease Dataset (Kaggle)** by computing covariance, correlation coefficients, correlation matrices, and heat maps, and interpret the relationships among features.
10. Perform time series analysis on the **Individual Household Electric Power Consumption Dataset (UCI Machine Learning Repository)** by preprocessing timestamps, analyzing trends and seasonality, computing moving averages, rolling statistics, and visualizing temporal patterns.
11. Identify and handle missing values and detect outliers in the **House Prices Dataset (Kaggle)** using mean, median, mode, interpolation, Interquartile Range (IQR), and Z-score techniques.
12. Develop supervised learning models using **Linear Regression** and **Decision Tree Classification** on the **Diabetes Dataset (Scikit-learn)** and evaluate the models using appropriate performance metrics.
13. Develop unsupervised learning models using **K-Means Clustering**, **Hierarchical Clustering**, and **Principal Component Analysis (PCA)** on the **Mall Customer Segmentation Dataset (Kaggle)** and visualize the resulting clusters.

Suggested Reading:

1. Mukhiya, Suresh Kumar, and Usman Ahmed. *Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data*. Packt Publishing Ltd, 2020.
2. Wes, McKinney. *Python for data analysis*. O'Reilly Media, Inc., 2012.



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SKILL DEVELOPMENT COURSE: IoT		
L:T:P (Hrs./week):0:0:2	SEE Marks : 60	Course Code : 25ES254EC
Credits : 1	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
- Understand the fundamentals of embedded IoT systems by interfacing sensors, actuators, and peripheral devices using ESP32/Arduino/Raspberry Pi. - Develop embedded programs to acquire, process, and display sensor data using appropriate programming techniques and hardware interfaces. - Implement wireless communication protocols and cloud platforms for remote monitoring and control of IoT devices. - Design IoT-based applications by integrating hardware, networking, cloud services, and mobile/web interfaces to solve real-world engineering problems. - Develop teamwork, problem-solving, and project implementation skills through the design and realization of an end-to-end IoT system.	CO1: Interface and program digital input/output devices, sensors, actuators, and display modules using ESP32/Arduino/Raspberry Pi. CO2: Acquire, process, and display sensor data using embedded programming and hardware interfacing techniques. CO3: Develop wireless IoT applications using Bluetooth and Wi-Fi for remote monitoring and control. CO4: Implement cloud-based IoT applications for sensor data acquisition, visualization, and remote device management. CO5: Design and demonstrate an end-to-end IoT application by integrating embedded hardware, communication, cloud, and user interfaces.

CO-PO and CO-PSO mapping- For CSE(DS)													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	3	-	-	-	1	-	2	2	2
CO2	3	3	2	2	3	-	-	-	1	-	2	2	1
CO3	3	2	3	2	3	-	1	-	1	1	2	3	2
CO4	3	3	3	3	3	-	1	-	1	1	2	3	3
CO5	3	3	3	3	3	2	2	1	3	2	3	3	2



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List of Experiments

1. Interface an LED with ESP32/Arduino/Raspberry Pi and write a program to blink the LED using digital output.
2. Interface a Push Button with ESP32/Arduino/Raspberry Pi and write a program to control an LED based on the button state.
3. IR/LDR Sensor Interfacing: Interface an IR or LDR sensor with ESP32/Arduino/Raspberry Pi and write a program to detect an object/light intensity and control an LED accordingly.
4. Interface a 16×2 LCD (I2C) with ESP32/Arduino/Raspberry Pi and write a program to display text and sensor readings.
5. Interface a DHT11 Temperature and Humidity Sensor with ESP32/Arduino/Raspberry Pi and display the measured values on the Serial Monitor/LCD.
6. Interface a Relay Module with ESP32/Arduino/Raspberry Pi and write a program to control a DC motor or AC load using a push button or sensor input.
7. Develop a Bluetooth Low Energy (BLE) or Bluetooth Serial application using ESP32 to control an LED or relay from a smartphone.
8. Interface an HC-SR04 Ultrasonic Sensor with ESP32/Arduino/Raspberry Pi and measure the distance to an object. Display the measured distance on the Serial Monitor/LCD.
9. Acquire temperature and humidity data from the DHT11 sensor using ESP32 and upload the sensor readings to the ThingSpeak Cloud. Visualize and analyze the data using ThingSpeak charts.
10. Develop a mobile-based IoT application using ESP32 to remotely monitor temperature and humidity and control an LED or relay through the Blynk IoT mobile dashboard.
11. Develop an embedded web server on ESP32 to monitor sensor data and control an LED/relay through a web browser over a Wi-Fi network.

Mini Project:

Students shall implement a complete domain-specific IoT application (Smart Home, Smart Agriculture, Smart Energy Monitoring, Smart Environment Monitoring, Smart Healthcare, etc.) using ESP32/Arduino/Raspberry Pi, integrating sensors, actuators, wireless communication, and cloud/mobile monitoring.

Suggested Reading:

1. Michael Margolis – Arduino Cookbook
2. Simon Monk – Programming Arduino: Getting Started with Sketches
3. John Boxall – Arduino Workshop
4. Neil Cameron – ESP32 Essentials
5. Simon Monk – Programming the Raspberry Pi: Getting Started with Python

Online Resources:

6. ThingSpeak Documentation: <https://www.mathworks.com/help/thingspeak/>
7. Blynk IoT Documentation: <https://docs.blynk.io/>
8. Arduino Documentation: <https://docs.arduino.cc/>
9. Arduino-ESP32 Documentation: <https://docs.espressif.com/projects/arduino-esp32/>
10. ESP-IDF Documentation: <https://docs.espressif.com/projects/esp-idf/>
11. Raspberry Pi Documentation: <https://www.raspberrypi.com/documentation/>



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SCHEME AND SYLLABUS FOR B.E. IV-SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	D/P	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	25PC221AI	Artificial Intelligence	3	-	-	3	40	60	3	3
2	25PC222DS	Data Analytics and Visualization	3	-	-	3	40	60	3	3
3	25PC223AI	Full Stack Development	3	-	-	3	40	60	3	3
4	25PC224DS	Database Systems	3	-	-	3	40	60	3	3
5	25PC225CS	Computer Networks and Operating Systems	3	1	-	3	40	60	3	4
Practical / Laboratory Courses										
6	25PC255DS	Data Analytics and Visualization Lab	-	-	2	2	40	60	3	1
7	25PC256DS	Database Systems Lab	-	-	2	2	40	60	3	1
8	25PC257DS	Computer Networks and Operating Systems Lab	-	-	2	2	40	60	3	1
9	25PW258DS	Mini Project	-	-	2	6	40	60	3	3
Total			15	1	8	27	360	540	27	22



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ARTIFICIAL INTELLIGENCE		
L:T:P (Hrs./week):3:0:0	SEE Marks : 60	Course Code : 25PC221AI
Credits :	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
1. To introduce the fundamental concepts, intelligent agents, and problem-solving techniques used in Artificial Intelligence. 2. To develop the ability to formulate and solve problems using classical search algorithms and adversarial search techniques. 3. To provide knowledge of logic programming and knowledge representation methods for intelligent reasoning. 4. To familiarize students with reasoning under uncertainty and the fundamental concepts of Machine Learning. 5. To introduce expert systems and connectionist approaches as important paradigms of modern Artificial Intelligence	CO1. Understand the fundamental concepts of Artificial Intelligence, formulate classical state-space problems and analyze the behavior of intelligent agents in different environments CO2. Apply search algorithms uninformed, informed and adversarial search techniques for problem solving tasks efficiently. CO3. Represent knowledge and perform logical reasoning using propositional logic, predicate logic, logic programming, semantic networks, and frames. CO4. Analyze methods for reasoning under uncertainty using probabilistic models and explain machine learning techniques. CO5. Describe expert systems, applications and compare connectionist and symbolic AI approaches.

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2	–	–	1	–	–	2	3	2
CO2	3	3	3	2	2	–	–	–	–	–	2	3	2
CO3	3	3	3	2	2	–	–	1	–	–	2	3	2
CO4	3	3	3	3	2	–	–	2	–	–	2	3	3
CO5	3	3	2	2	2	–	–	1	–	–	3	3	3



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Unit-I

Introduction to Artificial Intelligence

Introduction, Brief History, Intelligent Systems, foundations of AI, Sub-Areas of AI. AI Applications in Healthcare, Finance, Autonomous Systems, Generative AI.

State Space Representation, Problem Formulation, Classical State Space Problems.

Agents

Agents and Environments, the concept of Rationality, Performance measures, the nature of Environments, The Structure of Agents, Simple Reflex Agents, Model-Based Agents, Goal-Based Agents, Utility-Based Agents, Learning Agents.

Unit-II

Problem Solving

Problem Solving by Searching, Uninformed Search, Informed Search, Heuristic Functions, Greedy Best-First Search, A* Search, Local Search Algorithms, Hill Climbing, Simulated Annealing.

Adversarial Search

Game Trees, Minimax Algorithm, Alpha-Beta Pruning, Iterative Deepening.

Unit-III

Logic Concepts and Logic Programming

Introduction, Propositional Calculus, Propositional Logic, Natural Deduction System, Axiomatic System, Predicate Logic, Logic Programming.

Knowledge Representation

Introduction, Approaches to Knowledge Representation, Knowledge Representation using Semantic Network, Knowledge Representation using Frames.

Unit-IV

Uncertainty Measures

Bayesian Belief Networks, Certainty Factor Theory, Dempster-Shafer Theory

Introduction to Machine Learning: Machine Learning Systems, Supervised and Unsupervised Learning

Unit-V

Expert System

Introduction, Phases in Building Expert Systems, Expert System Architecture, Expert System versus Traditional Systems, Rule-Based Expert Systems, Truth Maintenance Systems, Applications of Expert System, List of Shells and Tools, Symbolic AI Vs Connectionist AI.

Suggested Reading:

1. Artificial Intelligence-A Modern Approach, Second Edition by Stuart Russell, Peter Norvig.
2. Artificial Intelligence, Saroj Kaushik, Cengage Learning.
3. Artificial Intelligence, Third Edition by Elaine Rich, Kevin Knight, Shivashankar B Nair, Tata-McGraw Hill.



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DATA ANALYTICS AND VISUALIZATION		
L:T:P (Hrs./week): 3:1:0	SEE Marks: 60	Course Code: 25PC222DS
Credits: 4	CIE Marks: 40	Duration of SEE: 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
- Understand the fundamentals of data analytics, R programming, and the R programming environment for performing data-driven analysis. - Acquire practical skills in data acquisition, preparation, cleaning, transformation, integration, and management using R. - Apply exploratory data analysis and develop effective data visualizations using base R graphics and ggplot2 to gain meaningful insights from data. - Perform statistical data analysis using appropriate statistical methods and regression models for analyzing real-world datasets. - Apply advanced analytical techniques including ANOVA, time series analysis, clustering, classification, and dimensionality reduction to solve practical data analytics problems.	CO1. Explain the concepts of data analytics and R programming and demonstrate proficiency in using R language. CO2. Prepare, clean, transform, integrate, and manage datasets by applying appropriate data preprocessing techniques using R. CO3. Perform exploratory data analysis and create appropriate statistical and graphical visualizations using base R and ggplot2 for effective interpretation of data. CO4. Apply statistical methods, hypothesis testing, correlation analysis, and regression techniques to analyze datasets and interpret analytical results. CO5. Implement advanced analytical techniques such as ANOVA, PCA, time series analysis, clustering, and classification to analyze real-world data using R.

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	1	3	-	-	-	-	-	2	1	2
CO2	3	3	2	2	3	-	-	-	-	-	2	2	3
CO3	3	3	3	3	3	-	-	-	3	-	2	2	3
CO4	3	3	3	3	3	-	-	-	2	1	2	3	3
CO5	3	3	3	3	3	-	-	-	2	1	2	3	3



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Unit I

Introduction to Data Analytics and R Programming: Introduction to Data Analytics and Data-Driven Decision Making, Data Analytics Process and Applications, Overview of Data Science and R Programming, Installation and Configuration of R and RStudio, R Programming Environment and Workspace, Packages and Package Management, Batch Processing and Script Execution, R Data Objects, Variables and Data Types, Vectors, Matrices, Arrays, Lists, Factors and Data Frames, Working with Built-in Datasets, Importing Data from CSV, Excel, XML, JSON, Web Sources and Databases, Annotating Datasets, Managing Data Objects and Workspace.

Unit II

Data Preparation and Data Management: Challenges in Analytical Data Processing, Data Quality Assessment, Data Acquisition and Loading from Files, Excel, XML, JSON, Web Sources and Databases, Working with Data Frames, Data Cleaning and Preparation, Handling Missing Values, Treating Outliers, Handling Variables, Type Conversion, Mathematical, Statistical, Probability and Character Functions, Data Transformation, Data Normalization, Centering and Scaling, Sorting, Filtering and Sampling Data, Data Selection and Sub-setting, Merging and Combining Datasets, Data Aggregation, Data Reshaping and Restructuring, Applying Functions to Data Frames.

Unit III

Exploratory Data Analysis and Data Visualization: Exploratory Data Analysis Process, Summary Statistics, Frequency and Contingency Tables, Measures of Central Tendency and Dispersion, Correlation Analysis, Graphical Parameters and Customization, Titles, Axes, Legends and Annotations, Combining Multiple Graphs, Bar Charts, Pie Charts, Histograms, Density Plots, Box Plots, Dot Plots, Scatter Plots, Scatter Plot Matrices, Line Charts, Correlation Plots, Mosaic Plots, Time Series Visualization, Interactive and Advanced Data Visualization using ggplot2, Univariate, Bivariate, and Multivariate Graphs.

Unit IV

Statistical Data Analysis: Descriptive Statistics, Tests of Independence, Measures of Association, Correlation Analysis, t-Tests, Non-Parametric Tests, Linear Regression, Simple Linear Regression, Multiple Linear Regression, Regression Diagnostics, Outliers and Influential Observations, Corrective Measures, Regression Model Selection, Cross Validation, Logistic Regression.

Unit V

Advanced Data Analytics: Analysis of Variance (ANOVA), Power Analysis, Resampling Statistics, Bootstrapping, Principal Component Analysis, Exploratory Factor Analysis, Time Series Analysis, Cluster Analysis, Classification Techniques, Advanced Methods for Missing Data.



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Suggested Reading:

1. Kabacoff, Robert I. *R in action: data analysis and graphics with R and Tidyverse*. Simon and Schuster, 2022.
2. Mount, John, and Nina Zumel. *Practical data science with R*. Simon and Schuster, 2019.
3. Baesens, Bart. *Analytics in a big data world: The essential guide to data science and its applications*. John Wiley & Sons, 2014.
4. Acharya, Seema. *Data Analytics using R*. McGraw-Hill Education, 2018.

Online Resources:

5. Modern Data Visualization with R : Robert Kabacoff, online version of “Modern Data Visualization with R”, published by CRC Press.



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FULL STACK DEVELOPMENT		
L:T:P (Hrs./week):3:0:0	SEE Marks : 60	Course Code : 25PC223AI
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
1. Understand the architecture of full-stack systems for AI applications.	CO1. Explain the architecture, components, and workflow of AI-based full-stack systems.
2. Develop backend services and APIs integrating machine-learning models.	CO2. Develop responsive front-end applications, backend REST APIs using modern web technologies, and Python frameworks.
3. Design responsive and interactive front-end interfaces.	CO3. Integrate databases and machine learning models into full-stack applications using appropriate data processing techniques.
4. Manage databases and data pipelines for AI systems.	CO4. Design and implement AI-enabled full-stack applications with authentication, data visualization, and frontend-backend integration.
5. Deploy AI-enabled web applications using modern tools and platforms	CO5. Deploy AI-enabled web applications using cloud and containerization technologies while applying version control and collaborative development practices.

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	–	2	–	–	1	–	–	1	2	2
CO2	3	3	3	2	3	–	–	–	–	–	2	2	3
CO3	3	3	3	2	3	–	–	–	–	–	2	3	3
CO4	3	3	3	3	3	–	–	2	–	–	2	3	3
CO5	3	3	3	3	3	–	–	2	1	1	3	3	3



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Unit-I

Introduction to Full Stack Development and Front-End Technologies

Overview of Full Stack Development, Architecture of AI-Based Full Stack Systems, Frontend, Backend, Database and AI Layer, Case Studies of AI Web Applications, HTML5 Fundamentals, CSS3 Styling, JavaScript Basics, Responsive Web Design Principles, Introduction to ReactJS, Components, Props, State, Hooks, Building Interactive User Interfaces.

Unit-II

Backend Development and Database Systems

Introduction to Flask Framework, Introduction to FastAPI Framework, REST API Design Principles, API Development using JSON, SQL using SQLite, NoSQL using MongoDB, Backend-Database Integration, CRUD Operations, Data Storage and Retrieval Techniques.

Unit-III

Machine Learning Integration and Data Processing

Machine Learning Workflow, Data Preprocessing Techniques, Data Validation, Data Processing Pipelines, Pipeline Design and Implementation, Model Serialization using Pickle and Joblib, Integration of Machine Learning Models with Backend Services, Prediction API Development.

Unit-IV

Full Stack Integration, Visualization and Deployment

Frontend-Backend Communication using Fetch API and Axios, Dynamic Data Rendering, Data Visualization using Plotly and Chart.js, Dashboard Development, Authentication Mechanisms using JWT and OAuth, Cloud Deployment Basics, Deployment using Streamlit, Render and Hugging Face Spaces, Docker Fundamentals, CI/CD Concepts, API Testing and Optimization.

Unit-V

AI-Based Full Stack Application Development

Development of AI-Based Full Stack Web Applications, End-to-End System Integration, Git and GitHub for Version Control, Project Documentation using README, Peer Code Review, Testing and Deployment of AI Applications, Mini Project Development, Project Demonstration and Presentation.

Suggested Reading:

1. M. Grinberg, Flask Web Development: Developing Web Applications with Python, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2018. ISBN: 978-1491991732.
2. A. Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022. ISBN: 978-1098125967.
3. A. Géron, Hands-On Machine Learning with Scikit-Learn and PyTorch. Sebastopol, CA, USA: O'Reilly Media, 2025. ISBN: 979-8341607989.



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4. S. Chen et al., Deep Learning and Machine Learning: From Theory to Practice. 2024. [Online]. Available: <https://arxiv.org/abs/2410.19849>
5. K. Chen et al., Deep Learning and Machine Learning: Design Patterns for Big Data Analytics. 2024. [Online]. Available: <https://arxiv.org/abs/2410.03795>
6. M. Makai, Full Stack Python. Self-published, 2016. [Online]. Available:



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DATABASE SYSTEMS		
L:T:P (Hrs./week):3:0:0	SEE Marks : 60	Course Code : 25PC224DS
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course,the students will be able to
- Understand the fundamentals, architecture, and components of database management systems. - Apply SQL to define, manipulate, and retrieve data from relational databases. - Design relational databases using ER modelling and relational algebra concepts. - Apply functional dependencies and normalization techniques to design efficient database schemas. - Understand indexing, transaction processing, and concurrency control mechanisms for efficient database management.	CO1. Explain the concepts, architecture, components, applications, and advantages of database systems over file processing systems. CO2. Design relational databases and apply SQL (DDL, DML, constraints, joins, views, triggers, and transactions) for database management. CO3. Apply ER modelling, relational algebra, and normalization techniques to design efficient relational databases. CO4. Analyse functional dependencies, normalization, indexing, and database design techniques to ensure data integrity and performance CO5. Evaluate transaction processing, concurrency control, indexing, and recovery mechanisms for reliable and secure database systems

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	1	-	-	-	-	-	1	2	1
CO2	3	2	3	1	1	-	-	-	-	-	1	2	3
CO3	3	3	3	2	1	-	-	-	-	-	2	3	2
CO4	3	3	2	2	-	1	-	-	-	-	2	3	3
CO5	2	3	2	2	1	-	-	-	-	-	2	2	3



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UNIT – I

Introduction to Database Systems

Database-System Applications, Purpose of Database Systems, Characteristics and Advantages of DBMS over File Processing Systems, View of Data, Data Abstraction (Physical, Logical, and View Levels), Data Independence, Database Languages (DDL, DML, DCL, and TCL), Database Design, Database Engine, Database and Application Architecture (Two-Tier and Three-Tier), Database Users and Administrator (DBA), History and Evolution of Database Systems.

UNIT – II

SQL and Advanced SQL

SQL: Introduction to SQL, Overview of SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of Database, Join Expressions, Views, Transactions, Integrity Constraints, and Triggers.

UNIT – III

Data Modeling and Relational Databases

Entity–Relationship Model: Entity Sets, Attributes, Keys, Relationship Sets, Mapping Cardinalities, Participation Constraints, Weak Entity Sets, Extended ER Features, and Reduction of ER Diagrams to Relational Schemas. Relational Algebra: Selection, Projection, Union, Set Difference, Cartesian Product, Rename, Join, Division, Extended Relational Algebra Operations, and Relational Algebra Queries.

UNIT – IV

Database Design and Normalization

Functional Dependencies, Armstrong's Axioms, Closure of Functional Dependencies, Decomposition, Lossless Join and Dependency Preservation, Database Design Process, Normalization, Anomalies, First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce–Codd Normal Form (BCNF), Fourth Normal Form (4NF), Fifth Normal Form (5NF), and Denormalization.

UNIT – V

Indexing and Transaction Processing

Indexing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B-Tree Index Files. Transaction Processing and Concurrency Control: Transaction Concepts, ACID Properties, Conflict Serializability, Transaction States.

Concurrency Control: Lock-Based Protocols, Multiple Granularity, Timestamp-Based Protocols.



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Suggested Reading:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, Database System Concepts, McGraw-Hill International Edition, 6th Edition, 2010
2. Raghu Ramakrishnan and Johannes Gehrke, —Database Management Systems, Tata McGraw-Hill, New Delhi, 2008.
3. RamezElmasri and Shamkant B Navathe, —Fundamentals of Database Systems, Addison Wesley, USA, 2010.



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COMPUTER NETWORKS AND OPERATING SYSTEMS		
L:T:P (Hrs./week):3:0:0	SEE Marks : 60	Course Code : 25PC225DS
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course,the students will be able to
- To provide a fundamental understanding of Operating System concepts, process management, memory management, and file systems. - To familiarize students with process synchronization, CPU scheduling, and memory management techniques used in modern operating systems. - To introduce the fundamentals of computer networks, layered architectures, and data communication concepts. - To develop an understanding of network layer, transport layer, and application layer protocols used in Internet communication. - To enable students to analyze the operation of Operating Systems and Computer Networks for solving real-world computing and communication problems.	CO1. Explain the concepts of Operating Systems, process management, CPU scheduling, synchronization, and deadlocks. CO2. Analyze main memory, file management techniques and secondary storage management in operating systems. CO3. Describe the Data Communication Components, architecture of computer networks, reference models network layer, internetworking and routing algorithms CO4. Illustrate the functions, transport layer, and Internet protocols for reliable data communication. CO5. Explain the working of application layer protocols and apply Operating System and Computer Network concepts to analyze basic computing and networking problems

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	-	-	-	-	-	-	1	2	3
CO2	3	2	3	3	1	1	1	-	-	-	2	3	2
CO3	3	3	3	1	1	-	-	-	-	-	2	2	2
CO4	3	3	2	1	-	1	-	-	-	-	2	2	3
CO5	3	3	3	3	1	-	-	-	-	-	2	3	2



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Unit-I

Introduction: What OS Do? Computing Environments, Operating System Services, User OS Interface, System Calls, Types of System Calls, System Programs, Operating-System Structure-Layered, Monolithic, Microkernel, Virtual Machines (only concept).

Processes: Process Concept, Process Scheduling, Thread: Overview, Multithreading Models.

CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms - FCFS, SJF, Priority, Round Robin.

Process Synchronization: Inter-Process Communication, Critical Section Problem, Peterson's Solution, Race Condition, Mutual Exclusion, Semaphores, and Classical Synchronization.

Problems: Producer-Consumer, Readers-Writers, Dining Philosopher.

Deadlocks: System Model, Deadlock Characterization, Methods for Handling, Deadlock Prevention, Deadlock Avoidance – Banker's Algorithm, Deadlock Detection and Recovery.

Unit-II

Memory Management: Basic Concept, Contiguous Memory Allocation, Paging: Concept, Structure of Page Table. Virtual Memory: Concept, Demand Paging, Page Replacement Algorithms- LRU, Optimal, Thrashing.

Storage Management: File Management: File Concept, Access Methods, File System Implementation.

Mass-Storage Structure: Disk Structure, Disk Management, Disk Scheduling Algorithms, RAID.

I/O Systems: I/O Hardware, Application I/O Interface. Transforming I/O Requests to Hardware Operations.

Unit-III

Data Communication Components: Representation of Data Communication, Flow of Network, Layered Architecture, OSI and TCP/IP Model.

Network Layer: Switching Techniques – Circuit and Packet. Logical Addressing: IPv4 and IPv6 Headers

Internetworking: Tunnelling Fragmentation, Congestion Control- Leaky and Token Bucket algorithms. Internet Control Protocols: ICMP, ARP, DHCP.

Routing Algorithms – Delivery, Forwarding, Unicast Routing Protocol, Gateway Protocols.

Unit-IV

Internetworking: Tunnelling Fragmentation, Congestion Control- Leaky and Token Bucket algorithms. Internet Control Protocols: ICMP, ARP, DHCP.

Routing Algorithms – Delivery, Forwarding, Unicast Routing Protocol, Gateway Protocols.

Unit-V

Transport Layer: Process to Process Communication, Elements of Transport Layer.

Internet Transport Protocols: UDP, TCP

Application Layer: Domain Name System, World Wide Web, HTTP.



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Suggested Reading:

1. Avi Silberchatz, Peter Galvin, Greg Gagne, Operating System concepts Essentials, 9th Edition, Wiley Asia Student Edition, 2017.
2. Andrew S. Tanenbaurn, Computer Networks Fourth Edition, Pearson Education.

References:

1. William Stallings, Operating Systems: Internals and Design Principles, 5th Edition, Prentice Hall of India, 2016.
2. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan McGrawHill.
3. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.



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DATA ANALYTICS AND VISUALIZATION LABORATORY		
L:T:P (Hrs./week): 0:0:2	SEE Marks: 60	Course Code: 25PC255DS
Credits: 1	CIE Marks: 40	Duration of SEE: 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
1. Develop proficiency in using R and RStudio for data analysis and programming. 2. Perform data acquisition, preparation, manipulation, and management using R. 3. Apply statistical analysis and develop analytical models using R for real-world datasets. 4. Create effective data visualizations using base R graphics and ggplot2 for data exploration and interpretation. 5. Integrate data preparation, analysis, visualization, and modeling techniques to solve practical data analytics problems.	CO1. Use R programming constructs, data structures, packages, and data import techniques to perform data analysis tasks. CO2. Prepare, clean, transform, manipulate, and manage datasets using appropriate preprocessing techniques in R. CO3. Perform statistical analysis and develop regression models to analyze and interpret real-world datasets. CO4. Create and customize statistical and analytical visualizations using base R graphics and ggplot2 for effective data exploration. CO5. Apply appropriate data analytics techniques to develop and interpret solutions for real-world problems using R.

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	3	-	-	-	-	-	2	1	2
CO2	2	2	2	2	3	-	-	-	-	-	2	2	3
CO3	3	3	3	3	3	-	-	-	3	-	2	2	3
CO4	3	3	3	3	3	-	-	-	2	1	2	3	3
CO5	3	3	3	3	3	-	-	-	2	1	2	3	3



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List of Experiments:

1. Installation and configuration of R and RStudio, R programming environment, workspace, packages, and execution of basic R programs.
2. Working with R data structures: vectors, matrices, arrays, lists, factors, data frames, and built-in datasets.
3. Importing data from CSV, Excel, XML, JSON, web sources, and databases; managing datasets and workspace.
4. Data cleaning and preparation: handling missing values, treating outliers, data transformation, type conversion, and variable manipulation.
5. Data manipulation in R: use sorting, filtering, sampling, merging, aggregation, reshaping, sub setting, and user-defined functions.
6. Exploratory Data Analysis (EDA) using summary statistics, frequency tables, contingency tables, measures of central tendency and dispersion, and correlation analysis.
7. Performing statistical analysis using descriptive statistics, tests of independence, t-tests, and non-parametric tests.
8. Developing simple and multiple linear regression models, and model interpretation.
9. Implementing logistic regression for binary classification and prediction.
10. Creating basic visualizations using bar charts, pie charts, histograms, density plots, box plots, dot plots, and line charts.
11. Creating advanced visualizations using scatter plots, scatter plot matrices, correlation plots, mosaic plots, and time series plots.
12. Data visualization and customization using ggplot2, including grouping, faceting, themes, labels, legends, and multiple plots. Save graphs via menus as well as codes.
13. Create Univariate, Bivariate, and Multivariate graphs using R datasets for both categorical and quantitative data types. Save graphs via menus as well as codes.
14. Performing Time Series Analysis, forecasting, and visualization using R.
15. Mini Project: End-to-end data analytics application involving data acquisition, preprocessing, exploratory data analysis, visualization, statistical analysis, predictive modeling, and interpretation using a real-world dataset chosen from R datasets.

Suggested Reading:

1. Kabacoff, Robert I. *R in action: data analysis and graphics with R and Tidyverse*. Simon and Schuster, 2022.
2. Mount, John, and Nina Zumel. *Practical data science with R*. Simon and Schuster, 2019.
3. Robert Kabacoff, *Modern Data Visualization with R*, online version, published by [CRC Press](#).



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DATABASE SYSTEMS LABORATORY		
L:T:P (Hrs./week):0:0:2	SEE Marks : 60	Course Code : 25PC256DS
Credits : 1	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course,the students will be able to
1. To develop skills in SQL for database definition, manipulation, and query processing. 2. To learn advanced database concepts such as joins, subqueries, integrity constraints, and views. 3. To gain practical knowledge of PL/SQL programming including procedures, functions, triggers, and exception handling 4. To understand transaction management, locking mechanisms, and real-time database applications through case studies 5. Get acquainted with GUI development tools and design	CO1. Apply DDL, DML, TCL, and DCL commands for database creation and management. CO2. Construct a few complex SQL queries. CO3. Design relational database tables with appropriate integrity constraints. CO4. Develop PL/SQL programs to demonstrate the basic construct of programming. CO5. Design case studies for practical database use cases such as student information, library systems, and payroll management.

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	1	-	-	-	-	-	1	2	3
CO2	3	2	2	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	2	-	-	-	-	-	-	1	3	3
CO4	3	2	3	2	-	-	-	-	1	-	2	2	3
CO5	3	3	3	3	-	1	-	2	2	2	2	2	3



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List of Programs:

1. Practice DDL Commands.
2. Practice DML Commands.
3. Practice Different Operators.
4. Practice Aggregate Functions and Sub Queries.
5. Practice Group by, Having and Order by Clauses.
6. Practice Various Types of Joins and Built in Functions.
7. Create tables with Complex Integrity Constrains.
8. Practice TCL and DCL Commands and Create Different Views
9. PL/SQL Programs on Control Structures, and Triggers.
10. PL/SQL Programs on Cursors and Exception Handling.
11. PL/SQL Programs on Functions, Procedures, Packages.
12. Create forms and generate reports for student information, library information etc.

Suggested Reading:

1. Nilesh Shah, Database System Using Oracle, PHI, 2007.
2. Rick F Vander Lans, Introduction to SQL, Fourth edition, Pearson Education, 2007.
3. Benjamin Rosenzweig, Elena Silvestrova, Oracle PL/SQL by Example, Third edition, Pearson Education, 2004.
4. Ivan Bayross, Sql Pl/SQL the Programming language of Oracle, 2003
5. Albert Lulushi, Oracle Forms Developer's Handbook, Pearson Education, 2006.



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COMPUTER NETWORKS & OPERATING SYSTEM LABORATORY		
L:T:P (Hrs./week):0:0:2	SEE Marks : 60	Course Code : 25PC257DS
Credits : 1	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course,the students will be able to
1. Explain network environment, utilities, client/server architecture in application development. 2. Demonstrate elementary socket system calls(TCP and UDP based sockets), routing protocols. 3. Demonstrate network simulators and network packet analyzer tools. 4. Illustrate the use of OS systems calls and IPC constructs. 5. Demonstrate simulation of processor, memory scheduling algorithms and classical synchronization problem solutions	CO1. Demonstrate the usage of basic network utility commands. CO2. Build Client-Server programs using TCP, and UDP sockets and implement Distance Vector Routing Algorithm. CO3. Model and analyze network topologies using modern open-source network simulation tools. CO4. Demonstrate thread creation and simultaneous execution within a Linux POSIX environment. CO5. Implement Inter-Process Communication mechanisms and simulate classical synchronization problem solutions in Linux environment.

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	2	1	1	-	1	1	-	1	3	2	2
CO3	2	2	2	3	2	-	-	-	-	-	3	3	2
CO4	3	4	4	3	2	-	-	-	-	-	2	2	3
CO5	3	3	3	1	1	-	1	1	-	-	2	3	3



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List of Programs

1. Execute basic network utility commands to analyze and troubleshoot network environments: ipconfig, ifconfig, netstat, ping, arp, telnet, ftp, finger, traceroute, whois.
2. Implement TCP and UDP clients that communicate with well-known services using their standard ports. (Ports;7, 13, 19, 37)
3. Develop concurrent and iterative server applications using connection-oriented (TCP) socket system calls.(Service: Daytime, Time, Echo server, String concatenation, Employee salary, Student Grade).
4. Develop concurrent and iterative server applications using connectionless (UDP) socket system calls.(Service: Daytime, Time, Echo server, String concatenation, Employee salary, Student Grade).
5. Simulate Routing Protocols (Shortest Path, Distance Vector Routing).
6. Analyze network packets using Wireshark.
7. Demonstrate device (router, switch) configuration, topologies and network simulation using open source network simulators (viz. Cisco Packet Tracer).
8. Demonstrate the use system calls in Linux:
9. i. Process Management: fork(), exec(), wait(), sleep(), exit(), getpid(), getppid().
10. ii. File Management[U1] : open(), read(), write(), seek(), close(), stat(), opendir(), readdir(), closedir().
11. Illustrate the use of IPC constructs in Linux environment:
12. i. pipes ii. shared memory iii. message queues iv. semaphore
13. Implement multithread communication using Pthread API.
14. Illustrate Producer Consumer Problem solution using semaphore.
15. Implement Dining philosopher's problem solution.
16. Simulate Processor Scheduling Algorithms: FCFS, SJF RoundRobin.
17. Simulate Bankers Algorithm for Dead Lock Avoidance.
18. Simulate Page Replacement Algorithms: FIFO, LRU, Optimal
19. Simulate Disk Scheduling algorithms: FCFS, SSTF, C-SCAN, C-LOOK.

Suggested Reading:

1. W. Richard Stevens, Unix Network Programming, Prentice Hall, Pearson Education,2009.
2. Douglas E. Comer, Handson Networking with Internet Technologies, Pearson Education

Online Resources:

3. <https://www.ibm.com/docs/en/i/7.1?topic=communications-socket-programming>
4. <https://www.wireshark.org/>
5. <https://www.netacad.com/courses/getting-started-cisco-packet-tracer?courseLang=en-US>



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MINI PROJECT		
L:T:P (Hrs./week):6:0:0	SEE Marks : 60	Course Code : 25PW258DS
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES On completion of the course, the students will be able to
1. To help students identify and understand real-world problems in their field.	CO1: Identify a relevant problem and formulate a clear problem statement with well-defined project objectives.
2. To encourage application of technical knowledge and skills learned in previous courses.	CO2: Apply technical and analytical skills to design and develop a solution.
3. To improve students' ability to work in teams and manage projects effectively.	CO3: Work effectively as a team to plan, implement, and manage the project.
4. To enhance communication skills through technical writing and presentations.	CO4: Communicate project ideas effectively through oral presentations and technical reports.
5. To promote awareness of current technologies, industry practices, and research trends.	CO5: Demonstrate awareness of industry standards and the effective use of modern tools and technologies in the chosen domain.

CO-PO and CO-PSO mapping													
CO/PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	2	1	-	-	1	1	3	3	3
CO2	3	3	3	3	2	2	3	-	1	1	3	3	3
CO3	3	3	3	2	2	-	2	3	3	3	2	1	1
CO4	3	3	3	2	3	-	2	2	2	3	2	1	1
CO5	3	3	3	3	3	2	1	-	1	1	3	2	3



MUFFAKHAM JAH COLLEGE OF ENGINEERING & TECHNOLOGY
(SULTAN-UL-ULOOM EDUCATION SOCIETY)
ACCREDITED BY NBA and NAAC WITH 'A+' GRADE
(An Autonomous Institution)
CSE(DATA SCIENCE) DEPARTMENT
SCHEME AND SYLLABUS FOR B.E. III - IV SEMESTER

Course Description

This course provides practical exposure to real-time project development through the design, implementation, and execution of software solutions. It enables students to apply theoretical knowledge, programming concepts, and problem-solving techniques in team to address real-world challenges using emerging technologies, modern tools, and industry practices. The course enhances project planning, teamwork, leadership, decision-making, technical skills, and employability.

Guidelines

The Mini Project shall be evaluated by **a minimum of two faculty members**. The sessional marks shall be awarded based on the students' performance in the following component:

- **Seminar Presentation I:** Evaluation of the project abstract, problem identification, and literature survey.
- **Project Progress Evaluation:** Assessment of problem definition, system design, implementation, testing, and execution of the proposed solution.
- **Seminar Presentation II:** Demonstration and technical explanation of the developed system.
- **Technical Report:** Evaluation of project documentation, clarity, structure, and technical content.

Responsibilities of the Mini Project Supervisor

The supervisor shall be responsible for overseeing the overall progress and successful completion of the mini-project. The responsibilities include:

1. Form student groups (maximum **3 students** per group).
2. Allot project topics and guides, approve the title, group and proposal.
3. Complete project allotment by the **4th week** of the semester.
4. Communicate guidelines issued by the monitoring committee.
5. Prepare and manage the seminar schedule from the **5th week** until the end of the semester.
6. Evaluating project progress, completion status, and student performance using prescribed assessment rubrics.
7. Coordinating seminar presentations, reviewing technical documentation, and providing suggestions for improvement wherever necessary.

Presentation Guidelines:

The presentation should include:

- Problem definition and specification
- Literature survey and research gaps
- Review existing solution techniques and compare it with proposed one.
- Project planning with activity (bar/Gantt) chart
- Technical report and oral presentation, Each group shall:
 - Submit a **one-page synopsis** before the seminar.
 - Deliver a **20-minute presentation** followed by a **10-minute discussion**.
 - Submit a **technical report** after the presentation.