



ST. JOSEPH'S
COLLEGE OF ENGINEERING
AND TECHNOLOGY,
- PALAI -
AUTONOMOUS

Choondacherry P.O., Pala, Kottayam - 686579
Kerala, India



S3 & S4 SYLLABUS
B. TECH.
COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence)
2024 SCHEME

THIRD SEMESTER (July-December)															
Sl. No:	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure					SS	Total Marks		Credits	Hrs./ Week
						L	T	P	R	CIE		ESE			
1	A	24SJGAMAT301	BSC	GC	Mathematics for Computer and Information Science-3	3	0	0	0	4.5	40	60	3	3	
2	B	24SJPCCAT302	PC	PC	Introduction to Artificial Intelligence	3	1	0	0	5	40	60	4	4	
3	C	24SJPC CST303	PC	PC	Data Structures and Algorithms	3	1	0	0	5	40	60	4	4	
4	D	24SJPCB CST304	PC-PBL	PB	Object Oriented Programming	3	0	0	1	5.5	60	40	4	4	
5	F	24SJGAEST305	ESC	GC	Digital Electronics and Logic Design	3	1	0	0	5	40	60	4	4	
6	G S3/S4	24SJICHUT346	HMC	IC	Economics for Engineers	2	0	0	0	3	50	50	2	2	
		24SJICHUT347			Engineering Ethics and Sustainable Development										
7	L	24SJPCCSL307	PCL	PC	Data Structures Lab	0	0	3	0	1.5	50	50	2	3	
8	Q	24SJPCCAL308	PCL	PC	Python Programming Lab	0	0	3	0	1.5	50	50	2	3	
9	R/M		VAC		Remedial/Minor Course	3	1	0	0	5			4*	4*	
Total										31/36			25/29*	27/31*	
Bridge Course for Lateral Entry Students: Total 15 Hrs.															
FOURTH SEMESTER (January-June)															
Sl. No:	Slot	Course Code	Course Type	Course Category	Course Title (Course Name)	Credit Structure					SS	Total Marks		Credits	Hrs./ Week
						L	T	P	R	CIE		ESE			
1	A	24SJGAMAT401	BSC	GC	Mathematics for Computer and Information Science-4	3	0	0	0	4.5	40	60	3	3	
2	B	24SJPC CST402	PC	PC	Database Management Systems	3	1	0	0	5	40	60	4	4	
3	C	24SJPC CST403	PC	PC	Operating Systems	3	1	0	0	5	40	60	4	4	
4	D	24SJPCB CST404	PC-PBL	PB	Computer Organization and Architecture	3	0	0	1	5.5	60	40	4	4	
5	E	24SJPECAT41N/24SJPECST41N	PE	PE	PE-1	3	0	0	0	4.5	40	60	3	3	
6	G S3/S4	24SJICHUT346	HMC	IC	Economics for Engineers	2	0	0	0	3	50	50	2	2	
		24SJICHUT347			Engineering Ethics and Sustainable Development										
7	L	24SJPCCSL407	PCL	PC	Operating Systems Lab	0	0	3	0	1.5	50	50	2	3	
8	Q	24SJPCCSL408	PCL	PC	DBMS Lab	0	0	3	0	1.5	50	50	2	3	
9	R/M/H		VAC		Remedial/Minor/Honours Course	3	1	0	0	5			4*	4*	
Total										31/36			24/28*	26/30*	

SEMESTER 3

MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-3

Course Code	24SJGAMAT301	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic calculus	Course Type	Theory

Course Objectives:

1. To familiarize students with the foundations of probability and analysis of random processes used in various applications in engineering and science.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, the Binomial probability distribution, the Poisson probability distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables. [Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]	9
2	Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables. [Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]	9

3	Limit theorems : Markov's Inequality, Chebyshev's Inequality, Strong Law of Large Numbers (Without proof), Central Limit Theorem (without proof), Stochastic Processes: Discrete-time process, Continuous-time process, Counting Processes, The Poisson Process, Interarrival times (Theorems without proof) [Text 2: Relevant topics from sections 2.7, 2.9, 5.3]	9
4	Markov Chains, Random Walk Model, Chapman–Kolmogorov Equations, Classification of States, Irreducible Markov chain, Recurrent state, Transient state, Long-Run Proportions. (Theorems without proof) [Text 2: Relevant topics from sections 4.1, 4.2, 4.3, 4.4]	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"> • Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	K3
CO2	Understand the concept, properties and important models of continuous random variables and to apply in suitable random phenomena.	K3
CO3	Familiarize and apply limit theorems and to understand the fundamental characteristics of stochastic processes.	K3
CO4	Solve problems involving Markov Chains, to understand their theoretical foundations and to apply them to model and predict the behaviour of various stochastic processes.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	-	2	-	-	-	-	-	-	2
CO2	3	3	-	2	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9 th edition, 2016
2	Introduction to Probability Models	Sheldon M. Ross	Academic Press	13 th edition, 2024

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability and Random Processes for Electrical and Computer Engineers	John A. Gubner	Cambridge University Press	2012
2	Probability Models for Computer Science	Sheldon M. Ross	Academic Press	1 st edition, 2001
3	Probability, Random Variables and Stochastic Processes	Papoulis, A. & Pillai, S.U.,	Tata McGrawHill.	4 th edition, 2002
4	Probability, Statistics and Random Processes	Kousalya Pappu	Pearson	2013

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1,2	https://onlinecourses.nptel.ac.in/noc22_mg31/preview
3,4	https://archive.nptel.ac.in/courses/108/103/108103112/

SEMESTER 3

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Course Code	24SJPCCAT302	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To understand the Principles Artificial Intelligence and Intelligent Systems
2. To identify the Application of AI Techniques in Problem Solving and Decision Making
3. To understand the concepts of learning methods and expert systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Foundations of AI and Intelligent Agents Introduction to AI and its History: Definitions and scope, Historical milestones in AI development Intelligent Agents: Concepts of agents and environments, Rationality and the nature of environments, Structures of agents: Simple reflex, model-based, goal-based, utility-based Problem-Solving Agents: Problem formulation and agent-based problem solving, Examples of problem-solving scenarios	10
2	Search Strategies and Game Playing Search Strategies for Solutions: Uninformed search strategies: Breadth-first search (BFS), Depth-first search (DFS), Heuristic search: Hill climbing, A* algorithm, Problem reduction techniques Game Playing and Adversarial Search: Concepts of adversarial search and game theory, Mini-max algorithm for optimal decision-making, Challenges in game playing and problem-solving in multiplayer games, Alpha-Beta pruning for efficient game tree exploration, Evaluation functions and heuristics in game playing	12

3	Knowledge Representation and Reasoning Knowledge Representation Techniques: Predicate logic and logic programming, Semantic networks, frames, and inheritance systems, Rule- based systems and constraint propagation Reasoning Under Uncertainty: Basics of probability theory and Bayesian reasoning, Dempster-Shafer theory for managing uncertainty, Applications of reasoning under uncertainty in AI systems	12
4	Learning Methods and Expert Systems Learning from Observations: Inductive learning and decision trees, Explanation-based learning, Statistical learning methods and reinforcement learning Expert Systems: Introduction and basic concepts of expert systems, Structure and functioning of expert systems, Knowledge engineering and acquisition methods, Societal impacts and ethical considerations in AI, Reasoning techniques: Rule-based, frame-based, model-based, case-based, Handling uncertainty in expert systems	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Mini project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamental concepts and historical milestones of artificial intelligence, including the roles and structures of intelligent agents.	K2
CO2	Apply uninformed and informed search strategies, including BFS, DFS, and A* algorithms, to solve complex problems and game scenarios.	K3
CO3	Identify different knowledge representation techniques such as predicate logic, semantic networks, and rule-based systems, and use reasoning methods to handle uncertainty.	K3
CO4	Apply learning techniques such as inductive learning, decision trees, and reinforcement learning for developing intelligent systems.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓								✓
CO5	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence: A Modern Approach	Stuart Russell, Peter Norvig	Pearson	4/e, 2020
2	Artificial Intelligence: Foundations of Computational Agents	David L. Poole, Alan K. Mackworth	Cambridge University Press	2/e, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence: Structures and Strategies for Complex Problem Solving	George F. Luger	Addison Wesley	6/e, 2018
2	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer	1/e, 2006
3	Machine Learning	Tom M. Mitchell	McGraw-Hill	1/e, 1997
4	Expert Systems: Principles and Programming	Joseph C. Giarratano and Gary D. Riley	Cengage Learning	4/e, 2004

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/fV2k2ivttL0 https://youtu.be/d39tTuUbDVw
2	https://youtu.be/TMLyKcBtHuo https://youtu.be/dtGRmhZ6Cuo https://youtu.be/ZOvRZ7UJMjk https://youtu.be/a2tqR2eUlek https://youtu.be/0oqhN5tvLgA
3	https://youtu.be/vmCSX4iUB_4 https://youtu.be/u1qrVIwjbw
4	https://youtu.be/nE5c5w4aizU

SEMESTER 3

DATA STRUCTURES AND ALGORITHMS

(Common to CS/CA/AD/CC)

Course Code	24SJPCST303	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJICEST105 & 24SJGXEST204	Course Type	Theory

Course Objectives:

1. To provide the learner a comprehensive understanding of data structures and algorithms.
2. To prepare them for advanced studies or professional work in computer science and related fields.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Concepts of Data Structures Definitions; Data Abstraction; Performance Analysis - Time & Space Complexity, Asymptotic Notations- Definition of Big Oh, Omega, Theta, Problems on Big Oh. Polynomial representation using Arrays, Sparse matrix (<i>Tuple representation</i>); Stacks and Queues - Stacks, Queues, Circular Queues, Double Ended Queues; Evaluation of Expressions- Infix to Postfix, Evaluating Postfix Expressions.	11
2	Linked List and Memory Management Singly Linked List - Operations on Linked List, Stacks and Queues using Linked List, Polynomial representation using Linked List; Doubly Linked List; Circular Linked List; Memory allocation - First-fit, Best-fit, and Worst-fit allocation schemes (Concept and Problems Only);	11

3	Trees and Graphs Trees: - Representation of Trees; Binary Trees - Types and Properties, Binary Tree Representation, Tree Traversals; Expression Trees; Binary Search Trees - Binary Search Tree Operations; Binary Heaps - Binary Heap Operations. Graphs: - Definitions; Representation of Graphs; Depth First Search and Breadth First Search; Applications of Graphs.	11
4	Sorting and Searching Sorting Techniques: - Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort. Searching Techniques: - Linear Search, Binary Search, Hashing - Hashing functions: Mid square, Division, Folding, Digit Analysis; Collision Resolution: Linear probing, Quadratic Probing, Double hashing, Open hashing.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify appropriate data structures for solving real world problems.	K3
CO2	Describe and implement linear data structures such as arrays, linked lists, stacks, and queues.	K3
CO3	Describe and implement non-linear data structures such as trees and graphs.	K3
CO4	Select appropriate searching and sorting algorithms to be used in specific circumstances.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Data Structures in C	Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed,	Universities press,	2/e, 2007
2	Introduction to Algorithms	Thomas H Cormen, Charles Leiserson, Ronald L Rivest, Clifford Stein	PHI	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Classic Data Structures	Samanta D.	Prentice Hall India.	2/e, 2018
2	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Publication.	1/e, 2003
3	Introduction to Data Structures with Applications	Tremblay J. P. and P. G. Sorenson	Tata McGraw Hill.	2/e, 2017
4	Theory and Problems of Data Structures	Lipschuts S.	Schaum's Series	2/e, 2014

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106102064
2	https://ocw.mit.edu/courses/6-851-advanced-data-structures-spring-2012/

SEMESTER S3

OBJECT ORIENTED PROGRAMMING

(Common to CS/CA)

Course Code	24SJBCST304	CIE Marks	60
Teaching Hours/Week (L:T:P:R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To teach the core object-oriented principles such as abstraction, encapsulation, inheritance, and polymorphism, robust error-handling using exception mechanisms to ensure program reliability.
2. To equip the learner to develop object-oriented programs encompassing fundamental structures, environments, and the effective utilization of data types, arrays, strings, operators, and control statements for program flow in Java.
3. To enable the learner to design and develop event-driven graphical user interface (GUI) database applications using Swing and database connection components.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Java: Structure of a simple java program; Java programming Environment and Runtime Environment (Command Line & IDE); Java compiler; Java Virtual Machine; Primitive Data types -Arrays; Strings; Vector class; (Basics only)-Operators - Arithmetic, Bitwise, Relational, Boolean Logical, Assignment, Conditional (Ternary); Operator Precedence; Control Statements - Selection Statements, Iteration Statements and Jump Statements; [<i>Use proper naming conventions</i>] OOP Concepts :- Classes, Objects, Data abstraction, encapsulation, inheritance, polymorphism, Declaring Objects; Object Reference; Introduction to Methods; Constructors; Access Modifiers; this keyword.	11

2	<p>Polymorphism :- Method Overloading, Recursion. Static Members, Final Variables, Inner Classes</p> <p>Inheritance - Super Class, Sub Class, Types of Inheritance, The <i>super</i> keyword, protected Members, Calling Order of Constructors. Method Overriding, Dynamic Method Dispatch, Using <i>final</i> with Inheritance.</p>	11
3	<p>Packages and Interfaces Packages - Defining a Package, CLASSPATH, Access Protection, Importing Packages.</p> <p>Interfaces - Interfaces v/s Abstract classes, defining an interface, implementing interfaces, accessing implementations through interface references, extending interface(s).</p> <p>Exception Handling - Checked Exceptions, Unchecked Exceptions, <i>try</i> Block and <i>catch</i> Clause, Multiple catch Clauses, Nested <i>try</i> Statements, <i>throw</i>, <i>throws</i> and <i>finally</i>, Java Built-in Exceptions, Custom Exceptions.</p>	11
4	<p>SOLID Principles in Java -Swings fundamentals – Overview of AWT, Swing v/s AWT, Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings–JFrame, JLabel, The Swing Buttons, JTextField.</p> <p>Event handling – Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model.</p> <p>Developing Database Applications using JDBC – JDBC overview, Types, Steps, Common JDBC Components, Connection Establishment, SQL Fundamentals [<i>For projects only</i>] - Creating and Executing basic SQL Queries, Working with Result Set, Performing CRUD Operations with JDBC.</p>	11

Suggestion on Project Topics

Student should Identify a topic to be implemented as project having the following nature

- i. It must accept a considerable amount of information from the user for processing.*
- ii. It must have a considerable amount of data to be stored permanently within the computer - as plain files / using databases.*
- iii. It must process the user provided data and the stored data to generate some output to be displayed to the user.*

Examples : -

1. Design and implement the Circulation function in a Library Management System using Object-Oriented Programming (OOP) principles in Java and limited use of SQL. The system should manage the operations of a library, such as book & user management, borrowing and returning books.

Requirements

I. Class Design

- Book: Attributes like title, author, ISBN, genre, and status (available/borrowed).
- User: Attributes like user ID, name, contact information, and a list of borrowed books.
- Library: Attributes like a list of books and a list of users.
- Librarian: Inherits from User, with additional functionalities like adding/removing books and managing users.
- Borrow Transaction: Attributes like transaction ID, book, user, borrow date, and return date

II. Functionalities

- a. Book Management:
 - Add, remove, and update book details.
 - Search books by title, author, ISBN, and genre.
- b. User Management:
 - Register new users.
 - Search users by user ID and name.

c. Borrowing and Returning:

- Borrow a book: Check if the book is available and if the user can borrow more books.
- Return a book: Update the book's status and remove it from the user's borrowed list.

III. Deliverables

1. Design Document: Describe the classes, their attributes, methods and relationships.
 2. Source Code: Well-documented Java code implementing the described functionalities.
 3. User Manual: Instructions on how to set up, run and use the system.
 4. Test Cases: A suite of test cases demonstrating the functionality of the system.
2. Design and implement an Online Payment Processing System using Object-Oriented Programming(OOP) principles in Java, with a focus on dynamic polymorphism. The system should support different types of payment methods and demonstrate polymorphism in processing payments.

Requirements

a. Class Design

- Payment: An abstract base class with common attributes and an abstract method for processing payments.
- Credit Card Payment: Inherits from Payment, with specific implementation for processing credit card payments.
- PayPal Payment: Inherits from Payment, with specific implementation for processing PayPal payments.
- Bank Transfer Payment: Inherits from Payment, with specific implementation for processing bank transfer payments.
- Payment Processor: A class to manage and process different types of payments.

b. Functionalities

- Add Payment Method: Add new payment methods (Credit Card Payment, PayPal Payment, Bank Transfer Payment) to the system.
- Process Payment: Demonstrate dynamic polymorphism by processing payments using different methods.

c. Deliverables

- Design Document: Describe the classes, their attributes, methods and relationships.
- Source Code: Well-documented Java code implementing the described functionalities.

- User Manual: Instructions on how to set up, run and use the system.
- Test Cases: A suite of test cases demonstrating the functionality of the system.

**Course Assessment Method (CIE:
60 marks, ESE: 40 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks (8x2 =16 marks) 	<ul style="list-style-type: none"> • 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 subdivisions. E • Each question carries 6 marks. (4x6 = 24 marks) 	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the process of writing, compiling, and executing basic Java programs, including their structure and components, to demonstrate proficiency.	K2
CO2	Utilize object-oriented programming principles in the design and implementation of Java applications.	K3
CO3	Develop and manage Java packages and interfaces, enhancing code modularity and reusability.	K3
CO4	Implement error handling using Java's exception mechanisms and leverage interfaces for modular applications.	K3
CO5	Develop event-driven Java GUI applications with database connectivity using Swing and JDBC.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓									✓
CO2	✓	✓	✓					✓			✓
CO3	✓	✓	✓		✓			✓			✓
CO4	✓	✓	✓		✓			✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Java: The Complete Reference	Herbert Schildt	Tata McGraw Hill	13/e, 2024
2	Introduction to Java Programming, Comprehensive Version	Y Daniel Liang	Pearson	10/e, 2014
3	Head First Design Patterns	Eric Freeman, Elisabeth Robson, Bert Bates, Kathy Sierra	O'Reilly Media	1/e, 2004

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Head First Java: A Brain Friendly Guide	Kathy Sierra & Bert Bates	O'Reilly	3/e, 2022
2	JAVA™ for Programmers	Paul Deitel	PHI	11/e, 2018
3	Clean Code : A Handbook of Agile Software Craftsmanship	Robert C. Martin	Prentice Hall	1/e, 2008
4	Programming with Java	E Balagurusamy	McGraw Hill Education	6/e, 2019
5	Java For Dummies	Barry A. Burd	Wiley	8/e, 2022
6	Effective Java	Joshua Bloch	Pearson	3/e, 2018

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105191 (Lecture no: 9, 10, 1, 2, 3, 4)
2	https://nptel.ac.in/courses/106105191 (Lecture no: 1, 7, 8, 11, 12, 13, 14, 15, 16)
3	https://nptel.ac.in/courses/106105191 (Lecture no: 17, 18, 19, 20, 21, 22, 23, 24, 25, 26)
4	https://nptel.ac.in/courses/106105191 (Lecture no: 43, 44, 45, 46, 47, 50, 51, 52, 53, 54, 55)

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER 3
DIGITAL ELECTRONICS AND LOGIC DESIGN

(Common to Group A)

Course Code	24SJGAEST305	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To familiarize the basic concepts of Boolean algebra and digital systems.
2. To enable the learner to design simple combinational and sequential logic circuits which is essential in understanding organization & design of computer systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Number systems, Operations & Codes</p> <p>Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers. Binary codes- Decimal codes, Error detection codes, Reflected code, Character coding schemes – ASCII, EBCDIC.</p> <p>Basics of Verilog - basic language elements: identifiers, data objects, scalar data types, operators.</p>	11

2	<p>Boolean Algebra</p> <p>Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh- Map Method (up to four variables), Don't care conditions, Product of sums simplification, Tabulation Method. Digital Logic gates- Implementation of Boolean functions using basic and universal gates. Modeling in Verilog, Implementation of gates with simple Verilog codes.</p>	11
3	<p>Combinational Logic Circuits</p> <p>Design Procedure & Implementation of combinational logic circuits- Binary adders and subtractors, Binary Parallel adder, Carry look ahead adder, BCD adder, Code converter, Magnitude comparator, Decoder, De-multiplexer, Encoder, Multiplexer, Parity generator/ Checker. Modeling and simulation of combinatorial circuits with Verilog codes at the gate level.</p>	10
4	<p>Sequential logic circuits:</p> <p>Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip- flops, Edge- triggered flip- flops. Excitation table and characteristic equation. Registers- register with parallel load. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down counter, BCD counter.</p> <p>Shift registers</p> <p>Shift registers – Serial In Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams.</p> <p>Programmable Logic devices</p> <p>ROM, Programmable Logic Array(PLA)- Implementation of simple circuits using PLA. Modeling and simulation of flip-flops and counters in Verilog.</p>	12

Course Assessment Method
(CIE:40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks. <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate decimal, binary, octal, hexadecimal and BCD number systems, perform conversions among them and do the operations - complementation, addition, subtraction, multiplication and division on binary numbers	K2
CO2	Simplify a given Boolean Function and design a combinational circuit to implement the simplified function using Digital Logic Gates	K3
CO3	Design combinational circuits - Adders, Code Convertors, Decoders, Magnitude Comparators, Parity Generator/Checker.	K3
CO4	Design sequential circuits - Registers, Counters and Shift Registers	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Logic Circuits & Logic Design with Verilog	Brock J. LaMeres	Springer International Publishing	2/e, 2017
2	Digital Logic & Computer Design	M. Morris Mano	Pearson	4/e, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Design with an Introduction to the Verilog HDL, VHDL, and System Verilog	M Morris Mano, Michael D Ciletti	Pearson	6/e, 2018
2	Digital Fundamentals	Thomas Floyd	Pearson	11/e, 2015
3	Fundamentals of Digital Logic with Verilog Design	Stephen Brown, Zvonko Vranesic	McGrawHill	3/e, 2014
4	Switching and Finite Automata Theory	Zvi Kohavi Niraj K. Jha	Cambridge University Press	3/e, 2010

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://nptel.ac.in/courses/117105080
2	https://onlinecourses.nptel.ac.in/noc21_ee39/
3	https://onlinecourses.nptel.ac.in/noc24_cs61/

SEMESTER 3/4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	24SJICHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender- sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Fundamentals of ethics - Personal vs. professional ethics, Civic Virtue, Respect for others, Profession and Professionalism, Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, Technology and digital revolution-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, High technologies: connecting people and places-accessibility and social impacts, Managing conflict, Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Codes of Ethics.</p> <p>Basic concepts in Gender Studies - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education,</p>	6

	employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, Ethical values and practices in connection with gender - equity, diversity & gender justice, Gender policy and women/transgender empowerment initiatives.	
2	<p>Introduction to Environmental Ethics: Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles: Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. Ecosystems and Biodiversity: Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.</p>	6
3	<p>Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.</p>	6

4	<p>Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change.</p> <p>Environmental Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. Case Studies and Future Directions: Analysis of real- world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.</p>	6
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Course Assessment Method (CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
Total Marks				50

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis:** Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts:** Ability to apply course concepts to real-world problems and local contexts.
- **Creativity:** Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills:** Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	K3
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	K4
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	K5
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	K4
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						✓	✓	✓	✓		✓
CO2		✓				✓	✓	✓	✓		✓
CO3						✓	✓	✓	✓		✓
CO4		✓				✓	✓	✓	✓		✓
CO5						✓	✓	✓	✓		✓

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero-waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy- saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER 3

DATA STRUCTURES LAB

(Common to CS/CA/AD/CC)

Course Code	24SJPCCSL307	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJGXEST204	Course Type	Lab

Course Objectives:

To give practical experience for learners on implementing different linear and non linear data structures, and algorithms for searching and sorting.

Expt. No.	Experiments
1	Find the sum of two polynomials using arrays
2	Find the sum of two sparse matrices and transpose the resultant matrix.
3	Convert infix expression to postfix (or prefix) and then evaluate using stack.
4	Implement Queue, DEQUEUE, and Circular Queue using arrays.
5	Implement Circular Queue using arrays.
6	Implement backward and forward navigation of visited web pages in a web browser (i.e. back and forward buttons) using doubly linked list operations.
7	Implement addition of polynomials using singly linked lists.
8	Create a binary tree for a given simple arithmetic expression and find the prefix / postfix equivalent.
9	Implement binary search trees by performing insertion, search and deletion of numbers using linked list.
10	Implement BFS using arrays.
11	Implement the find and replace feature in a text editor

12	Given an array of sorted items, implement an efficient algorithm to search for specific item in the array and also find the time and space complexities.
13	Implement Bubble sort, Insertion Sort, Quick Sort, and Merge Sort and compare the number of steps involved.
14	Simulation of a basic memory allocator and garbage collector using doubly linked list
15	The CSE dept is organizing a tech fest with so many exciting events. By participating in an event, you can claim for activity points as stipulated by KTU. Each event i gives you $A[i]$ activity points where A is an array. If you are not allowed to participate in more than k events, what's the max number of points that you can earn?
16	You are given a hash table with 10 slots (indexed from 0 to 9). You are also provided with a set of integers that need to be inserted into the hash table using a hash function.

Course Assessment Method

(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- **Submission of Record:** Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- **Endorsement by External Examiner:** The external examiner shall endorse the record

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Model a real-world problem using suitable data structure and implement the solution.	K3
CO2	Compare efficiency of different data structures in terms of time and space complexity.	K4
CO3	Evaluate the time complexities of various searching and sorting algorithms.	K4
CO4	Differentiate static and dynamic data structures in terms of their advantages and application.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓				✓			✓
CO2	✓	✓	✓	✓				✓			✓
CO3	✓	✓	✓	✓				✓			✓
CO4	✓	✓	✓	✓				✓			✓

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Data Structures in C	Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed,	Universities Press,	2/e, 2007
2	Introduction to Algorithms	Thomas H Cormen, Charles Leiserson, Ronald L Rivest, Clifford Stein	PHI	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Classic Data Structures	Samanta D.	Prentice Hall India.	2/e, 2018
2	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Publication.	1/e, 2003
3	Introduction to Data Structures with Applications	Tremblay J. P., P. G. Sorenson	Tata McGraw Hill.	2/e, 2017
4	Theory and Problems of Data Structures	Lipschutz S.	Schaum's Series	2/e, 2014

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://nptel.ac.in/courses/106102064
2	https://ocw.mit.edu/courses/6-851-advanced-data-structures-spring-2012/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 3

PYTHON PROGRAMMING LAB

Course Code	24SJPCAL308	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJCEST105	Course Type	Lab

Course Objectives:

1. To equip the learner to use Python data structures like Lists, Tuples, Sets, and Dictionaries in solving problems and also constructs such as Strings, Functions, Modules, Regular Expressions, turtle, and Tkinter.
2. To introduce the fundamentals of data analysis using Numpy, Pandas, and SciPy.

Expt. No.	Experiments
1	Write a Python program to sort a list of tuples based on the second element in each tuple.
2	Write a Python program to count the occurrences of each word in a given text and store the result in a dictionary.
3	Write a Python program to find all unique elements in a list.
4	Write a Python program to create a set of squares of all even numbers between m and n using set comprehension.
5	Write a Python program using sets to find all unique characters in a given string.
6	Write a Python program that takes a list of numbers and returns a new list containing only the even numbers from the original list.
7	Write a Turtle program to draw an equilateral triangle. Modify the program to draw triangles of different sizes.
8	Write a Turtle program to draw a flower with a specified number of petals.
9	A basic calculator that can perform addition, subtraction, multiplication, and division using Tkinter
10	A digital clock that displays the current time and updates every second using Tkinter.
11	Write a Python program to copy the contents of one text file to another.
12	Write a Python program to merge the contents of two text files and write the result into a third file.
13	Write a Python program using NumPy to create an array of 10 random numbers and calculate the mean and standard deviation.
14	Write a Python program using NumPy to create a 3x3 matrix of integers. Reshape it into a 1D array and then flatten it back to a 2D array.
15	Write a Python program using NumPy to create two 3x3 matrices and perform matrix multiplication.
16	Write a Python program using Pandas to load a CSV file into a DataFrame, display the first five rows, and calculate the mean of a specified column.

17	Write a Python program using Pandas to read a CSV file and perform basic data analysis tasks like finding the sum, mean, and standard deviation of a specified column.
18	Write a Python program using Pandas to load a CSV file into a DataFrame. Remove duplicate rows and display the cleaned DataFrame.
19	Write a Python program using Matplotlib to plot a line graph of a dataset representing monthly sales figures.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Choose Control Structures and Functions in Python to solve complex problems.	K3
CO2	Utilize Python Libraries for Data Manipulation and Analysis	K3
CO3	Develop Geometric Shapes Using Turtle and Graphics Basic GUI Applications Using Tkinter	K3
CO4	Make use of File Handling and Basic Data Visualization in Python.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓						✓
CO2	✓	✓	✓	✓	✓						✓
CO3	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓						✓

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Learning Python	Mark Lutz	O'Reilly Media	5/e, 2013
2	Python Crash Course: A Hands-On, Project-Based Introduction to Programming	Eric Matthes	No Starch Press	2/e, 2019
3	Python for Everyone	Cay S. Horstmann, Rance D. Nicaise	Wiley	3/e, 2024

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automate the Boring Stuff with Python: Practical Programming for Total Beginners	Al Sweigart	No Starch Press	2/e, 2019
2	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython	Wes McKinney	O'Reilly Media	2/e, 2017
3	Python Cookbook: Recipes for Mastering Python 3	David Beazley and Brian K. Jones	O'Reilly Media	3/e, 2013
4	Fluent Python: Clear, Concise, and Effective Programming	Luciano Ramalho	O'Reilly Media	1/e, 2015
5	Core Python Programming	R. Nageswara Rao	Dreamtech	3/e, 2022

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.swayam2.ac.in/cec22_cs20/preview
2	https://onlinecourses.nptel.ac.in/noc24_cs45/preview
3	https://onlinecourses.nptel.ac.in/noc19_cs41/preview
4	

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S4

MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-4

Course Code	24SJGAMAT401	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of fundamental concepts of graph theory including paths, cycles, trees, graph algorithms, graph coloring and matrix representations, emphasizing their applications across various disciplines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Graphs - Basic definition, Application of graphs, finite and infinite graphs, Incidence and Degree, Isolated vertex, Pendant vertex and Null graph. Isomorphism, Sub graphs, Walks, Paths and circuits, Connected graphs, Disconnected graphs and components. [Text 1: Relevant topics from sections 1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.4, 2.5. Proofs of theorems 2.5, 2.7 are excluded.]	9
2	Euler graphs, Operations on Graphs, Hamiltonian paths and circuits, Travelling Salesman Problem, Connectivity, Edge connectivity, Vertex connectivity, Directed graphs, Types of directed graphs. [Text 1: Relevant topics from sections 2.6, 2.7, 2.8, 2.9, 2.10, 4.1, 4.2, 4.5, 9.1, 9.2. Proofs of theorems 4.6, 4.11, 4.12 are excluded.]	9
3	Trees- properties, Pendant vertices, Distance and centres in a tree, Rooted and binary trees, Counting trees, Spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm, Floyd-Warshall	9

	shortest path algorithm. [Text 1: Relevant topics from sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.10, 11.5. Proofs of theorems 3.10, 3.16 are excluded.]	
4	Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix, Coloring, Chromatic number, Chromatic polynomial, Greedy colouring algorithm. [Text 1: Relevant topics from sections 7.1, 7.3, 7.8, 7.9, 8.1, 8.3. Proofs of theorems 7.4, 7.7, 7.8, 8.2, 8.3, 8.5, 8.6 are excluded.]	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental concepts of graph theory such as types of graphs, degree of a vertex, graph isomorphism, connectedness.	K2
CO2	Understand the concepts of Euler graphs, Hamiltonian graphs and connectivity.	K2
CO3	Understand the concept of tree and apply Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's and Floyd-Warshall algorithms for finding shortest paths.	K3
CO4	Illustrate various representations of graphs using matrices and apply vertex coloring in real life problems.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	-	-	-	-	-	-	-	2
CO2	3	3	2	-	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Graph Theory with Applications to Engineering and Computer Science	Narsingh Deo	Prentice Hall India Learning Private Limited	1st edition, 1979

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Graph Theory 2e	Douglas B. West	Pearson Education India	2nd edition, 2015
2	Introduction to Graph Theory	Robin J. Wilson	Longman Group Ltd.	5th edition, 2010
3	Graph Theory with Applications	J.A. Bondy and U.S.R. Murty	Elsevier Science Publishing Co., Inc	1976

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1,2	https://onlinecourses.nptel.ac.in/noc22_ma10/preview
3,4	https://onlinecourses.nptel.ac.in/noc21_cs48/preview



SEMESTER 4
DATABASE MANAGEMENT SYSTEMS
(Common to CS/CA/AD/CC)

Course Code	24SJPCST402	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCST303	Course Type	Theory

Course Objectives:

1. Equip the students with a comprehensive understanding of fundamental DBMS concepts as well as the principles and applications of NoSQL databases
2. Enable students to design, implement, and manage both relational and NoSQL databases

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Databases: - Database System Concepts and Architecture- Data Models, Schemas and Instances, Three-Schema Architecture and Data Independence, Database Languages, Centralized and Client/Server Architectures for DBMSs. Conceptual Data Modelling and Database Design:- Data Modelling Using the Entity, Relationship (ER) Model - Entity Types, Entity Sets, Attributes, and Keys, Relationship Types, Relationship Sets, Roles, and Structural Constraints, Weak Entity Types, ER Notations, ER diagrams	11
2	The Relational Data Model and SQL - Relational Database Design Using ER-to-Relational Mapping-The Relational Data Model and Relational Database Constraints-Relational Algebra and Relational Calculus - Structured Query Language (SQL)-Data Definition Language, Data Manipulation Language, Aggregation and Grouping, Triggers, views.	11

3	Database Design Theory & Normalization - Functional Dependencies - Basic definition; Normalization- First, Second, and Third normal forms. Transaction Management - Transaction Processing : Introduction, problems and failures in transaction, Desirable properties of transaction, Characterizing schedules based on recoverability and serializability; Concurrency Control with Two-Phase Locking Techniques.	11
4	Introduction To NoSQL Concepts - types of NoSQL databases- CAP Theorem- BASE properties- Use Cases and limitations of NoSQL. SQL architectural Patterns - Key value Stores, Graph Stores, Column Family stores and Document Stores.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p>(8x3 =24marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course, students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Summarize and exemplify the fundamental nature and characteristics of database systems	K2
CO2	Model and design solutions for efficiently representing data using the relational model or non-relational model	K3
CO3	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems	K3
CO4	Construct advanced SQL queries to effectively retrieve, filter, and manipulate data from relational databases.	K3
CO5	Experiment with NoSQL databases in real world applications	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓	✓				✓	✓		✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Database Systems [Module 1,2,3,4]	Elmasri, Navathe	Pearson	7/e,
2	Making the Sense of NoSQL : A guide for Managers and rest of us [Module 4]	Dan McCreary and Ann Kelly	Manning	2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A., H. F. Korth and S. Sudarshan, Database System Concepts,	Slberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.	McGraw Hill,	7/e, 2011
2	Beginning Database Design Solutions	Rod Stephens	Wiley	2/e, 2023
2	NoSQL Distilled	Pramod J. Sadalage, Martin Fowler	Addison-Wesley	1/e, 2012
3	NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data),	Olivier Pivert	Wiley	2018

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_cs04/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs04/preview
3	https://onlinecourses.nptel.ac.in/noc21_cs04/preview
4	https://archive.nptel.ac.in/courses/106/104/106104135/

SEMESTER 4

OPERATING SYSTEMS

(Common to CS/CA/AD/CC)

Course Code	24SJPCST403	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To introduce the structure of a typical operating system and its core functionalities
2. To impart to the students, a practical understanding of OS implementation nuances based on the Linux operating system

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Introduction to Operating Systems (Book 1 Ch 2 introductory part), Operating System Services (Book 3 Ch 2) Overview of Operating Systems and Kernels, Linux Versus Classic Unix Kernels (Book 2 Ch 1)</p> <p>Process concepts: Process Creation, Process States, Data Structures, Process API (Book 1 Ch 4, 5), Sharing processor among processes - user and kernel modes, context switching (Book 1 Ch 6), System boot sequence (Book 3 Ch 2)</p> <p>Case study: <i>Linux kernel process management (Book 2, Ch 3)</i></p> <p>Threads and Concurrency: Concept of a thread, Multithreading benefits, Multithreading models (Book 3 Ch 4)</p> <p>Case study: <i>The Linux Implementation of Threads (Book 2, Ch 3)</i></p> <p>Process scheduling: Concepts and basic algorithms (Book 1 Ch 7), The Multilevel Feedback Queue: Basic Rules (Book 1 Ch 8)</p> <p>Case study: <i>The Linux Completely Fair Scheduler (CFS) (Book 1 Ch 9, Implementation with RB trees not required), The Linux Scheduling Implementation, Preemption and Context Switching (Book 2, Ch 4)</i></p>	11

2	<p>Concurrency and Synchronization - Basic principles (Book 3 Sections 6.1, 6.2), Mechanisms - Locks: The Basic Idea, Building Spin Locks with Test-And-Set, Compare and Swap, Using Queues: Sleeping Instead of Spinning (Book 1 Ch 28), Semaphores - Definition, Binary Semaphores, The Producer/Consumer (Bounded Buffer) Problem and its solution using semaphores, Reader-Writer Locks (Book 1 Ch 31)</p> <p>Case study: <i>Linux Kernel Synchronization Methods - Spin Locks, Semaphores, Mutexes (Book 2 Ch 10)</i></p> <p>Concurrency: Deadlock and Starvation - Deadlock Characterization, Deadlock Prevention and Avoidance, Deadlock Detection and recovery (Book 3 Ch 8), Dining Philosophers Problem and its solution (Book 1 Ch 31)</p>	11
3	<p>Memory management - Address Space, Memory API, Address Translation - An Example, Dynamic (Hardware-based) Relocation, Segmentation: Generalized Base/Bounds, Address translation in segmentation, Support for Sharing (Book 1 Ch 13 to 16)</p> <p>Virtual memory - Paging: Introduction, page tables and hardware support, TLBs, Example: Accessing an Array, - TLB hits and misses, Handling TLB misses, TLB structure, Reducing the page table size (Book 1 Ch 18 to 20)</p> <p>Going beyond physical memory - Swap space, page fault and its control flow, page replacement policies, Thrashing (Book 1 Ch 21, 22)</p>	11
4	<p>I/O system: Modern System architecture, Programmed I/O, Interrupts, Device interaction methods, The Device Driver (Book 1 Ch 36),</p> <p>Hard disk: Geometry (Book 1 Ch 37), disk scheduling (Book 3 Section 11.2)</p> <p>Case study: <i>Linux I/O schedulers - Elevator, Complete Fair Queuing (Book 2 Ch 14)</i></p> <p>Files and Directories: The File System Interface - File descriptor, reading and writing files (sequential and random access), Creating, reading and deleting directories, Permission bits and Access Control Lists, Mounting a file system (Book 1 Ch 39)</p> <p>File Organization: The Inode, The Multi-Level Index (Book 1 Ch 40)</p> <p>Case study: <i>VFS Objects and Their Data Structures - The Inode Object, Inode Operations (Book 2 Ch 13)</i></p>	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub-divisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the concepts of process management and process scheduling mechanisms employed in operating systems.	K3
CO2	Choose various process synchronization mechanisms employed in operating systems.	K3
CO3	Use deadlock prevention and avoidance mechanisms in operating systems.	K3
CO4	Select various memory management techniques in operating systems.	K3
CO5	Understand the storage management in operating systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓								✓
CO5	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Operating Systems: Three Easy Pieces	Andrea Arpaci-Dusseau, Remzi Arpaci-Dusseau	CreateSpace	1/e, 2018
2	Linux Kernel Development	Robert Love	Pearson	3/e, 2018
3	Operating System Concepts	Abraham Silberschatz, Peter B. Galvin, Greg Gagne	Wiley	10/e, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Operating Systems	Andrew S. Tanenbaum Herbert Bos	Pearson	5/e, 2012
2	The Design of the UNIX Operating System	Maurice J. Bach	Prentice Hall of India	1/e, 1994
3	The Little Book of Semaphores	Allen B. Downey	Green Tea Press	1/e, 2016

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105214/
2	https://www.youtube.com/playlist?list=PLDW872573QAb4bj0URobvQTD41IV6gRkx

SEMESTER 4

COMPUTER ORGANIZATION AND ARCHITECTURE

(Common to CS/CA/AD/CC)

Course Code	24SJBCST404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJGAEST305	Course Type	Theory

Course Objectives

1. Introduce principles of computer organization and the basic architectural concepts.
2. Introduce the concepts of Processing units, pipelining, memory systems, and I/O systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Structure of computers: – Functional units - Basic operational concepts; Memory map; Endianness. Programming concepts - Program flow, Branching, Conditional statements, Loops, Arrays, Function calls; Machine language - Instructions, addressing modes, Stored program concept.	12
2	Basic Processing Units -Fundamental concepts, instruction cycle, execution of a complete instruction, single bus and multiple bus organization; Pipelining - Pipelined Processor - Pipelined Data Path, Pipelined Control: Hazards, Solving Data/Control Hazards, Performance Analysis.	12
3	Memory Systems: Introduction; Internal organization of memory chips, Memory system consideration. Caches - Basic concepts, Cache mapping, Cache replacement, Performance Considerations.	10
4	Input / Output -Accessing of I/O devices- I/O Modules; Programmed I/O, Interrupt Driven I/O; Interrupts, Interrupt hardware External Devices; Direct Memory Access;.	10

Suggestion on Project Topics

Use simulators such as Ripes (<https://github.com/mortbopet/Ripes>) / GEM5 (<https://www.gem5.org/>) implement components of computer systems such as Various Cache organization and study the effect, Solutions to hazards, TLBs.

Course Assessment Method (CIE:60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">2 Questions from each module.Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify the basic structure and functional units of a digital computer.	K2
CO2	Understand architecture concepts, including processing units, instruction cycles, bus organizations, and pipelining for performance optimization.	K3
CO3	Utilize the memory organization in modern computer systems.	K3
CO4	Experiment with the I/O organization of a digital computer.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Organization	Hamacher C., Z. Vranesic and S. Zaky	McGraw Hil	5/e, 2011
2	Computer Organization and Architecture Designing for Performance	William Stallings	Pearson	9/e, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Organization and Design : The Hardware/ Software Interface: RISC-V Edition	David A. Patterson John L. Hennessy	Morgan Kaufman	1/e,2018
2	Computer Organization and Embedded Systems	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian	McGraw Hil	6/e, 2012
3	Modern Computer Architecture and Organization	Jim Ledin	Packt Publishing	1/e,2020

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105163/
2	https://archive.nptel.ac.in/courses/106/106/106106166/

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches



ECONOMICS FOR ENGINEERS (Common to All Branches)

Course Code	24SJICHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects. Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function.	6
2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	6

3	Monetary System – Money – Functions - Central Banking – Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) – GST. National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions-Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY.	6
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning.	6

Course Assessment Method

(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Case study/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> Minimum 1 and Maximum 2 Questions from each module. Total of 6 Questions, each carrying 3 marks (6x3 =18marks) 	<ul style="list-style-type: none"> 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. (4x8 = 32 marks) 	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market.	K2
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques.	K3

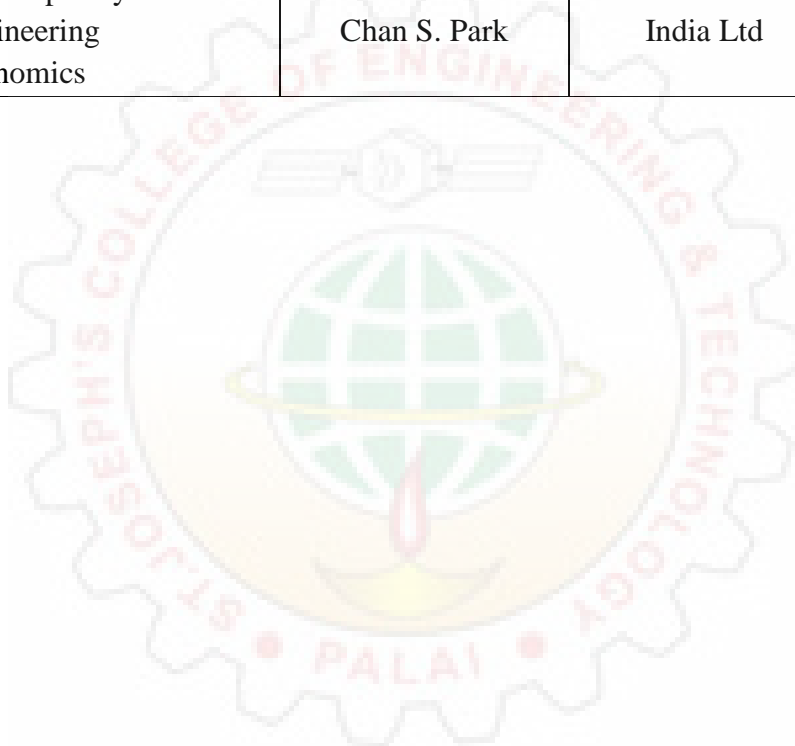
Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						✓					✓
CO2						✓	✓				✓
CO3											✓
CO4					✓	✓					✓

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001



SEMESTER 4

OPERATING SYSTEMS LAB

(Common to CS/CA/CC)

Course Code	24SJPCCSL407	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJGXEST204	Course Type	Lab

Course Objectives:

1. To familiarize various Linux commands related to Operating systems.
2. To give practical experience for learners on implementing different functions of Operating systems such as process management, memory management, and disk management.

Expt. No.	Experiments
1	Familiarisation with basic Linux programming commands: ps, strace, gdb, strings, objdump, nm, file, od, xxd, time, fuser, top
2	Use /proc file system to gather basic information about your machine: (a) Number of CPU cores (b) Total memory and the fraction of free memory (c) Number of processes currently running. (d) Number of processes in the running and blocked states. (e) Number of processes forked since the last bootup. How do you compare this value with the one in (c) above? (f) The number of context switches performed since the last bootup for a particular process.
3	Write a simple program to print the system time and execute it. Then use the /proc file system to determine how long this program (in the strict sense, the corresponding process) ran in user and kernel modes.
4	Create a new process using a fork system call. Print the parent and child process IDs. Use the ps command to find the process tree for the child process starting from the init process.

5	Write a program to add two integers (received via the command line) and compile it to an executable named “myadder” . Now write another program that creates a new process using a fork system call. Make the child process add two integers by replacing its image with the “myadder” image using execvp system call.
6	Create a new process using a fork system call. The child process should print the string “PCCSL407” and the parent process should print the string “Operating Systems Lab” . Use a wait system call to ensure that the output displayed is “PCCSL407 Operating Systems Lab”
7	<p>Inter-process Communication (https://www.linuxdoc.org/LDP/lpg/node7.html)</p> <p>(a) Using Pipe – Evaluate the expression $\sqrt{b^2 + 4ac}$. The first process evaluates b^2. The second process evaluates a and sends it to the first process which evaluates the final expression and displays it.</p> <p>(b) Using Message Queue - The first process sends a string to the second process. The second process reverses the received string and sends it back to the first process. The first process compares the original string and the reversed string received from the second one and then prints whether the string is a palindrome or not.</p> <p>(c) Using Shared Memory - The first process sends three strings to the second process. The second process concatenates them to a single string (with whitespace being inserted between the two individual strings) and sends it back to the first process. The first process prints the concatenated string in the flipped case, that is if the concatenated string is “Hello S4 Students”, the final output should be “hELLO s4 sTUDENTS”</p>
8	Input a list of processes, their CPU burst times (integral values), arrival times, and priorities. Then simulate FCFS, SRTF, non-preemptive priority (a larger priority number implies a higher priority), and RR (quantum = 3 units) scheduling algorithms on the process mix, determining which algorithm results in the minimum average waiting time (over all processes).
9	Use semaphores to solve the producer-consumer problem with writers being given priority over readers.

10	Obtain a (deadlock-free) process mix and simulate the banker's algorithm to determine a safe execution sequence.
11	Obtain a process mix and determine if the system is deadlocked.
12	Implement the deadlock-free semaphore-based solution for the dining philosopher's problem.
13	<p>Simulate the address translation in the paging scheme as follows: The program receives three command line arguments in the order</p> <ul style="list-style-type: none"> • size of the virtual address space (in megabytes) • page size (in kilobytes) • a virtual address (in decimal notation) <p>The output should be the physical address corresponding to the virtual address in <frame number, offset> format. You may assume that the page table is implemented as an array indexed by page numbers. (NB: If the page table has no index for the page number determined from the virtual address, you may just declare a page table miss!)</p>
14	<p>Simulate the FIFO, LRU, and optimal page-replacement algorithms as follows: First, generate a random page-reference string where page numbers range from 0 to 9. Apply the random page-reference string to each algorithm, and record the number of page faults incurred by each algorithm. Assume that demand paging is used. The length of the reference string and the number of page frames (varying from 1 to 7) are to be received as command line arguments.</p>
15	<p>Simulate the SSTF, LOOK, and CSCAN disk-scheduling algorithms as follows: Your program will service a disk with 5,000 cylinders numbered 0 to 4,999. The program will generate a random series of 10 cylinder requests and service them according to each of the algorithms listed earlier. The program will be passed the initial position of the disk head (as a parameter on the command line) and will report the total number of head movements required by each algorithm.</p>

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate the use of various systems calls in Operating Systems.	K3
CO2	Implement process creation and inter-process communication in Operating Systems	K3
CO3	Compare the performance of various CPU scheduling algorithms	K4
CO4	Compare the performance of various disk scheduling algorithms	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓				✓			✓
CO2	✓	✓	✓	✓				✓			✓
CO3	✓	✓	✓	✓				✓			✓
CO4	✓	✓	✓	✓				✓			✓
CO5	✓	✓	✓	✓				✓			✓

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Operating Systems: Three Easy Pieces	Andrea Arpaci-Dusseu, Remzi Arpaci-Dusseu	CreateSpace	1/e, 2018
2	Linux Kernel Development	Robert Love	Pearson	3/e, 2018
3	Unix Network Programming - Volume 2: Interprocess Communications	Richard Stevens	Prentice Hall	2/e, 1999

Reference Books/Websites				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Design of the UNIX Operating System	Maurice J. Bach	Prentice Hall of India	1/e, 1994
2	The Little Book of Semaphores	Allen B. Downey	Green Tea Press	1/e, 2016

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105214/
2	https://www.youtube.com/playlist?list=PLDW872573QAb4bj0URobvQTD41IV6gRkx

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 4

DBMS LAB

(Common to CS/CA/AD//CC)

Course Code	24SJPCCSL408	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To equip students with comprehensive skills in SQL, PL/SQL, and NoSQL databases.
2. To enable the learner to proficiently design, implement, and manage relational and non-relational databases to meet diverse data management needs

Expt. No.	Experiments
1	Design a database schema for an application with ER diagram from a problem description.
2	Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables)
3	Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands).
4	Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases).
5	Implementation of various aggregate functions, Order By, Group By & Having clause in SQL.
6	Implementation of set operators nested queries, and join queries.
7	Practice of SQL TCL DCL commands like Rollback, Commit, Save point, Practice of SQL DCL commands for granting and revoking user privileges.
8	Practice of SQL commands for creation of views.
9	Creation of Procedures, Triggers and Functions.
10	Creation of Packages and cursors.
11	Perform basic CRUD (Create, Read, Update, Delete) operations on a Cassandra table.
12	Write and execute CQL queries to retrieve specific data from Cassandra tables
13	Create a simple application using MongoDB with any front-end Tool.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop database schema for a given real world problem-domain using standard design and modeling approaches	K3
CO2	Construct queries using SQL for database creation, interaction, modification, and updation.	K3
CO3	Plan and implement triggers and cursors, procedures, functions, and control structures using PL/SQL	K3
CO4	Perform CRUD operations in NoSQL Databases	K3
CO5	Design database applications using front-end tools and back-end DBMS	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓					✓		✓
CO2	✓	✓	✓	✓					✓		✓
CO3	✓	✓	✓	✓					✓		✓
CO4	✓	✓	✓	✓	✓				✓		✓
CO5	✓	✓	✓	✓	✓				✓	✓	✓

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Database Systems	Elmasri, Navathe	Pearson	7/e, 2017
2	Professional NoSQL	Shashank Tiwari	Wiley	1/e, 2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Database System Concepts,	Sliberschatz Korth and S. Sudarshan	McGraw Hill,	7/e, 2017
2	NoSQL for Dummies	Adam Fowler	John Wiley & Sons	1/e, 2015
3	NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data),	Olivier Pivert	Wiley	1/e, 2018
4	Making the Sense of NoSQL : A guide for Managers and Rest of us.	Dan McCreary and Ann Kelly	Manning	1/e, 2014

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_cs04/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs04/preview
3	https://onlinecourses.nptel.ac.in/noc21_cs04/preview
4	https://archive.nptel.ac.in/courses/106/104/106104135/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

The logo is a circular emblem with a gear-like outer border. Inside the border, the text "ST. JOSEPH'S COLLEGE OF ENGINEERING & TECHNOLOGY" is written in a circular path. At the bottom of the inner circle, the word "PALAI" is written. The center of the logo features a green globe with a yellow equator, a red flame-like shape at the bottom, and a small icon at the top.

PROGRAM ELECTIVE-1

SLOT	COURSE CODE	COURSES	L-T-P-R	HOURS	CREDIT
E	24SJPECST411	Software Engineering	3-0-0-0	3	3
	24SJPECST412	Pattern Recognition	3-0-0-0		3
	24SJPECST413	Functional Programming	3-0-0-0		3
	24SJPECAT414	Agent Based Intelligent Systems	3-0-0-0		3
	24SJPECST416	Signals and Systems	3-0-0-0		3
	24SJPECST417	Soft Computing	3-0-0-0		3
	24SJPECST419	Cyber Ethics Privacy and Legal Issues	3-0-0-0		3
	24SJPECAT415	Algorithm Analysis and Design	3-0-0-1		5/3
	24SJPECST410	Advanced Data Structures	3-0-0-1		5/3

SEMESTER S4

SOFTWARE ENGINEERING

(Common to CS/CA/AD)

Course Code	24SJPECST411	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To Provide fundamental knowledge in the Software Development Process including Software Development, Object Oriented Design, Project Management concepts and technology trends.
2. To enable the learners to apply state of the art industry practices in Software development.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Introduction to Software Engineering and Process Models - Software engineering, Software characteristics and types, Layers of Software Engineering-Process, Methods, Tools and Quality focus. Software Process models – Waterfall, Prototype, Spiral, Incremental, Agile model – Values and Principles.</p> <p>Requirement engineering - Functional, Non-functional, System and User requirements. Requirement elicitation techniques, Requirement validation, Feasibility analysis and its types, SRS document characteristics and its structure. <i>Case study:</i> SRS for College Library Management Software</p>	9
2	<p>Software design - Software architecture and its importance, Software architecture patterns: Component and Connector, Layered, Repository, Client- Server, Publish-Subscribe, Functional independence – Coupling and Cohesion <i>Case study:</i> Ariane launch failure</p> <p>Object Oriented Software Design - UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram, Sequence diagram</p> <p><i>Case Studies:</i> Voice mail system, ATM Example</p> <p>Software pattern - Model View Controller, Creational Design Pattern types –</p>	9

	Factory method, Abstract Factory method, Singleton method, Prototype method, Builder method. Structural Design Pattern and its types – Adapter, Bridge, Proxy, Composite, Decorator, Façade, Flyweight. Behavioral Design Pattern	
3	Coding, Testing and Maintenance: Coding guidelines - Code review, Code walkthrough and Code inspection, Code debugging and its methods. Testing - Unit testing, Integration testing, System testing and its types, Black box testing and White box testing, Regression testing Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD), <i>Case study</i> – Netflix. Software maintenance and its types- Adaptive, Preventive, Corrective and Perfective maintenance. Boehm's maintenance models (both legacy and non- legacy)	9
4	Software Project Management - Project size metrics – LOC, Function points and Object points. Cost estimation using Basic COCOMO. Risk management: Risk and its types, Risk monitoring and management model Software Project Management - Planning, Staffing, Organizational structures, Scheduling using Gantt chart. Software Quality Management – ISO 9000, CMM, Six Sigma for software engineering. Cloud-based Software -Virtualisation and containers, Everything as a service (IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">2 Questions from each module.Total of 8 Questions, each carrying 3 marks <p>(8x3 =24marks)</p>	<ul style="list-style-type: none">Each question carries 9 marks.Two questions will be given from each module, out of which 1 question should be answered.Each question can have a maximum of 3 sub divisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Plan the system requirements and recommend a suitable software process model	K3
CO2	Model various software patterns based on system requirements	K3
CO3	Apply testing and maintenance strategies on the developed software product to enhance quality	K3
CO4	Develop a software product based on cost, schedule and risk constraints	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Software Engineering: A practitioner's approach	Roger S. Pressman	McGraw-Hill International edition	8/e, 2014
2	Software Engineering	Ian Sommerville	Addison-Wesley	10/e, 2015
3	Design Patterns, Elements of Reusable Object Oriented Software	Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides	Pearson Education Addison-Wesley	1/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Pankaj Jalote's Software Engineering: With Open Source and GenAI	Pankaj Jalote	Wiley India	1/e, 2024
2	Software Engineering: A Primer	Waman S Jawadekar	Tata McGraw-Hill	1/e, 2008
3	Object-Oriented Modeling and Design with UML	Michael Blaha, James Rumbaugh	Pearson Education.	2/e, 2007
4	Software Engineering Foundations : A Software Science Perspective	Yingux Wang	Auerbach Publications	1/e, 2008
5	Object-Oriented Design and Patterns	Cay Horstmann	Wiley India	2/e, 2005
6	Engineering Software Products: An Introduction to Modern Software Engineering	Ian Sommerville	Pearson Education	1/e, 2020

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://www.youtube.com/watch?v=Z6f9ckEElsU
2	https://www.youtube.com/watch?v=1xUz1fp23TQ
3	http://digimat.in/npTEL/courses/video/106105150/L01.html
4	https://www.youtube.com/watch?v=v7KtPLhSMkU

SEMESTER S4
PATTERN RECOGNITION
(Common to CS/CA)

Course Code	24SJPECST412	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJGAMAT101, 24SJGAMAT201, 24SJGAMAT301, 24SJPCST303	Course Type	Theory

Course Objectives:

1. To introduce a foundational understanding of the fundamental principles, theories, and methods used in pattern recognition.
2. To develop practical skills in implementing pattern recognition algorithms and techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p style="text-align: center;">Foundations of Pattern Recognition</p> <p>Introduction to Pattern Recognition - Definitions and applications of pattern recognition, Overview of pattern recognition systems (Text 2, Chapter 1)</p> <p>Statistical Pattern Recognition - Bayes decision theory, Parametric methods: Maximum likelihood estimation, Bayesian estimation (Text 1, Chapters 1, 2)</p> <p>Non-Parametric Methods - k-Nearest neighbors, Parzen windows (Text 2, Chapter 4)</p>	9
2	<p style="text-align: center;">Feature Extraction and Selection</p> <p>Feature Extraction - Importance of feature extraction, Techniques for feature extraction: PCA, LDA, Feature extraction in image and signal processing (Text 1, Chapter 3)</p> <p>Feature Selection - Importance of feature selection, Techniques for feature selection: filter methods, wrapper methods, Feature selection criteria (Text 2, Chapter 6)</p>	9

3	<p align="center">Supervised and Unsupervised Learning</p> <p>Supervised Learning - Basics of supervised learning, Linear classifiers: perceptron, Linear Basis Function Models (// Module 2 discusses Feature Extraction and Selection, which lays the foundation for understanding complex models like Linear Basis Function Models. Introducing this model in Module 3 ensures a natural progression from simple classifiers to more sophisticated models that require a solid understanding of feature engineering. //) logistic regression, Support vector machines (SVM) (Text 1, Chapter 3, Chapter 4)</p> <p>Unsupervised Learning - Basics of unsupervised learning, Clustering techniques: k-means, hierarchical clustering, Gaussian Mixture Models (GMM) (Text 1, Chapter 9)</p>	9
4	<p align="center">Advanced Topics and Applications</p> <p>Hidden Markov Models (HMMs) - Basics of HMMs, HMM for sequence modeling, Applications of HMMs in speech and language processing (Text 1, Chapter 13)</p> <p>Ensemble Methods - Basics of ensemble methods, Bagging, boosting, and random forests, Applications and case studies (Text 1, Chapter 14)</p> <p>Applications and Case Studies - Real-world applications of pattern recognition, Case studies in image and speech recognition, Future trends in pattern recognition, Examples of real-life data set (//Since Module 4 emphasizes Applications and Case Studies, adding real-life datasets aligns well with this focus. //) (Text 2, Chapter 10)</p>	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">2 Questions from each module.Total of 8 Questions, each carrying 3 marks <p>(8x3 =24marks)</p>	<ul style="list-style-type: none">Each question carries 9 marks.Two questions will be given from each module, out of which 1 question should be answered.Each question can have a maximum of 3 sub divisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand Recognition and Explain fundamental Concepts of Pattern	K2
CO2	Apply Classification and Clustering Techniques:	K3
CO3	Implement Feature Extraction and Dimensionality Reduction Techniques	K3
CO4	Apply Statistical and Non-Parametric Methods for Pattern Recognition	K3
CO5	Develop Solutions for Real-World Pattern Recognition Problems and Analyze Case Studies:	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓		✓						✓
CO3	✓	✓	✓		✓						✓
CO4	✓	✓	✓		✓						✓
CO5	✓	✓	✓			✓		✓			✓

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Pattern Recognition and Machine Learning	Christopher M. Bishop	SPRINGER	1/e, 2009
2	Pattern Classification	Richard Duda, Peter Hart, David Stork	Wiley	2/e, 2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Nature of Statistical Learning Theory	Vladimir Vapnik	Springer-Verlag New York Inc.	2/e, 2010
2	The Elements of Statistical Learning	Jerome Friedman, Robert Tibshirani, Trevor Hastie	Springer-Verlag New York Inc	9/e, 2017
3	Pattern Recognition	S.Theodoridis and K.Koutroumbas	Academic Press	4/e, 2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/117/105/117105101/
2	https://archive.nptel.ac.in/courses/117/105/117105101/
3	https://archive.nptel.ac.in/courses/117/105/117105101/
4	https://archive.nptel.ac.in/courses/117/105/117105101/

SEMESTER S4
FUNCTIONAL PROGRAMMING
(Common to CS/CA/AD)

Course Code	24SJPECST413	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJGXEST204	Course Type	Theory

Course Objectives:

1. To enable the learner write programs in a functional style and reason formally about functional programs;
2. To give the concepts of polymorphism and higher-order functions in Haskell to solve the

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introducing Functional Programming; Getting Started with Haskell and GHCi; Basic Types and Definitions; Designing and Writing Programs; Data Types, Tuples and Lists. <i>[Text Ch. 1, 2, 3, 4, 5]</i>	9
2	Programming with Lists; Defining Functions over Lists; Playing the Game: I/O in Haskell; Reasoning about Programs; <i>[Text Ch. 6, 7, 8, 9]</i>	9
3	Generalization: Patterns of Computation; Higher-order Functions; Developing Higher-order Programs; Overloading, Type Classes and Type Checking. <i>[Text Ch. 10 11, 12, 13]</i>	9
4	Algebraic Types; Case Study - Huffman Codes; Abstract Data Types; Lazy Programming; Time and Space Behaviour. <i>[Text Ch. 15, 16, 17, 20]</i>	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Write computer programs in a functional style.	K2
CO2	Reason formally about functional programs and develop programs using lists.	K3
CO3	Use patterns of computation and higher-order functions.	K3
CO4	Reason informally about the time and space complexity of programs.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓			✓						✓
CO2	✓	✓	✓		✓						✓
CO3	✓	✓	✓		✓						✓
CO4	✓	✓	✓		✓						✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	HASKELL : The Craft of Functional Programming	Simon Thompson	Addison Wesley	3/e, 2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Thinking Functionally with Haskell	Richard Bird	Cambridge University Press	1/e, 2015
2	Programming in Haskell	Graham Hutton	Cambridge University Press	2/e, 2023
3	Real World Haskell	Bryan O'Sullivan, John Goerzen, Donald Bruce Stewart	O'Reilly	1/e, 2008

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106137/

SEMESTER 4

AGENT BASED INTELLIGENT SYSTEMS

Course Code	24SJPECAT414	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To equip students with the algorithmic foundation of agents and multi agent systems.
2. To equip students to develop systems that make informed and adaptive decisions
3. To impart the knowledge of how agents collaborate, negotiate, and compete.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Definitions, Foundations, History, Intelligent Agents, Problem Solving agents, Uninformed Search Strategies, Heuristic Search Strategies, Constraint satisfaction Problems, Game Playing.	9
2	Knowledge representation and reasoning: Logical agents, First order logic, First Order Inference, Unification, Chaining Resolution Strategies, Knowledge Representation, Objects, Actions, Events.	9
3	Planning Agents: Planning Problem and examples, State Space Search, Partial Order Planning, Planning Graphs, Planning and acting in Nondeterministic Domains, Conditional Planning, Continuous Planning, Multiagent Planning.	9
4	Agents And Uncertainty: Acting under uncertainty, Basic Probability Notation, Bayes Rule and Bayesian Networks, Other approaches to Uncertain Reasoning, Time and Uncertainty, Temporal Models, Utility Theory, Decision Network, Making Complex Decisions.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Define the algorithmic foundation of agents and multi agent systems.	K2
CO2	Understand knowledge representation and reasoning	K2
CO3	Explain theoretical foundations of agent based systems.	K2
CO4	Apply Bayesian networks for probabilistic reasoning.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓								✓
CO3	✓	✓	✓								✓
CO4	✓	✓	✓								✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence - A Modern Approach	Stuart Russell and Peter Norvig	Pearson	3/e, 2010
2	An Introduction to Multi Agent System	Michael Wooldridge	John Wiley	2/e, 2009.

Reference Book				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial intelligence	Winston, Patrick Henry	Wesley	3/e, 1993

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Artificial Intelligence: Knowledge Representation and Reasoning , IIT Madras https://nptel.ac.in/courses/106106140
2	Responsible & Safe AI Systems https://onlinecourses.nptel.ac.in/noc24_cs132/preview
3	Learn AI Agents https://www.coursera.org/learn/learn-ai-agents

SEMESTER S4
SIGNALS AND SYSTEMS
(Common to CS/CA)

Course Code	24SJPECST416	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To teach the concept of a Discrete Time (DT) signal
2. To enable the learner to analyze the spectral information of any DT signal and its transformed version.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Continuous Time Signals Definition of signal. Basic continuous-time signals. Frequency and angular frequency of continuous- time signals. Basic operation on signals. Classification of continuous-time signals: Periodic and Non- periodic signals. Even and Odd signals, Energy and power signals. Noise and Vibration signals.	9

2	Discrete Time Signals Basic discrete-time signals. Frequency and angular frequency of discrete-time signals. Classification of discrete-time signals: Periodic and Non-periodic signals. Even and Odd signals, Energy and power signals.	9
3	Systems System definition. Continuous-time and discrete-time systems. Properties – Linearity, Time invariance, Causality, Invertibility, Stability. Representation of systems using impulse response.	8
4	Linear time invariant systems & Frequency analysis of signals LTI system definition. Response of a continuous-time LTI system and the Convolutional Integral. Properties. Response of a discrete-time LTI system and the Convolutional Sum. Properties. Correlation of discrete-time signals. Concept of frequency in continuous-time and discrete-time signals. Fourier transform of continuous-time and discrete-time signals. Parseval's theorem.	10

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">2 Questions from each module.Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	<ul style="list-style-type: none">Each question carries 9 marks.Two questions will be given from each module, out of which 1 question should be answered.Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Definition and classification of continuous signals	K2
CO2	Definition and classification of discrete signals	K2
CO3	Explain and characterize a system	K2
CO4	Explain the spectrum of a signal	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

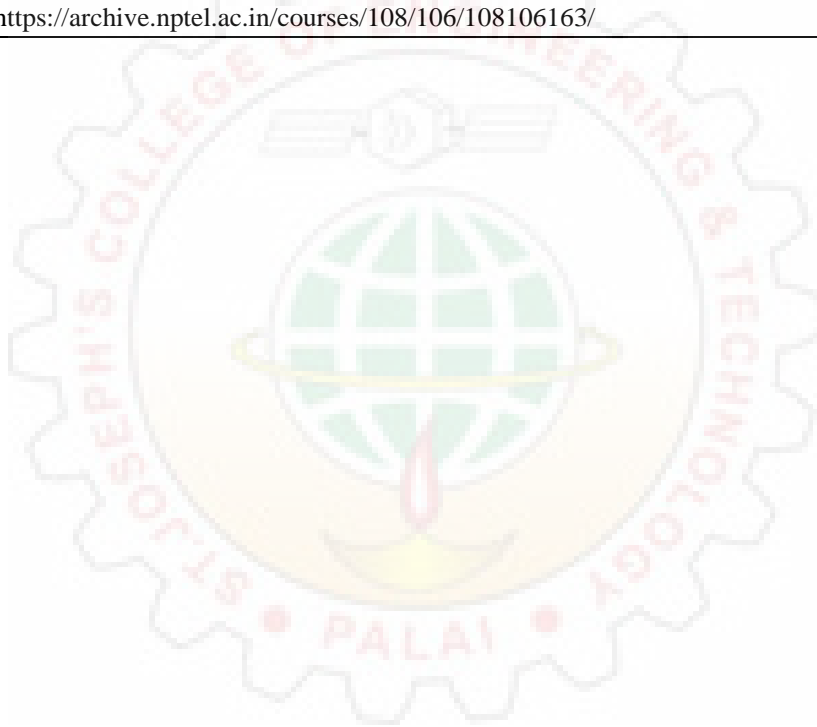
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Signals and Systems	Michael D. Adams	University of Victoria, British Columbia, Canada	3/e 2020
2	Signals and systems	Barry Van Veen, Simon Haykins	Wiley	2/e, 2007
3	Signals and systems	Page 95 of 116 A Nagor Khani	McGraw Hill	2/e, 2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Signals and Systems Using the Web and MATLAB	Edward W. Kamen, Bonnie S Heck	Pearson	3/e, 2014

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/108/104/108104100/
2	https://archive.nptel.ac.in/courses/108/106/108106163/



SEMESTER S4

SOFT COMPUTING

Course Code	24SJPECST417	CIE Marks	40
Teaching Hours/Week (L: T: P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To give exposure on soft computing, various types of soft computing techniques, and applications of soft computing
2. To impart solid foundations on Neural Networks, its architecture, functions and various algorithms involved, Fuzzy Logic, various fuzzy systems and their functions, and Genetic algorithms, its applications and advances.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Soft Computing. Difference between Hard Computing & Soft Computing. Applications of Soft Computing. Artificial Neurons Vs Biological Neurons. Activation Functions. McCulloch and Pitts Neuron. Hebb network, Perceptron Networks– Learning rule, Training and testing algorithm. Adaptive Linear Neuron– Architecture, Training and testing algorithm.	10
2	Fuzzy logic, Fuzzy sets – Properties, Fuzzy membership functions, Features of Fuzzy membership functions. operations on fuzzy set. Linguistic variables, Fuzzy Relations, Fuzzy If-Then Rules, Fuzzification, Defuzzification– Lambda cuts, Defuzzification methods. Fuzzy Inference mechanism - Mamdani and Sugeno types.	10
3	Evolutionary Computing, Terminologies of Evolutionary Computing, Concepts of genetic algorithm. Operators in genetic algorithm – coding, selection, cross over, mutation. Stopping condition for genetic algorithm.	8

4	Multi-objective optimization problem. Principles of Multi- objective optimization, Dominance and pareto-optimality. Optimality conditions. Collective Systems, Biological Self- Organization, Particle Swarm Optimization, Ant Colony Optimization, Swarm Robotics.	9
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Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> • Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the techniques used in soft computing and outline the fundamental models of artificial neural networks	K2
CO2	Solve practical problems using neural networks	K3
CO3	Illustrate the operations, model, and applications of fuzzy logic.	K3
CO4	Illustrate the concepts of evolutionary algorithms such as Genetic Algorithm	K3
CO5	Describe the concepts of multi-objective optimization models and collective systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓								✓
CO2	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓
CO5	✓	✓	✓								✓

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Soft Computing	S.N.Sivanandam, S.N. Deepa	John Wiley & Sons.	3/e, 2018
2	Multi-objective Optimization using Evolutionary Algorithms	Kalyanmoy Deb,	John Wiley & Sons	1/e, 2009
3	Computational intelligence: synergies of fuzzy logic, neural networks and evolutionary computing.	Siddique N, Adeli H.	John Wiley & Sons	1/e, 2013
4	Bio-inspired artificial intelligence: theories, methods, and technologies.	Floreano D, Mattiussi C.	MIT press; 2008 Aug 22.	1/e, 2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fuzzy Logic with Engineering Applications	Timothy J Ross,	John Wiley & Sons,	3/e, 2011
2	Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis and Applications	T.S.Rajasekaran, G.A.Vijayalakshmi Pai	Prentice-Hall India	1/e, 2003
3	Neural Networks- A Comprehensive Foundation	Simon Haykin	Pearson Education	2/e, 1997
4	Fuzzy Set Theory & Its Applications	Zimmermann H. J,	Allied Publishers Ltd.	4/e, 2001

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105173/

SEMESTER S4

CYBER ETHICS, PRIVACY AND LEGAL ISSUES

(Common to CS/CA)

Course Code	24SJPECST419	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of the fundamental concepts of cyberspace and cyber law, enabling them to analyse and address the challenges of regulating and securing the digital world
2. To explain cybercrime, intellectual property, cyber ethics, and ethical issues in emerging technologies, enabling them to tackle related challenges effectively.
3. To give awareness on data protection and privacy in cyberspace, and to learn legal frameworks protecting privacy, enabling them to address and manage privacy-related challenges effectively

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Cyber Law and Cyber Space:- Introduction to cyber law, Contract aspects in cyber law, Security aspects of cyber law, Intellectual property aspects in cyber law and Evidence aspects in cyber law, Criminal aspects in cyber law, Need for Indian cyber law Cyberspace- Web space, Web hosting and web development agreement, Legal and Technological Significance of domain Names, Internet as a tool for global access.	9

2	<p>Cybercrime and Cyber Ethics:- Cybercrime and Cyber Ethics:- Introduction to cybercrime- Definition and Origins of Cybercrime- Classifications of Cybercrime, Cyber Offences- Strategic Attacks, Types of Attacks, Security Challenges Faced by Mobile Devices. Organizational Measures for Handling Mobile Phones.</p> <p>Cyber Ethics: The Importance of Cyber Law, Significance of Cyber Ethics, Need for Cyber regulations Based on Cyber Ethics, Ethics in Information society, Artificial Intelligence Ethics- Ethical Issues in AI and core Principles, Block chain Ethics- Definition and Description.</p>	9
3	<p>Data Protection and Privacy Concerns in Cyberspace: Need to protect data in cyberspace, Types of data, Legal framework of data protection, Data protection bill -an overview, GDPR, Concept of privacy, Privacy concerns of cyberspace, Constitutional framework of privacy, Judicial interpretation of privacy in India, Privacy Law and Regulation, Organizational Response, Privacy and Data Surveillance</p>	9
4	<p>Security Policies and Information Technology Act</p> <p>Need for an Information Security policy, Information Security Standards- ISO, Introducing various security policies and their review process, Information Technology Act, 2000, Penalties, Adjudication and appeals under the IT Act,2000, Offences under IT Act, 2000, Right to Information Act, 2005, IT Act,2008 and its amendments.</p>	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none">• Each question carries 9 marks.• Two questions will be given from each module, out of which 1 question should be answered.• Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the concepts of cyber law and the various components and challenges associated with cyberspace.	K2
CO2	Discuss the concept of cybercrime and computer crime, the challenges faced by law enforcement, and the importance of intellectual property in the digital age.	K2
CO3	Explain the importance of cyber law and ethics, the need for regulations, and the ethical considerations in emerging technologies like AI and blockchain.	K2
CO4	Identify data protection and privacy issues in cyberspace and describe various laws and regulations to address these challenges in the digital age, ensuring comprehensive privacy protection and compliance.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓									✓
CO2	✓	✓									✓
CO3	✓	✓									✓
CO4	✓	✓									✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cyber Security and Cyber Laws	Nilakshi Jain, Ramesh Menon	Wiley	1/e, 2020
2	Cyber Security understanding Cyber Crimes, Computer Forensics and Legal Perspectives	Sumit Belapure , Nina Godbole	Wiley India Pvt.Ltd.	1/e, 2011
3	Cyber Ethics 4.0: Serving Humanity with Values	Christoph Stückelberger, Pavan Duggal	Globethics	1/e, 2018
4	Cyber Laws: Intellectual property & E Commerce, Security	K. Kumar	Dominant Publisher	1/e,2011
5	Introduction to Information Security and Cyber Laws	Surya Prakash Tripathi, Ritendra Goel, Praveen Kumar Shukla	Dreamtech Press	1/e, 2014
6	Cyber Law: The Law of the Internet and Information Technology	Craig B	Pearson Education	First Edition,2013

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://www.wbnsou.ac.in/NSOU-MOOC/mooc_cyber_security.shtml
2	https://onlinecourses.swayam2.ac.in/cec22_lw07/preview
3	https://www.coursera.org/learn/data-security-privacy#modules
4	https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044

SEMESTER 4

ALGORITHM ANALYSIS AND DESIGN

Course Code	24SJPECAT415	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCST303	Course Type	Theory

Course Objectives:

1. To impart the concept of time complexity, space complexity, and other metrics to evaluate the performance of algorithms.
2. To equip the learners to design and implement efficient algorithms using various techniques such as divide and conquer, dynamic programming, and greedy algorithms.
3. To teach the complexity classes and the limitations and capabilities of different algorithmic approaches.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Algorithm Analysis :- Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big - Omega (Ω), Big-Theta (Θ), Little-oh (o) and Little- Omega (ω) and their properties, Time and Space Complexity Calculation of simple algorithms. Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master’s Theorem (Proof not required).	9
2	Divide & Conquer and Greedy Strategy: - General method, Recurrence equation for divide and conquer, Finding the maximum and minimum, Merge sort, Strassen’s matrix multiplication, Advantages and Disadvantages of divide and conquer; Divide and Conquer Approach - Topological Sort;	9

	The Control Abstraction of Greedy Strategy-, Minimum Cost Spanning Tree Computation - Kruskal's Algorithms, Analysis; Single Source Shortest Path Algorithm - Dijkstra's Algorithm, Analysis.	
3	Dynamic Programming - General method with Examples, Multistage Graphs; Transitive Closure - Warshall's Algorithm; All Pairs Shortest Paths - Floyd's Algorithm, Optimal Binary Search Trees; Knapsack problem. Fractional Knapsack Problem, 0/1 knapsack problem, Bellman-Ford Algorithm; Travelling Salesperson Problem; Reliability design.	9
4	Backtracking and Branch & Bound: - Backtracking - General method, N-queen problem, Sum of subsets problem, Graph coloring, Bin Packing, Hamiltonian cycles. Branch and Bound - General method, Travelling Salesperson Problem, LC branch and bound solution, FIFO branch and bound solution.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyse): 20 marks

For this project, you'll apply algorithms like Divide & Conquer, Greedy Strategy, and Dynamic Programming to a scenario such as optimizing delivery routes for a logistics company. You'll implement these algorithms to find the most efficient paths, balancing factors like distance, time, and cost. By analysing their time and space complexities, you'll compare how well each algorithm performs under different conditions, determining the most effective solution for minimizing overall delivery time and expenses. The project will provide insights into the practical applications and limitations of each algorithm in real-world situations.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">2 Questions from each module.Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the characteristics of algorithms and apply various criteria to analyze them, including time and space complexity and asymptotic notations.	K4
CO2	Implement divide and conquer algorithms such as binary search, merge sort, and Strassen's matrix multiplication, and analyze their recurrence equations and performance.	K3
CO3	Design greedy algorithms for optimization problems, such as the fractional knapsack problem and minimum cost spanning trees using Kruskal's algorithm, and evaluate their efficiency.	K3
CO4	Develop dynamic programming solutions for various problems, including multistage graphs, shortest path algorithms, and the traveling salesperson problem, and analyze their computational complexity.	K4
CO5	Solve complex computational problems using backtracking and branch & bound techniques, including the n-queen problem, sum of subsets problem, and 0/1 knapsack problem.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

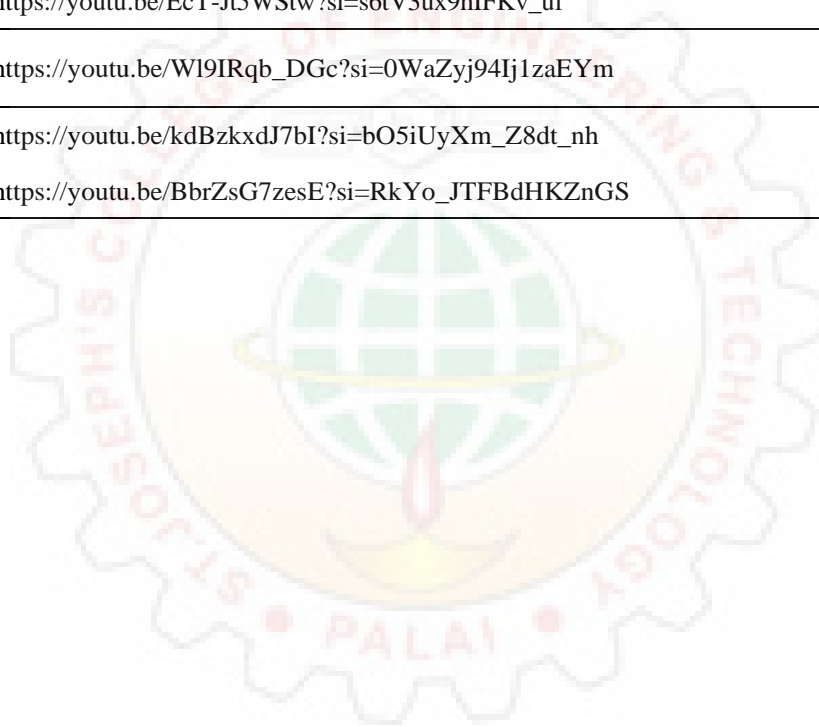
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓							✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	MIT Press	3/e, 2009
2	Fundamentals of Computer Algorithms	Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran	Orient Longman Universities Press	2/e, 2008
3	Computer Algorithms, Introduction to Design and Analysis	Sara Baase and Allen Van Gelder	Pearson Education	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Algorithm Design Manual	Steven S. Skiena	Springer	2/e, 2008
2	Algorithms	Robert Sedgewick, Kevin Wayne	Pearson	4/e, 2011
3	Algorithm Design	Jon Kleinberg, Eva Tardos	Pearson	1/e, 2005
4	Fundamentals of Algorithmic	Gilles Brassard, Paul Bratley	Pearson	1/e, 1996

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/VxwnDYt80rQ?si=CyX07_Nc1ZLi4Qtb https://youtu.be/-Lw8isQC4g?si=ndYWVodltfaieCOV https://youtu.be/uWpFXTUXMXw?si=4aR0SPwZl4GcVp0N https://youtu.be/hK6R4zUgtho?si=Xp_XuaR-3zkGJMtl
2	https://youtu.be/_VV9v41FIq0?si=SfxKb5Uw7lbJ6vgZ https://youtu.be/3AtyFp0T6II?si=FhbZg3uRRxafztHT https://youtu.be/EcT-Jt5WStw?si=s6tV3ux9hIFKv_uf
3	https://youtu.be/Wl9IRqb_DGc?si=0WaZyj94Ij1zaEYm
4	https://youtu.be/kdBzkxdJ7bI?si=bO5iUyXm_Z8dt_nh https://youtu.be/BbrZsG7zesE?si=RkYo_JTFBdHKZnGS



SEMESTER 4

ADVANCED DATA STRUCTURES

(Common to CS/CA/CC)

Course Code	24SJPECST410	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	24SJPCST303	Course type	Theory

Course Objectives:

1. To equip students with comprehensive knowledge of advanced data structures utilized in cutting-edge areas of computer science, including database management, cyber security, information retrieval, and networked systems.
2. To prepare students to address challenges in emerging fields of computer science by applying advanced data structures to practical, real-world problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Foundational Data Structures- Overview of Arrays and Linked Lists, implementation of pointers and objects, Representing rooted trees, Hashing - Hash Tables, Hash functions, Cuckoo Hashing; Bloom Filters - Count-Min Sketch, Applications to Networks - Click Stream Processing using Bloom Filters, Applications to Data Science - Heavy Hitters and count-min structures.	9
2	Advanced Tree Data Structures - Balanced Trees - AVL Trees (review), Red-Black Trees, Suffix Trees and Arrays, Segment Trees, Heaps and Related Structures – Binomial heap, Fibonacci Heaps, Merkle Trees, Applications to information Retrieval and WWW - AutoComplete using Tries.	9

3	Specialized Data Structures - Spatial Data Structures – Quadtree, K-D Trees (k-dimensional tree); R-trees; Temporal Data Structures- Persistence, Retroactivity; Search and Optimization Trees – Skip List, Tango Trees; Applications to Data Science - Approximate nearest neighbor search, Applications to information Retrieval and WWW, Posting List intersection.	9
4	Data Structure applications - Distributed and Parallel Data Structures - Distributed Hash Tables (DHTs); Consistent Hashing; Distributed BST; Data Compression and Transformations - Burrows-Wheeler Transform; Histogram; Wavelet Trees; Cryptographic Applications – Hashing.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyze): 20 marks

Implement various real world problems using multiple suitable data structures and compare the performance.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24 marks) 	<ul style="list-style-type: none"> 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 9 marks. (4x9 = 36 marks) 	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Implement and use arrays, linked lists, rooted trees and hashing techniques in various programming scenarios.	K3
CO2	Design and implement advanced tree data structures for information retrieval.	K3
CO3	Use spatial and temporal data structures in data science problems.	K3
CO4	Analyze data structures in special scenarios such as distributed, parallel and data compression areas.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	✓	✓	✓	✓	✓					✓	✓
CO2	✓	✓	✓	✓	✓					✓	✓
CO3	✓	✓	✓	✓	✓					✓	✓
CO4	✓	✓	✓	✓	✓					✓	✓

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Data Structures: Theory and Applications	Suman Saha, Shailendra Shukla	CRC Press	1/e, 2019
2	Advanced Data Structures	Peter Brass	Cambridge University Press	1/e, 2008
3	Introduction to Algorithms	Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein	MIT Press	4/e, 2022
4	Fundamentals of Computer Algorithms	Ellis Horowitz, Satraj Sahani and Rajasekharam	University Press	2/e, 2009
5	Advanced Data Structures	Reema Thareja, S. Rama Sree	Oxford University Press	1/e, 2018
6	Data Structures and Algorithm Analysis in C++,	Mark Allen Weiss	Pearson	2/e, 2004.
7	Design and Analysis of Algorithms	M T Goodrich, Roberto Tamassia	Wiley	1/e, 2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://web.stanford.edu/class/cs166/



Programme Outcomes (POs)

- PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2: Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.
- PO3: Design/development of solutions:** Design solutions for complex engineering problems and system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO7: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO8: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.
- PO09: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO10: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.
- PO11: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



ST. JOSEPH'S

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MISSION

- To maintain a conducive infrastructure and learning environment for world class education.
 - To nurture a team of dedicated, competent and research-oriented faculty.
- To develop students with moral and ethical values, for their successful careers, by offering variety of programs and services.