SEMESTER 3

COMPUTER SCIENCE AND ENGINEERING

(ARTIFICIAL INTELLIGENCE)

SEMESTER S3

MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-3

(Group A)

Course Code	**GAMAT301**	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	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	PO12
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	1st edition, 2001
3	Probability, Random Variables and Stochastic Processes	Papoulis, A. & Pillai, S.U.,	Tata McGrawHill.	4th edition, 2002
4	Probability, Statistics and Random Processes	Kousalya Pappu	Pearson	2013

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

SEMESTER S3

THEORY OF COMPUTATION

(Common to CS/CA/CM/CD/CN/CC)

Course Code	PCCST302	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)	PCCST205	Course Type	Theory

Course Objectives:

1. To introduce the concept of formal languages.
2. To discuss the Chomsky classification of formal languages with a discussion on grammar and automata for regular, context-free, context-sensitive, and unrestricted languages.
3. To discuss the notions of decidability and halting problem.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Foundations (Linz, Hopcroft)** Motivation for studying computability, need for mathematical modeling - automata, Introducing automata through simple models - On/Off switch, coffee vending machine. Three basic concepts: Alphabet, Strings, and Languages **Finite Automata (Linz, Hopcroft)** Formal definition of a finite automaton, Deterministic Finite Automata (DFA), Regular languages, Nondeterminism (guess and verify paradigm), Formal definition of a nondeterministic finite automaton, NFA with epsilon transitions, Eliminating epsilon transitions (Proof not expected), Equivalence of NFAs and DFAs (Proof not expected) - The Subset Construction. DFA State Minimization, Applications of finite automata - text search, keyword recognition	11
2	**Regular Expressions (Linz)** The formal definition of a regular expression, Building Regular Expressions, Equivalence with finite automata (Proof not expected) -	

	Converting FA to Regular Expressions, Converting Regular Expressions to FA, Pattern Matching and Regular Expressions, Regular grammar, Equivalence with FA - Conversion in both directions **Properties of Regular Languages (Linz)** Closure and Decision Properties of Regular Languages (with proofs), The Pumping Lemma for Regular Languages (with formal proof), Pumping lemma as a tool to prove non regularity of languages **Context-Free Grammars and Applications (Linz)** Formal definition of a context-free grammar, Designing context-free grammars, Leftmost and Rightmost Derivations Using a Grammar, Parse Trees, Ambiguous Grammars, Resolving ambiguity, Inherent ambiguity, CFGs, and programming languages	**11**
3	**Pushdown Automata (Linz)** Formal definition of a pushdown automaton, DPDA and NPDA, Examples of pushdown automata Equivalence NPDAs and CFGs (Proof not expected) - conversions in both directions **Simplification of Context-Free Languages (Linz)** Elimination of useless symbols and productions, Eliminating epsilon productions, Eliminating unit productions, Chomsky normal form, Greibach normal form, **Properties of Context-Free Languages (Linz)** The Pumping Lemma for Context-Free Languages (with formal proof), Closure and Decision Properties of Context-Free Languages (with formal proofs)	**11**
4	**Turing Machines (Kozen)** The formal definition of a Turing machine, Examples of Turing machines - Turing machines as language acceptors, Turing machines as computers of functions, Variants of Turing Machines (Proofs for equivalence with basic model not expected), Recursive and recursively enumerable languages Chomskian hierarchy, Linear bounded automaton as a restricted TM. **Computability (Kozen)** Church Turing thesis, Encoding of TMs, Universal Machine and Diagonalization, Reductions, Decidable and Undecidable Problems, Halting problem, Post Correspondence Problem and the proofs for their undecidability.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	Classify formal languages into regular, context-free, context-sensitive, and unrestricted languages.	**K2**
CO2	Design finite state automata, regular grammar, regular expression, and Myhill- Nerode relation representations for regular languages.	**K3**
CO3	Design push-down automata and context-free grammar representations for context-free languages.	**K3**
CO4	Design Turing Machines to accept recursive and recursively enumerable languages.	**K3**
CO5	Understand the notions of decidability and undecidability of problems, Halting problem.	**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	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

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	An Introduction to Formal Languages and Automata	Peter Linz and Susan H. Rodger	Jones and Bartlett Publishers, Inc	7/e, 2022
2	Introduction to Automata Theory Languages and Computation	John E.Hopcroft, Jeffrey D.Ullman	Rainbow Book Distributiors	3/e, 2015
3	Automata and Computability	Dexter C. Kozen	Springer	1/e,2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to the Theory of Computation	Michael Sipser	Cengage India Private Limited	3/e, 2014
2	Introduction to Languages and the Theory of Computation	John C Martin	McGraw-Hill Education	4/e, 2010
3	Theory of Computation: A Problem-Solving Approach	Kavi Mahesh	Wiley	1/e, 2012
4	Elements of the Theory of Computation	Harry R. Lewis, Christos Papadimitriou	Pearson Education	2/e, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/104/106104148/ https://nptel.ac.in/courses/106106049
2	https://archive.nptel.ac.in/courses/106/104/106104148/ https://nptel.ac.in/courses/106106049
3	https://archive.nptel.ac.in/courses/106/104/106104148/ https://nptel.ac.in/courses/106106049
4	https://archive.nptel.ac.in/courses/106/104/106104148/ https://nptel.ac.in/courses/106106049

SEMESTER S3

DATA STRUCTURES AND ALGORITHMS

(Common to CS/CA/CM/CD/CR/AI/AM/AD/CB/CN/CC/CU/CI/CG)

Course Code	**PCCST303**	**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)	UCEST105	**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; Polynomial representation using Arrays, Sparse matrix (*Tuple representation*); Stacks and Queues - Stacks, Multi-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; Garbage collection and compaction.	**11**
3	**Trees and Graphs** Trees :- Representation Of Trees; Binary Trees - Types and Properties, Binary Tree Representation, Tree Operations, Tree Traversals; Expression Trees; Binary Search Trees - Binary Search Tree Operations; Binary Heaps - Binary Heap Operations, Priority Queue.	**11**

	Graphs :- Definitions; Representation of Graphs; Depth First Search and Breadth First Search; Applications of Graphs - Single Source All Destination.	
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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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	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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

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 Leisesrson, 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/CD/AM/CB/CN/CU/CG)

Course Code	**PBCST304**	**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 and Wrapper Types; Casting and Autoboxing; Arrays; Strings; Vector class; Operators - Arithmetic, Bitwise, Relational, Boolean Logical, Assignment, Conditional (Ternary); Operator Precedence; Control Statements - Selection Statements, Iteration Statements and Jump Statements; Functions; Command Line Arguments; Variable Length Arguments; Classes; Abstract Classes; Interfaces. [***Use proper naming conventions***] **OOP Concepts :-** Data abstraction, encapsulation, inheritance, polymorphism, Procedural and	**10**

	object oriented programming paradigm; Microservices. **Object Oriented Programming in Java :-** Declaring Objects; Object Reference; Introduction to Methods; Constructors; Access Modifiers; ***this*** keyword.	
2	**Polymorphism :-** Method Overloading, Using Objects as Parameters, Returning Objects, Recursion**.** Static Members, Final Variables, Inner Classes. **Inheritance -** Super Class, Sub Class, Types of Inheritance, The ***super*** keyword, protected Members, Calling Order of Constructors. Method Overriding, Dynamic Method Dispatch, Using ***final*** with Inheritance.	**8**
3	**Packages and Interfaces –** Packages - Defining a Package, CLASSPATH, Access Protection, Importing Packages. **Interfaces -** Interfaces v/s Abstract classes, defining an interface, implementing interfaces, accessing implementations through interface references, extending interface(s). **Exception Handling -** Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause, Multiple catch Clauses, Nested ***try*** Statements, ***throw***, ***throws*** and ***finally***, Java Built-in Exceptions, Custom Exceptions**.** **Introduction to design patterns in Java :** Singleton and Adaptor.	**9**
4	**SOLID Principles in Java (https://www.javatpoint.com/solid-principles-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. **Event handling –** Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model**.** **Developing Database Applications using JDBC –** JDBC overview, Types, Steps, Common JDBC Components, Connection Establishment, SQL Fundamentals [***For projects only***] - Creating and Executing basic SQL Queries, Working with Result Set, Performing CRUD Operations with JDBC.	**10**

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.
   - BorrowTransaction: 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.
   - CreditCardPayment: Inherits from Payment, with specific implementation for processing credit card payments.
   - PayPalPayment: Inherits from Payment, with specific implementation for processing PayPal payments.
   - BankTransferPayment: Inherits from Payment, with specific implementation for processing bank transfer payments.
   - PaymentProcessor: A class to manage and process different types of payments.

b. Functionalities
   - Add Payment Method: Add new payment methods (CreditCardPayment, PayPalPayment, BankTransferPayment) 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
• 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	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	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3	3		3							3
CO4	3	3	3		3							3
CO5	3	3	3		3							3

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 S3

DIGITAL ELECTRONICS AND LOGIC DESIGN

(Common to Group A)

Course Code	GAEST305	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	**Introduction to digital Systems :-** Digital abstraction Number Systems – Binary, Hexadecimal, grouping bits, Base conversion; Binary Arithmetic – Addition and subtraction, Unsigned and Signed numbers; Fixed-Point Number Systems; Floating-Point Number Systems Basic gates- Operation of a Logic circuit; Buffer; Gates - Inverter, AND gate, OR gate, NOR gate, NAND gate, XOR gate, XNOR gate; Digital circuit operation - logic levels, output dc specifications, input dc specifications, noise margins, power supplies; Driving loads - driving other gates, resistive loads and LEDs. **Verilog (Part 1)** :- HDL Abstraction; Modern digital design flow - Verilog constructs: data types, the module, Verilog operators.	11
2	**Combinational Logic Design: –** Boolean Algebra - Operations, Axioms, Theorems; Combinational logic	11

	analysis - Canonical SOP and POS, Minterm and Maxterm equivalence; Logic minimization - Algebraic minimization, K-map minimization, Dont cares, Code convertors. **Modeling concurrent functionality in Verilog:-** Continuous assignment - Continuous Assignment with logical operators, Continuous assignment with conditional operators, Continuous assignment with delay.	
3	**MSI Logic and Digital Building Blocks** MSI logic - Decoders (One-Hot decoder, 7 segment display decoder), Encoders, Multiplexers, Demultiplexers; Digital Building Blocks - Arithmetic Circuits - Half adder, Full adder, half subtractor, full subtractor; Comparators. Structural design and hierarchy - lower level module instantiation, gate level primitives, user defined primitives, adding delay to primitives.	**8**
4	**Sequential Logic Design** :- Latches and Flip-Flops- SR latch, SR latch with enable, JK flipflop, D flipflop, Register Enabled Flip-Flop, Resettable Flip-Flop. Sequential logic timing considerations; Common circuits based on sequential storage devices - toggle flop clock divider, asynchronous ripple counter, shift register. **Finite State Machines :-** Finite State Machines - logic synthesis for an FSM, FSM design process and design examples; Synchronous Sequential Circuits - Counters; **Verilog (Part 2)** : - Procedural assignment; Conditional Programming constructs; Test benches; Modeling a D flipflop in Verilog; Modeling an FSM in Verilog.	**14**

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks. **(8x3 =24 marks)**	• 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. **(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	Summarize the basic concept of different number systems and perform conversion and arithmetic operations between different bases.	**K2**
CO2	Interpret a combinational logic circuit to determine its logic expression, truth table, and timing information and to synthesize a minimal logic circuit through algebraic manipulation or with a Karnaugh map.	**K2**
CO3	Illustrate the fundamental role of hardware description languages in modern digital design and be able to develop the hardware models for different digital circuits.	**K3**
CO4	Develop MSI logic circuits using both the classical digital design approach and the modern HDL-based approach.	**K3**
CO5	Develop common circuits based on sequential storage devices including counter, shift registers and a finite state machine using the classical digital design approach and an HDL-based structural approach.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	3	3	3	3	3							3

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 Design and Computer Architecture - RISC-V Edition	Sarah L. Harris, David Harris	Morgan Kaufmann	1/e, 2022

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…)	
Module 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 S3

ECONOMICS FOR ENGINEERS

(Common to All Branches)

Course Code	**UCHUT346**	**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/Microproject	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
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks **(6x3 =18marks)**	• 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	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

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 S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	**UCHUT347**	**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	**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**. **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**,	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	**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.	**6**
3	**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.	**6**
4	**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. **Environmental**	**6**

	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.	

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	PO12
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

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 & Assessmen	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 S3

DATA STRUCTURES LAB

(Common to CS/CA/CM/CD/CR/AI/AM/AD/CB/CN/CC/CU/CI/CG)

Course Code	**PCCSL307**	**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)	GYEST204	**Course Type**	Lab

Course Objectives :

1. 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 sparse polynomials using arrays
2	Find the transpose of a sparse matrix and sum of two sparse matrices.
3	Convert infix expression to postfix (or prefix) and then evaluate using stack,
4	Implement Queue, DEQUEUE, and Circular Queue using arrays.
5	Implement backward and forward navigation of visited web pages in a web browser (i.e. back and forward buttons) using doubly linked list operations.
6	Implement addition and multiplication of polynomials using singly linked lists.
7	Create a binary tree for a given simple arithmetic expression and find the prefix / postfix equivalent.
8	Implement a dictionary of word-meaning pairs using binary search trees.
9	Find the shortest distance of every cell from a landmine inside a maze.
10	We have three containers whose sizes are 10 litres, 7 litres, and 4 litres, respectively. The 7-litre and 4-litre containers start out full of water, but the 10-litre container is initially empty. We are allowed one type of operation: pouring the contents of one container into another, stopping only when the source container is empty or the destination container is full. We want to know if there is a sequence of pourings that leaves exactly 2 litres in the 7 or 4-litre container. Model this as a graph problem and solve.

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.
13	Implement Bubble sort, Insertion Sort, Radix sort, Quick Sort, and Merge Sort and compare the number of steps involved.
14	The General post office wishes to give preferential treatment to its customers. They have identified the customer categories as Defence personnel, Differently abled, Senior citizen, Ordinary. The customers are to be given preference in the decreasing order - Differently abled, Senior citizen, Defence personnel, Normal person. Generate the possible sequence of completion.
15	Implement a spell checker using a hash table to store a dictionary of words for fast lookup. Implement functions to check if a word is valid and to suggest corrections for misspelled words.
16	Simulation of a basic memory allocator and garbage collector using doubly linked list
17	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?
18	Merge K sorted lists into a single sorted list using a heap. Use a min-heap to keep track of the smallest element from each list. Repeatedly extract the smallest element and insert the next element from the corresponding list into the heap until all lists are merged.

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.	**K5**
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	PO12
CO1	3	3	3	3				3				3
CO2	3	3	3	3				3				3
CO3	3	3	3	3				3				3
CO4	3	3	3	3				3				3

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 Leisesrson, 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 S3

PYTHON PROGRAMMING LAB

(Common to CA / AI)

Course Code	**PCCAL308**	**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)	UCEST105	**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	PO12
CO1	3	2	2	2	2							3
CO2	3	3	2	2	2							3
CO3	3	2	3	2	3							3
CO4	3	2	3	2	3							3

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. Necaise	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 4

COMPUTER SCIENCE AND ENGINEERING
(ARTIFICIAL INTELLIGENCE)

SEMESTER S4

MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-4

(Group A)

Course Code	**GAMAT401**	**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 shortest path algorithm.	**9**

	[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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	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	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	PO12
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	https://onlinecourses.nptel.ac.in/noc22_ma10/preview
2	https://onlinecourses.nptel.ac.in/noc22_ma10/preview
3	https://onlinecourses.nptel.ac.in/noc21_cs48/preview
4	https://onlinecourses.nptel.ac.in/noc21_cs48/preview

SEMESTER S4

DATABASE MANAGEMENT SYSTEMS

(Common to CS/CD/CA/CR/AD/AI/CB/CN/CC/CU/CI/CG)

Course Code	**PCCST402**	**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)	PCCST303	**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 and Interfaces, 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. Refining the ER Design for the COMPANY Database.	**11**
2	**The Relational Data Model and SQL** - The Relational Data Model and Relational Database Constraints-Relational Algebra and Relational Calculus - Structured Query Language (SQL)-Data Definition Language, Data Manipulation Language, Assertions, Triggers, views, Relational Database Design Using ER-to-Relational Mapping.	**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	**11**

	with Two-Phase Locking Techniques- Database Recovery management: Deferred update-immediate update- shadow paging.	
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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	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	PO12
CO1	3	3	3									3
CO2	3	3	3	3						2	2	3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

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,	Sliberschatz 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 S4

OPERATING SYSTEMS

(Common to CS/CD/CM/CR/CA/AD/AI/CB/CN/CC/CU/CI/CG)

Course Code	**PCCST403**	**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	**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) **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) ***Case study**: Linux kernel process management (Book 2, Ch 3)* **Threads and Concurrency**: Concept of a thread, Multithreading benefits, Multithreading models (Book 3 Ch 4) ***Case study:** The Linux Implementation of Threads (Book 2, Ch 3)* **Process scheduling**: Concepts and basic algorithms (Book 1 Ch 7), The Multilevel Feedback Queue: Basic Rules (Book 1 Ch 8) ***Case study:** 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)*	**11**
2	**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) ***Case study****: Linux Kernel Synchronization Methods - Spin Locks, Semaphores, Mutexes (Book 2 Ch 10)* **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)	**12**
3	**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) **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) **Going beyond physical memory** - Swap space, page fault and its control flow, page replacement policies, Thrashing (Book 1 Ch 21, 22)	**11**
4	**I/O system:** Modern System architecture, Programmed I/O, Interrupts, DMA, Device interaction methods, The Device Driver (Book 1 Ch 36), **Hard disk:** Geometry (Book 1 Ch 37), disk scheduling (Book 3 Section 11.2) ***Case study****: Linux I/O schedulers - Elevator, Complete Fair Queuing (Book 2 Ch 14)* **Files and Directories**: The File System Interface - File descriptor, reading and writing files (sequential and random access), Removing files - Hard links and Symbolic links, Creating, reading and deleting directories, Permission bits and Access Control Lists, Mounting a file system (Book 1 Ch 39) **File Organization**: The Inode, The Multi-Level Index (Book 1 Ch 40) ***Case study:*** *VFS Objects and Their Data Structures - The Inode Object, Inode Operations (Book 2 Ch 13)*	**10**

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
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	● 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	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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

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 S4

COMPUTER ORGANIZATION AND ARCHITECTURE

(Common to CS/CD/CR/CA/AD/CB/CN/CC/CU/CG)

Course Code	**PBCST404**	**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)	GAEST305	**Course Type**	Theory

Course Objectives

1. Introduce principles of computer organization and the basic architectural concepts using RISC.
2. Introduce the concepts of microarchitecture, 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. **CISC vs RISC architectures:-** RISC Introduction - Assembly Language, Assembler directives, Assembling. **Programming concepts -** Program flow, Branching, Conditional statements, Loops, Arrays, Function calls; Instruction execution cycle. **Machine language -** Instructions, addressing modes, Stored program concept. Evolution of the RISC Architecture.	**11**
2	**Microarchitecture -** Introduction; Performance analysis; Single-Cycle Processor - Single Cycle Datapath, Single Cycle Control; Pipelined Processor - Pipelined Data Path, Pipelined Control: Hazards, Solving Data/Control Hazards, Performance Analysis.	**11**
3	**Memory Systems:** Introduction; performance analysis; Caches - basic concepts, Cache mapping, Cache replacement, Multiple-Level Caches, Reducing Miss Rate, Write Policy; Virtual Memory - Address Translation; Page Table; Translation Lookaside Buffer; Memory Protection.	**11**
4	**Input / Output -** External Devices; I/O Modules; Programmed I/O, Interrupt Driven I/O; Direct Memory Access; Embedded I/O Systems - Embedded I/O, General Purpose I/O, Serial I/O, Other Peripherals.	**11**

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
• 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 and the features of RISC architecture.	**K2**
CO2	Experiment with the single cycle processor, pipelining, and the associated problems.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Design and Computer Architecture - RISC-V Edition	Sarah L. Harris, David Harris	Morgan Kaufmann	1/e, 2022
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 Kaufaman	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

SEMESTER S4

SOFTWARE ENGINEERING

(Common to CS/CD/CM/CR/CA/AD/AM/CB/CN/CU/CI)

Course Code	**PECST411**	**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	**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. **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. *Case study:* SRS for College Library Management Software	9
2	**Software design -** Software architecture and its importance, Software architecture patterns: Component and Connector, Layered, Repository, Client-Server, Publish-Subscribe, Functional independence – Coupling and Cohesion *Case study:* Ariane launch failure **Object Oriented Software Design -** UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram, Sequence diagram *Case Studies*: Voice mail system, ATM Example **Software pattern -** Model View Controller, Creational Design Pattern types –	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), *Case study* – 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 Configuration Management and its phases, 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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

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/CM/CA/AM/CN/CI)

Course Code	**PECST412**	**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)	GAMAT101, GAMAT201, GAMAT301, PCCST303	**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	**Foundations of Pattern Recognition** **Introduction to Pattern Recognition -** Definitions and applications of pattern recognition, Overview of pattern recognition systems **(Text 2, Chapter 1)** **Statistical Pattern Recognition -** Bayes decision theory, Parametric methods: Maximum likelihood estimation, Bayesian estimation **(Text 1, Chapters 1, 2)** **Non-Parametric Methods -** k-Nearest neighbors, Parzen windows **(Text 2, Chapter 4)**	9
2	**Feature Extraction and Selection** **Feature Extraction -** Importance of feature extraction, Techniques for feature extraction: PCA, LDA, Feature extraction in image and signal processing **(Text 1, Chapter 3)** **Feature Selection -** Importance of feature selection, Techniques for feature	9

	selection: filter methods, wrapper methods, Feature selection criteria **(Text 2, Chapter 6)**	
3	**Supervised and Unsupervised Learning** **Supervised Learning -** Basics of supervised learning, Linear classifiers: perceptron, logistic regression, Support vector machines (SVM) **(Text 1, Chapter 4)** **Unsupervised Learning -** Basics of unsupervised learning, Clustering techniques: k-means, hierarchical clustering, Gaussian Mixture Models **(GMM) (Text 1, Chapter 9)**	9
4	**Advanced Topics and Applications** **Hidden Markov Models (HMMs) -** Basics of HMMs, HMM for sequence modeling, Applications of HMMs in speech and language processing **(Text 1, Chapter 13)** **Ensemble Methods -** Basics of ensemble methods, Bagging, boosting, and random forests, Applications and case studies **(Text 1, Chapter 14)** **Applications and Case Studies -** Real-world applications of pattern recognition, Case studies in image and speech recognition, Future trends in pattern recognition **(Text 2, Chapter 10)**	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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	Understand and Explain fundamental Concepts of Pattern Recognition:	**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	PO12
CO1	3	3	3									3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3		3							3
CO5	3	3	3			3		3				3

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/CD/CM/CR/CA/AD/AM/CB/CN/CU/CG)

Course Code	**PECST413**	**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)	GYEST204	**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. ***[Text Ch. 1, 2, 3, 4, 5]***	**9**
2	Programming with Lists; Defining Functions over Lists; Playing the Game: I/O in Haskell; Reasoning about Programs; ***[Text Ch. 6, 7, 8, 9]***	**9**
3	Generalization: Patterns of Computation; Higher-order Functions; Developing Higher-order Programs; Overloading, Type Classes and Type Checking. ***[Text Ch. 10 11, 12, 13]***	**9**
4	Algebraic Types; Case Study - Huffman Codes; Abstract Data Types; Lazy Programming; Time and Space Behaviour. ***[Text Ch. 15, 16, 17, 20]***	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	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	PO12
CO1	3	2			3							3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3		3							3

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 S4

NATURE INSPIRED COMPUTING TECHNIQUES

(Common to CA/AI)

Course Code	**PECAT414**	**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 the knowledge and skills required to design and implement Bio-inspired optimization techniques to problems using evolutionary algorithms like Genetic Algorithms and various Swarm optimization techniques such as ACO, ABC, and PSO.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:-** Optimization Techniques- Introduction to Optimization Problems, Single and Muti-objective Optimization Classical Techniques, Overview of various Optimization methods, Evolutionary Computing. Genetic Algorithm and Genetic Programming - Basic concept; Bio- inspired Computing (BIC) -Motivation, Overview of BIC, Usage of BIC, Merits and demerits of BIC.	**8**
2	**Swarm Intelligence: -** Biological foundations of Swarm Intelligence, Swarm Intelligence in Optimization. Ant Colonies - Ant Foraging Behaviour, Towards Artificial Ants; Ant Colony Optimization (ACO) – S-ACO, Ant Colony Optimization Metaheuristic, Combinatorial Optimization, ACO Metaheuristic Problem solving using ACO, Local search methods, Scope of ACO algorithms.	**8**
3	**Swarm Robotics :-** Foraging for food, Clustering of objects, Collective Prey retrieval, Scope of Swarm Robotics; Social Adaptation of Knowledge - Particle Swarm, Particle Swarm Optimization (PSO), Particle Swarms for Dynamic Optimization Problems; Artificial Bee Colony (ABC) Optimization biologically inspired algorithms in engineering.	**10**
4	Other Swarm Intelligence algorithms - Fish Swarm, Bacteria foraging,	**10**

	Intelligent Water Drop Algorithms, Applications of biologically inspired algorithms in engineering; Case Studies:- ACO and PSO for NP-hard problems , Routing problems, Assignment problems, Scheduling problems, Subset problems, Machine Learning Problems, Travelling Salesman Problem.	

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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. **(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	Describe the fundamentals in bio-inspired optimization techniques which influence computing.	**K2**
CO2	Make use of the concepts of Genetic algorithms in various domains.	**K3**
CO3	Comprehend the concepts of Swarm Intelligence and collective systems such as ACO, ABC, and PSO.	**K2**
CO4	Illustrate the concepts of biologically inspired algorithmic design.	**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	PO12
CO1	**3**	**2**										**2**
CO2	**3**	**2**										**2**
CO3	**3**	**3**	**3**									**2**
CO4	**3**	**2**										**2**

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 Evolutionary Computing	A. E. Elben, J. E. Smith	Springer	2/e,2015
2	Bio-Inspired Artificial Intelligence Theories, Methods, and Technologies	Floreano D. , Mattiussi C	MIT Press,	1/e,2008
3	Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications	Leandro Nunes de Castro	Chapman & Hall/ CRC	1/e, 2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Swarm Intelligence: From Natural to Artificial Systems	Eric Bonabeau, Marco Dorigo, Guy Theraulaz	Oxford University Press	1/e,2000
2	Ant Colony Optimization	Marco Dorigo and Thomas Stutzle	MIT Press	1/e, 2004
3	Swarm Intelligence Introduction and Application	Christian Blum and Daniel Merkle	Springer	1/e,2008

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.academia.edu/15627526/Nature_inspired_computing_technology_and_applications
2	https://nptel.ac.in/courses/112103301
3	http://digimat.in/nptel/courses/video/106106226/L33.html
4	https://onlinecourses.nptel.ac.in/noc21_me43/preview

SEMESTER S4

SIGNALS AND SYSTEMS

(Common to CS/CD/CM/CA/AM/CB/CN/CU/CI)

Course Code	**PECST416**	**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.
3. To provide the learner the concepts of a DT system, how it behaves to an arbitrary input, and also to analyze the behaviour of a given DT system based on z-transform

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**1D Signals -** A general introduction to real time signals - CT and DT signals, Sinusoids, Spectrum representation, Sampling and Aliasing (Concept only), Analog frequency and Digital frequency. Elementary sequences- Real Sinusoidal Sequences, Complex Exponential Sequences. - Unit impulse, step and ramp sequences, Representation of discrete time signals- (Graphical representation, Functional representation, Sequence representation) **Properties of DT Signals -** Even and Odd, Periodic and non periodic signal, Energy and Power signals. Periodicity and Symmetry property of DT signals, support of sequences, Bounded Sequences. **Operations on Signals -** Time shifting (Translation), Time Reversal (Reflection), Time scaling - Upsampling and downsampling **DTFS -** Determining the Fourier-Series Representation of a Sequence, Properties of Discrete-Time Fourier Series - Linearity, Translation (Time Shifting) , Modulation (Frequency Shifting), Reflection (Time Reversal), Conjugation, Duality, Multiplication, Parseval's Relation, Even/Odd symmetry, Real sequence.	8

	(Practice of Visualization of a discrete time signal and operations on the DT signal using python. Demonstration of sampling and reconstruction using Python/Matlab.)	
2	Discrete-Time Fourier Transform for Aperiodic Sequences - Properties of the Discrete-Time Fourier Transform (Periodicity, Linearity, Translation (Time Shifting), Modulation (Frequency-Domain Shifting), Conjugation, Time Reversal, Convolution, Multiplication, Frequency-Domain Differentiation, Differencing, Parseval's theorem, Even/Odd symmetry, real sequences) DTFT of periodic sequences - Frequency Spectra of Sequences, Bandwidth of Sequences, Energy density spectra, Characterizing LTI Systems Using the Fourier Transform.	**10**
3	Discrete time systems - Block diagram representation and mathematical representation of discrete-time systems-Some common elements of Discrete-time systems (adder, constant multiplier, signal multiplier, unit delay, unit advance), Recursive DT systems and non recursive discrete time systems, Relaxed system, Linearity and time invariance property of a DT system. Discrete time LTI systems - Discrete time convolution, Properties of Convolution, Characterizing LTI Systems and Convolution - Impulse response of an LTI system, Difference equation, Properties of an LTI system - Causality, Memory, Invertibility, BIBO Stability, Eigen Sequences/ eigen functions for discrete-Time LTI Systems.	**9**
4	**Z transform** - motivation for z transform, Relationship Between z Transform and Discrete-Time Fourier Transform, Region of Convergence for the z Transform. Properties of z transform - Translation (Time Shifting), Complex Modulation (z-Domain Scaling), Conjugation, Time Reversal, Upsampling (Time Expansion, Downsampling, Convolution, z-Domain Differentiation, Differencing, Initial and Final Value Theorems Determination of the Inverse z Transform LTI systems and difference equations, Characterizing LTI systems using z transform, Transfer function of an LTI system. Solving Difference Equations Using the Unilateral z Transform Block Diagram Representation of Discrete-Time LTI Systems, Interconnection of LTI systems.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	Demonstrate the concept and different types of DT signals and the effect of different operations on the signals.	**K2**
CO2	Explain how DTFS can be used to represent a periodic DT signal.	**K2**
CO3	Apply the concept of DTFT for an aperiodic signal to determine the frequency spectrum.	**K3**
CO4	Utilize the properties of a DT system based on its impulse response and z transform.	**K3**
CO5	Identify the response of a DT LTI system to an arbitrary input sequence.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	2	2								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

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	A Nagoor 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

(Common to CS/CD/CM/CR/CA/AD/AI/AM/CB/CN/CI)

Course Code	**PECST417**	**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. Basic models of artificial neural networks – Connections, Learning, 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, Linguistic hedges Fuzzy Relations, Fuzy If-Then Rules, Fuzzification, Defuzzification– Lamda cuts, Defuzzification methods. Fuzzy Inference mechanism - Mamdani and Sugeno types.	9
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**

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	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	PO12
CO1	3	3	3									3
CO2	3	3	2	2								3
CO3	3	3	3	2								3
CO4	3	3	2	2								3
CO5	3	3	3									3

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	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.Vijaylakshmi 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 4

CYBER ETHICS, PRIVACY AND LEGAL ISSUES

(Common to CS/CM/CA/AM)

Course Code	**PECST419**	**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	**Cyber crime and Cyber Ethics:-** Cyber crime and Cyber Ethics:- Introduction to cybercrime- Definition and Origins of Cyber crime- Classifications of Cybercrime, Cyber Offences- Strategic Attacks, Types of Attacks, Security Challenges Faced by Mobile Devices. Organizational	9

	Measures for Handling Mobile Phones. 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.	
3	**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	**9**
4	**Security Policies and Information Technology Act** 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.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	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	PO12
CO1	2	2										2
CO2	2	2										2
CO3	2	2										2
CO4	2	2										2

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 S4

ALGORITHM ANALYSIS AND DESIGN

Course Code	PECAT415	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST303	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 quip 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. Classifying functions by their asymptotic growth rate, 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, Binary search, Recurrence equation for divide and conquer, Finding the maximum and minimum, Merge sort, Strassen's matrix multiplication, Advantages and Disadvantages of divide and conquer; Decrease and Conquer Approach - Topological Sort;	9

	The Control Abstraction of Greedy Strategy- Fractional Knapsack Problem, 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; 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, Hamiltonian cycles. Branch and Bound - General method, Travelling Salesperson Problem, 0/1 knapsack 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):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
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**
• 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.	**K5**
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	PO12
CO1	3	3	2	3								3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

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 Brately	Pearson	1/e, 1996

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/VxwnDYt80rQ?si=CyX07_Nc1ZLi4Qtb https://youtu.be/-Lw8isQCi4g?si=ndYWVodltfaieCOV https://youtu.be/uWpFXTUXMXw?si=4aR0SPwZl4GcVp0N https://youtu.be/hK6R4zUgtho?si=Xp_XuaR-3zkGJMtI
2	https://youtu.be/_VV9v41FIq0?si=SfxKb5Uw7lbJ6vgZ https://youtu.be/3AtyFp0T6lI?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 S4

ADVANCED DATA STRUCTURES

(Common to CS/CD/CM/CA/AM/CB/CN/CC/CU/CI/CG)

Course Code	**PECST495**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST303		

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):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
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**
• 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	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	PO12
CO1	3	3	3	2	3						2	3
CO2	3	3	3	3	3						2	3
CO3	3	3	3	3	3						2	3
CO4	3	3	3	3	3						2	2

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, SatrajSahani 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/

SEMESTER S4

ECONOMICS FOR ENGINEERS

(Common to All Branches)

Course Code	**UCHUT346**	**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 -	**6**

	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	
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: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ 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
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks **(6x3 =18marks)**	• 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	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

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 S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	**UCHUT347**	**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	**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**. **Basic concepts in Gender Studies** - sex, gender, sexuality, gender	**6**

	spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, **Gender disparity and discrimination in education**, 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	**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.	**6**
3	**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.	**6**
4	**Renewable Energy and Sustainable Technologies:** Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in	**6**

	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. **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.	

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	PO12
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

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 & Assessmen	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 S4

OPERATING SYSTEMS LAB

(Common to CS/CD/CM/CR/CA/AI/CB/CN/CC/CU/CI/CG)

Course Code	**PCCSL407**	**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)	GYEST204	**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 **pstree** 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	**Inter-process Communication (https://www.linuxdoc.org/LDP/lpg/node7.html)** (a) Using Pipe – Evaluate the expression $\sqrt{b^2 - 4ac}$. The first process evaluates b^2. The second process evaluates $4ac$ and sends it to the first process which evaluates the final expression and displays it. (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. (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**"
8	Write a multithreaded program that calculates the mean, median, and standard deviation for a list of integers. This program should receive a series of integers on the command line and will then create three separate worker threads. The first thread will determine the mean value, the second will determine the median and the third will calculate the standard deviation of the integers. The variables representing the mean, median, and standard deviation values will be stored globally. The worker threads will set these values, and the parent thread will output the values once the workers have exited.
9	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).
10	Use semaphores to solve the readers-writers problem with writers being given priority over readers.
11	Obtain a (deadlock-free) process mix and simulate the banker's algorithm to determine a safe execution sequence.
12	Obtain a process mix and determine if the system is deadlocked.
13	Implement the deadlock-free semaphore-based solution for the dining philosopher's problem.
14	Simulate the address translation in the paging scheme as follows: The program receives three command line arguments in the order ● size of the virtual address space (in megabytes)

	• page size (in kilobytes) • a virtual address (in decimal notation) 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!)
15	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.
16	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.

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	PO12
CO1	3	3	3	3				3				3
CO2	3	3	3	3				3				3
CO3	3	3	3	3				3				3
CO4	3	3	3	3				3				3
CO5	3	3	3	3				3				3

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	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 S4

DBMS Lab

(Common to CS/CD/CR/CA/AD/AI/CB/CN/CC/CU/CI/CG)

Course Code	**PCCSL408**	**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). Export ER diagram from the database and verify relationships (with the ER diagram designed in step 1).
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, Savepoint,Practice of SQL DCL commands for granting and revoking user privileges.
8	Practice of SQL commands for creation of views and assertions.
9	Creation of Procedures, Triggers and Functions.
10	Creation of Packages and cursors.
11	Design a database application using any front-end tool for any problem selected in experiment number 1. The application constructed should have five or more tables**.
12	Perform basic CRUD (Create, Read, Update, Delete) operations on a Cassandra table.
13	Write and execute CQL queries to retrieve specific data from Cassandra tables
14	Create a simple application using Mongodb with python

** The problem must be designed to convey the difference of NoSQL from SQL databases.

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	PO12
CO1	3	3	3	1						3		3
CO2	3	3	3	1						3		3
CO3	3	3	3	1						3		3
CO4	3	3	3	2	3					3		3
CO5	3	3	3	2	3					3	3	3

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

SEMESTER 5

COMPUTER SCIENCE AND ENGINEERING
(ARTIFICIAL INTELLIGENCE)

SEMESTER S5

COMPUTER NETWORKS

(Common to CS/CD/CM/CR/CA/AD/AI/CB/CN/CU/CI)

Course Code	**PCCST501**	**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 core concepts of computer networking.
2. To develop a big picture of the internetworking implementation on Linux-based systems.
3. To impart an overview of network management concepts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of the Internet, Protocol layering (Book 1 Ch 1) Application Layer: Application-Layer Paradigms, Client-server applications - World Wide Web and HTTP, FTP. Electronic Mail, DNS. Peer-to-peer paradigm - P2P Networks, Case study: BitTorrent (Book 1 Ch 2)	6
2	Transport Layer: Services, Protocols, UDP, TCP (Book 1 Ch 3). ***Hands-on: Sockets Introduction, Elementary TCP Sockets, TCP Client/Server Example, I/O Multiplexing: The select and poll Functions (Book 2 Ch 3 to 6), Elementary UDP Sockets (Book 2 Ch 8), Advanced I/O Functions (Book 2 Ch 14)*** Network Layer: Introduction, Network-layer protocols, Unicast routing, Multicast routing - Multicasting Basics, Intra domain and inter-domain routing, Next generation IP (Book 1 Ch 4), Quality of Service (Book 1 Ch 8) ***Hands-on: Linux Kernel Implementation of Routing Table and Caches, Routing Cache Implementation Overview, Adding new entry in the Routing***	18

	Table using ip command (Book 3 Ch 14)	
3	Data-Link Layer: Data link control (DLC), Multiple access protocols (MAC), Link-layer addressing, Ethernet protocol, Connecting devices (Book 1 Ch 5) Wireless LANs, Mobile IP (Book 1 Ch 6) ***Hands-on: Datalink Provider Interface, SOCK_PACKET and PF_PACKET (Book 2 Ch 29)***	**11**
4	SNMP, ASN.1 (Book 1 Ch 9) Physical Layer: Data and signals, Digital transmission, Analog transmission, Bandwidth utilization, Transmission media (Book 1 Ch 7)	**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
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● 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. **(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	Understand the internetworking design in terms of protocol stack and the role of various application layer protocols	**K2**
CO2	Illustrate the functions of the transport layer from connectionless and connection-oriented perspectives	**K3**
CO3	Identify how the network layer achieves host-to-host connectivity and caters to the diverse service requirements of the host applications	**K3**
CO4	Explain the nuances of the data link layer design and demonstrate the various data link link layer protocols	**K3**
CO5	Describe the fundamental characteristics of the physical layer and understand how the physical layer supports the functionalities of the top layers	**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	PO12
CO1	3											3
CO2	3	2										3
CO3	3	2			2							3
CO4	3	2										3
CO5	3											3

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	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017
2	Unix Network Programming, Volume 1: The Sockets Networking API	W. Richard Stevens, Andrew M. Rudoff, Bill Fenner	Pearson Education	3/e, 2004
3	TCP/IP Architecture, design, and implementation in Linux	Sameer Seth M. Ajaykumar Venkatesulu	Wiley	1/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networking: A Top-Down Approach Featuring Internet	J. F. Kurose and K. W. Ross	Pearson Education	8/e, 2022
2	Computer Networks, A Systems Approach	L. L. Peterson and B. S. Davie	Morgan Kaufmann	5/e, 2011

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://nptel.ac.in/courses/106/105/106105183/

SEMESTER S5

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Course Code	PCCAT502	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	10

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	10
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	Continuous Assessment (Accurate Execution of Programming Tasks)	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Internal Examination- 3 (Lab Examination)	Total
5	5	10	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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	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	Implement learning techniques such as inductive learning, decision trees, and reinforcement learning for developing intelligent systems.	**K3**
CO5	Develop expert systems, considering their structures, knowledge acquisition methods, and ethical implications in AI 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	PO12
CO1	3	2	2									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

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/u1qrVIwijbw
4	https://youtu.be/nE5c5w4aizU

SEMESTER S5

MACHINE LEARNING

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

Course Code	**PCCST503**	**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 impart the fundamentals principles of machine learning in computer and science.
2. To provide an understanding of the concepts and algorithms of supervised and unsupervised learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to ML :-** Machine Learning vs. Traditional Programming, Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. Parameter Estimation - Maximum likelihood estimation (MLE) and maximum aposteriori estimation (MAP), Bayesian formulation. **Supervised Learning :-** Feature Representation and Problem Formulation, Role of loss functions and optimization Regression - Linear regression with one variable, Linear regression with multiple variables : solution using gradient descent algorithm and matrix method.	9
2	**Classification** - Logistic regression, Naïve Bayes, KNN, Decision Trees – ID3	9

	Generalisation and Overfitting - Idea of overfitting, LASSO and RIDGE regularization, Idea of Training, Testing, Validation Evaluation measures – Classification - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC). Regression - Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination.	
3	SVM – Linear SVM, Idea of Hyperplane, Maximum Margin Hyperplane, Non-linear SVM, Kernels for learning non-linear functions Neural Networks (NN) - Perceptron, Neural Network - Multilayer feed-forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm.	**9**
4	**Unsupervised Learning** Clustering - Similarity measures, Hierarchical Clustering - Agglomerative Clustering, partitional clustering, K-means clustering Dimensionality reduction - Principal Component Analysis, Multidimensional scaling Ensemble methods - bagging, boosting; Resampling methods - Bootstrapping, Cross Validation. Practical aspects - Bias-Variance tradeoff.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Illustrate Machine Learning concepts and basic parameter estimation methods.	**K2**
CO2	Demonstrate supervised learning concepts (regression, classification).	**K3**
CO3	Illustrate the concepts of Multilayer neural network and Decision trees	**K3**
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques	**K3**
CO5	Use appropriate performance measures to evaluate machine learning models	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

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 Machine Learning	Ethem Alpaydin	MIT Press	4/e, 2020
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki | Wagner Meira	Cambridge University Press	1/e, 2016
3	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1/e, 1998

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Applied Machine Learning	M Gopal	McGraw Hill	2/e, 2018
2	Machine Learning using Python	Manaranjan Pradhan | U Dinesh Kumar	Wiley	1/e, 2019
3	Machine Learning: Theory and Practice	M.N. Murty, V.S. Ananthanarayana	Universities Press	1/e, 2024

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105152/
2	https://archive.nptel.ac.in/courses/106/106/106106139/
3	https://nptel.ac.in/courses/106106202\

SEMESTER S5

ADVANCED GRAPH ALGORITHM

Course Code	**PBCAT504**	**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)	GAMAT401	**Course Type**	Theory

Course Objectives:

1. To provide a comprehensive understanding of the fundamental concepts of graphs and trees.
2. To learn matching and covering algorithms, connectivity and path effectively.
3. To equip the learner to apply vertex coloring, planar graph, Line graph and edge coloring effectively.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Graphs & its Applications, Basics of Paths, Cycles, and Trails, Connection, Bipartite Graphs, Eulerian Circuits, Vertex Degrees and Counting, Degree-sum formula, The Chinese Postman Problem and Graphic Sequences. Trees and Distance, Properties of Trees, Spanning Trees and Enumeration, Matrix-tree computation, Cayley's Formula, Prufer code	**12**
2	Matchings and Covers, Hall's Condition, Min-Max Theorem, Independent Sets, Covers and Maximum Bipartite Matching, Augmenting Path Algorithm, Weighted Bipartite Matching, Hungarian Algorithm. Stable Matchings and Faster Bipartite Matching, Factors & Perfect Matching in General Graphs, Matching in General Graphs: Edmonds' Blossom Algorithm	**12**
3	Connectivity and Paths: Cuts and Connectivity, k-Connected Graphs, Network Flow Ford-Fulkerson Labeling Algorithm, Max-Flow Min-cut	**10**

	Theorem, Menger's Proof using Max-Flow Min-Cut Theorem Vertex Coloring and Upper Bounds, Brooks' Theorem and Color-Critical Graphs, Counting Proper Colorings.	
4	Planar Graphs, Characterization of Planar Graphs, Kuratowski's Theorem, Wagner's Theorem Line Graphs and Edge-coloring, Hamiltonian Graph, Traveling Salesman Problem and NP-Completeness, Dominating Sets.	**10**

Suggestion on Project Topics

- Applications of advanced graph theory in routing, social network analysis , disease spreading models etc

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Examination-1	Internal Examination-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
• 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 sub divisions. • 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 fundamental graph concepts and algorithms to analyse and solve problems involving paths, cycles, trees, and network optimization.	**K3**
CO2	Illustrate matching and covering problems in graphs using algorithms and theorems, including Hall's Condition, the Min-Max Theorem, and the Hungarian Algorithm.	**K3**
CO3	Apply connectivity and paths including Network Flow Ford-Fulkerson Labeling Algorithm, Max-Flow Min-cut Theorem, Menger's Proof using Max-Flow Min-Cut Theorem	**K3**
CO4	Illustrate Vertex Coloring and Upper Bounds, Brooks' Theorem and Color-Critical Graphs, Counting Proper Colorings.	**K3**
CO5	Apply concepts of planar graphs, including Kuratowski's and Wagner's theorems, to analyze graph planarity and edge-coloring, while solving complex problems related to Hamiltonian graphs, the Traveling Salesman Problem, and dominating sets	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

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 Graph Theory	D.B. West	Pearson Publication	2/e, 2001
2	Introduction to Graph Theory	Robin J. Wilson	Longman Group Ltd	5/ e, 2015
3	Graph theory with Applications	J.A. Bondy and U.S.R. Murty.	Elsevier Science Publishing Co.., Inc	1/e, 1982

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Graph Theory	R.Diestel	Springer	4/e, 2010
2	Graph theory and its application	Jay Yellen, Jonathan L. Gross, et al.	CRC press	3/e, 2019
3	Modern Graph Theory	Bela Bollobas	Springer	1/e, 1998
4	Network Flows: Theory, Algorithms, and Applications	Ravindra Ahuja, Thomas Magnanti, et al.	Prentice-Hall	1/e, 1993

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_cs48/preview
2	(14) Graph Theory by Sarada Herke - YouTube
3	(14) Graph Algorithms - YouTube
4	(14) distanceedjohn - YouTube

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 S5

SOFTWARE PROJECT MANAGEMENT

(Common CS/CD/CM/CR/CA/AD/AM)

Course Code	**PECST521**	**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)	PECST411	**Course Type**	Theory

Course Objectives:

1. To learn the techniques to effectively plan, manage, execute, and control projects within time and cost targets with a focus on Information Technology and Service Sector.
2. To learn agile project management techniques such as Scrum and DevOps.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Project scheduling and feasibility study : -** Project Overview and Feasibility Studies - Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal; Project Scheduling - Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.	**8**
2	**Resource Scheduling, Cost Control and Project management Features :-** Cost Control and Scheduling - Project Cost Control (PERT/Cost), Resource Scheduling & Resource Levelling; Project Management Features - Risk Analysis, Project Control, Project Audit and Project Termination.	**8**
3	**Agile Project Management :-** Agile Project Management - Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL;. Other Agile Methodologies - Introduction to	**9**

	XP, FDD, DSDM, Crystal.	
4	**Scrum and DevOps in project management :-** Scrum - Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum, Case Study; DevOps - Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test-Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring, Case Study.	**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
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● 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. **(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	Understand how effectively plan, and schedule projects within time and cost targets	**K2**
CO2	Apply project estimation and evaluation techniques to real world problem	**K3**
CO3	Discuss different Agile Project Methodologies	**K2**
CO4	Apply various SCRUM practices in project management.	**K3**
CO5	Demonstrate the techniques used in DevOps.	**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	PO12
CO1	3	3	3								2	2
CO2	3	3	3								2	2
CO3	3	3	3								2	2
CO4	3	3	3								2	2
CO5	3	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	Succeeding with Agile: Software Development Using Scrum	Mike Cohn	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	Agile Product Management with Scrum	Roman Pichler	Addison-Wesley	1/e, 2010
2	Agile Project Management with Scrum	Ken Schwaber	Microsoft Press	1/e, 2004

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs70/
2	https://www.youtube.com/watch?v=TPEgII1OilU
3	https://www.youtube.com/watch?v=7Bxdds2siU8

SEMESTER 5

ARTIFICIAL NEURAL NETWORKS TECHNIQUES

Course Code	**PECAT522**	**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 help the learners in recognizing and modelling complex patterns and relationships in data that might be challenging for traditional algorithms to handle.
2. To enable the students to create models that can predict future outcomes based on historical data, which is valuable in various domains such as finance, healthcare, and marketing.
3. To equip the learners to perform classification tasks in a better way, such as image and speech recognition, where they can categorize input data into predefined classes with high accuracy.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Artificial Neural Networks:** Human Brain, Model of an artificial Neuron, Basic concepts of Neural Networks, Fundamentals of Biological Neural Network and Artificial Neural Network, Types of activation functions, Applications of Neural Networks. **Learning Methods** - Supervised, Unsupervised and reinforcement, Taxonomy of Neural Network Architectures, Terminologies – weights, bias, threshold, learning rate, Applications of Neural Networks.	**8**
2	**Basic of ANN Model** : McCulloch-Pitts Neuron, Architecture, Algorithm and Applications. Biases and Thresholds, Linear Separability. Hebb Net - Algorithm, Applications. Perceptron - Architecture, Algorithm, Applications. Perceptron Learning Rule Convergence Theorem. Adaline - Architecture, Algorithm, Applications.	**9**
3	**Multilayer Perceptrons:** Multi-Layered network architecture, Back propagation Algorithm, Applications, XOR problem, Replacing and Modifying Back propagation Algorithms Using Heuristics.	**10**

	Cover's Theorem on the Separability of Patterns, The Interpolation Problem, Radial Basis Function Networks, Comparison of MLP and RBF Networks (Theory only).	
4	**SOMs and ART Networks** : Self-organizing maps - Building, Training, Evaluating, Interpreting and Visualizing a Self- organizing Map. Applications of Self Organizing Maps. Adaptive Resonance Theory -Stability Plasticity Dilemma, ART-1- Architecture, Algorithm, Applications. ART-2 – Architecture, Algorithms, Applications.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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 basic concepts and the learning rules of ANN.	**K2**
CO2	Identify the fundamental learning algorithms namely, Mc-Culloch Pitts, Hebb Perceptron and Adaline to solve real world problems.	**K2**
CO3	Illustrate Back propagation learning algorithm, Generic Radial Basis Function network.	**K3**
CO4	Demonstrate Self Organizing Maps and Adaptive Resonance Theory.	**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	PO12
CO1	2	2										2
CO2	3	2										2
CO3	3	2										2
CO4	3	2										2

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 neural networks: An Introduction	Kevin L. Priddy, Paul E. Keller	SPIE Press	1/e, 2005
2	Neural networks, A Comprehensive Foundation	Simon Hykin	Pearson Education	2/e,1997

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Neural Networks – A classroom approach	Satish Kumar	Tata McGraw-Hill Publishing Company Limited	2/e, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Introduction to Artificial Neural Networks https://nptel.ac.in/courses/117105084
2	Deep Learning https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3	Machine Learning And Deep Learning -- Fundamentals And Applications, IIT Guwahati- https://nptel.ac.in/courses/108103192

SEMESTER S5

KNOWLEDGE ENGINEERING

Course Code	PEAIT521	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 impart a comprehensive understanding of knowledge representation, reasoning, and real-world applications.
2. To provide the concepts of constructing and applying semantic networks, ontologies, and rule-based systems
3. To help the learner master probabilistic and fuzzy logic techniques for reasoning under uncertainty and designing ethical knowledge-based systems for specific domains.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Knowledge Engineering** Definition of knowledge engineering, Role of knowledge in AI, Knowledge representation languages (e.g., semantic networks, ontologies, production rules), Knowledge acquisition techniques (e.g., expert interviews, knowledge elicitation), Applications of Knowledge Engineering Expert systems: Development, applications, and limitations.	9
2	**Natural language processing:** Knowledge-based approaches Semantic Networks and Ontologies **Semantic networks:** Structure, properties, and applications, Ontologies: Definition, components, and benefits, Ontology development methodologies (e.g., ontology engineering, ontology-based systems)	9
3	**Production Rules and Rule-Based Systems**	9

	Production rules: Syntax, semantics, and inference mechanisms Rule-based systems: Architecture, forward chaining, backward chaining Applications of rule-based systems (e.g., expert systems, decision support systems) Application in Robotics: Knowledge representation and planning	
4	**Uncertainty and Reasoning under Uncertainty** Uncertainty in knowledge representation: Probability theory, fuzzy logic, possibility theory, Reasoning under uncertainty: Bayesian networks, probabilistic reasoning, fuzzy inference, Applications of uncertainty reasoning (e.g., medical diagnosis, risk assessment)	**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
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● 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. **(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	Define knowledge engineering, identify knowledge representation languages, and describe knowledge acquisition methods.	**K2**
CO2	Explain semantic networks and ontologies, and analyze their benefits.	**K2**
CO3	Describe various rule-based systems, and evaluate their effectiveness.	**K2**
CO4	Apply probabilistic and fuzzy logic techniques, and evaluate the effectiveness of uncertainty 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	PO12
CO1	**3**											**2**
CO2	**2**	**3**										**2**
CO3	**2**	**2**										**2**
CO4	**2**	**3**	**3**									**2**

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 Education	4/e, 2021
2	An Introduction to Knowledge Engineering	Simon Kendal, Simon L. Kendal, Malcolm Creen	Springer London	1/e, 2007
3	Modeling with Rules Using Semantic Knowledge Engineering	Grzegorz J. Nalepa	Springer International Publishing	1/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Guide to Expert Systems	Wateman, Waterman Donald A.	Pearson	1/e, 1986
2	Building Expert Systems Principles, Procedures, and Applications	Elias M. Awad	West Publishing Company	1/e,1996
3	Knowledge Engineering Principles, Methods and Applications	Alfonso Perez Gama ·	Nova Science Publishers	2/e, 2015
4	Knowledge Acquisition in Practice : A Step-by-step Guide	N. R. Milton	Springer London	1/e, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	**Artificial Intelligence: Knowledge Representation and Reasoning , IIT Madras** **Prof. Deepak Khemani** **https://nptel.ac.in/courses/106106140**
3	**Artificial Intelligence : Search Methods For Problem solving** **By Prof. Deepak Khemani | IIT Madras** **https://onlinecourses.nptel.ac.in/noc24_cs88/preview**
4	**Decision-Making Under Uncertainty** **By Prof. N. Gautam | Syracuse University** **https://onlinecourses.nptel.ac.in/noc24_mg69/preview**

SEMESTER S5

HEALTHCARE ANALYTICS

Course Code	**PEAIT523**	**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 health data formats, health care policy and standards and the significance and need of data analysis and data visualization.
2. To make the learner aware of the health data management frameworks and to help them to use of machine learning and deep learning algorithms in healthcare

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Healthcare Analysis** - Overview - History of Healthcare Analysis Parameters on medical care systems- Health care policy- Standardized code sets – Data Formats – Machine Learning Foundations: Tree Like reasoning , Probabilistic reasoning and Bayes Theorem, Weighted sum approach.	**8**
2	**Analytics on Machine Learning** - Machine Learning Pipeline – Pre-processing –Visualization – Feature Selection – Training model parameter – Evaluation model : Sensitivity , Specificity , PPV ,NPV, FPR , Accuracy , ROC , Precision Recall Curves , Valued target variables – Python: Variables and types, Data Structures and containers , Pandas Data Frame : Operations – Scikit –Learn : Pre-processing , Feature Selection.	**8**
3	**Healthcare Management -** IOT- Smart Sensors – Migration of Healthcare Relational database to NoSQL Cloud Database – Decision Support System – Matrix block Cipher System – Semantic Framework Analysis – Histogram bin Shifting and Rc6 Encryption – Clinical Prediction Models – Visual Analytics for Healthcare.	**10**
4	**Healthcare and Deep Learning -** Introduction on Deep Learning – DFF network CNN- RNN for Sequences – Biomedical Image and Signal Analysis	**10**

	– Natural Language Processing and Data Mining for Clinical Data – Mobile Imaging and Analytics – Clinical Decision Support System.	

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Describe the health data formats, health care policy and standards	**K2**
CO2	Identify the significance and need of data analysis and data visualization	**K2**
CO3	Explain the health data management frameworks	**K2**
CO4	Explain the use of machine learning and deep learning algorithms in healthcare	**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	PO12
CO1	**2**	**2**										**2**
CO2	**3**	**2**										**2**
CO3	**3**	**2**										**2**
CO4	**3**	**2**	**2**									**2**

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	Big Data Analytics in HealthCare	Kulkarni , Siarry, Singh , Abraham, Zhang, Zomaya , Baki,	Springer	1/e, 2020
2	Healthcare Analytics: From Data to Knowledge to Healthcare Improvement,	Hui Yang and Eva K. Lee,	Wiley,	1/e,2016
3	Healthcare Data Analytics	Chandan K. Reddy and Charu C Aggarwal	Taylor & Francis,	1/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Health Care Analysis Made Simple	Vikas Kumar,	Packt	1/e, 2018
2	Health Care Data Analysis and Management	Nilanjan Dey, Amira Ashour, Simon James Fong, Chintan Bhatl,	Academic Press	1/e, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	**Exploring Survey Data on Health Care, IIT Roorkee** https://nptel.ac.in/courses/109107190
2	**Medical Image Analysis** https://onlinecourses.nptel.ac.in/noc24_ee57/preview
3	**Analytics in Healthcare Management and Administration** https://www.coursera.org/learn/analytics-in-healthcare-management-and-administration
4	**Big Data Analytics for Healthcare** https://www.my-mooc.com/en/mooc/bigdataanalytics

SEMESTER S5

DIGITAL SIGNAL PROCESSING

(Common to CS/CM/CA/AM)

Course Code	**PECST526**	**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)	Signals and Systems	**Course Type**	Theory

Course Objectives:

1. To teach the concept of DFT and apply it for filtering data sequences.
2. To educate on the algorithms for complexity reduction in the computation of DFT.
3. To teach the theory of FIR and IIR filters and to design FIR filters.
4. To get exposed to the basic idea of some of the important techniques for designing efficient VLSI architectures for DSP.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Definition of a digital signal processing system, Sampling, Sampling rate, DFT and IDFT (Properties of DFT). Linear Convolution using Circular Convolution, Convolution of long data sequences- Overlap add method, overlap save method. Linear filtering methods based on DFT – FFT (DIT-FFT only) – efficient computation of the DFT of a 2N point real sequences – correlation – use of FFT in linear filtering and correlation, Symmetries in the DFT	**9**
2	Types of transfer functions- Ideal filters, Zero phase and linear phase transfer functions, Types of linear phase FIR transfer functions; Simple digital filters: Simple FIR digital filters (Low pass and high pass), Simple IIR digital filters (Low pass and high pass), All pass and minimum phase transfer function Design of FIR filter : window based design (Rectangular, Hamming, Hanning windows). Applications of DSP-Spectral analysis of sinusoidal signals.	**8**

3	Realization structures for FIR filters- direct, cascade, parallel. IIR Filter realization structures (Direct form I, II, cascade and Parallel and transposed structures); Computational accuracy in DSP implementation- Number formats for signals and coefficients in DSP systems, Dynamic range and precision, Sources of error in DSP implementation - A/D conversion error, DSP computational error, D/A Conversion error.	**9**
4	FFT and FIR Filter realization on a fixed point processor -finite wordlength effects - Quantization, rounding and truncation, overflow and scaling. DSP Algorithm representations, data flow, control flow, signal flow graphs, block diagrams - Loop bound, iteration bound, critical path - Pipelining, parallel processing, low power architectures - Retiming, folding and unfolding techniques, applications. **Hands-on** : - ● FPGA based hardware realization of the FFT algorithm, circular convolution, IIR and FIR filter structures using iVerilog. ● To realize different DSP algorithms including basic multiply accumulation and shifting operations on a fixed point processor. ● Analyze the effect of the finite wordlength by implementing the FFT algorithm and FIR filters by using fixed point coefficient representation in different formats like Q7, Q15 etc. ● Design an FIR low pass filter using MATLAB/SCILAB and check how it filters a speech signal by recording it and playing the result.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 Marks)**	• 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. **(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	Understand the concept of DFT and apply it for determining the spectral information of data sequences.	**K2**
CO2	Apply algorithms for complexity reduction in the computation of DFT.	**K3**
CO3	Use the theory of FIR and IIR filters and be able to design FIR filters using the window method.	**K3**
CO4	Build the IIR and FIR filter transfer functions using suitable structures	**K3**
CO5	Identify the effect of finite wordlength on DSP algorithm implementation.	**K3**
CO6	Utilize the low power architectures for implementing the DSP algorithms	**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	PO12
CO1	3	3	3									2
CO2	3	3	3									2
CO3	3	3	3	3								2
CO4	3	3	3	3								2
CO5	3	3	3	3								2
CO6	3	3	3				3					2

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	Digital Signal Processing [Modules 1,2,3]	S. Salivahanan	McGraw Hill	10/e, 2019
2	Digital Signal Processing: A Computer - Based Approach [Modules 2]	Sanjit K.Mitra	McGraw Hill	4/e, 2013
3	VLSI Signal Processing Systems, Design and Implementation [Module 4]	Keshab K. Parhi	Wiley	1/e, 2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal Processing	John G. Prokais, Dimitris K Manolakis	Pearson	4/e, 2007
2	Introduction to Digital Signal Processing	Johnny R Johnson	Pearson	1/e, 2015
3	Mathematics of the Discrete Fourier Transform (DFT): with Audio Applications	Julius O. Smith III	W3K Publishing	2/e, 2007
4	Digital Signal Processing : Fundamentals, Techniques and Applications	Juan Zhang	Nova Science Publishers	1/e, 2016
5	Fast Fourier Transform Algorithms for Parallel Computers (Vol 2)	Daisuke Takahashi	Springer	1/e,

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/101/108101174/
2	https://methodist.edu.in/web/uploads/files/DSP%20NOTES.pdf

SEMESTER S5

COMPUTER GRAPHICS & MULTIMEDIA

(Common to CS/CD/CR/CA/AD)

Course Code	**PECST527**	**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 strong technological concepts in computer graphics including the three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build applications.
2. To give a good understanding of the multimedia frameworks for audio/video domains and different compression algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basics of Computer graphics -** Basics of Computer Graphics and its applications. Video Display devices - LED, OLED, LCD, PDP and FED and reflective displays. Random and Raster scan displays and systems. **Line and Circle drawing Algorithms -** Line drawing algorithms- Bresenham's algorithm, Liang-Barsky Algorithm, Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's Circle drawing algorithm.	**10**
2	**Geometric transformations -** 2D and 3D basic transformations - Translation, Rotation, Scaling, Reflection and Shearing, Matrix representations and homogeneous coordinates. **Filled Area Primitives -** Scan line polygon filling, Boundary filling and flood filling.	**8**
3	**Transformations and Clipping Algorithms -** Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping	**8**

	algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms. **Three dimensional graphics -** Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm.	
4	**Fundamental of Multimedia -** Introduction to Multimedia, Authoring and Tools, Graphics and Image Data Representations, Popular File Formats, Fundamental Concepts and types of Video, Basics of Digital Audio and its types. **Compression Methods -** Lossless Compression Algorithms- Run-Length Coding, Arithmetic Coding. Lossy Compression Algorithms- Transform Coding. JPEG and JPEG-LS Standard Image Compression, H.261. Video Compression Technique.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Understand the principles of computer graphics and displays	**K2**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	**K3**
CO3	Illustrate 2D and 3D basic transformations and matrix representation	**K3**
CO4	Demonstrate different clipping algorithms and 3D viewing pipeline.	**K3**
CO5	Summarize the multimedia features and specific compression algorithms.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3									3

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	Computer Graphics : Algorithms and Implementations	D. P. Mukherjee, Debasish Jana	PHI	1/e, 2010
2	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4/e, 2013
3	Fundamentals of Multimedia	Ze-Nian Li and Mark S. Drew	Pearson	2003

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Flat Panel Displays	Jiun-Haw Lee, I-Chun Cheng, Hong Hua, Shin-Tson Wu	Wiley	1/e, 2020
2	Computer Graphics and Multimedia	ITL ESL	Pearson	1/e, 2013
3	Computer Graphics	Zhigang Xiang and Roy Plastock	McGraw Hill	2/e, 2000
4	Principles of Interactive Computer Graphics	William M. Newman and Robert F. Sproull	McGraw Hill	1/e, 2001
5	Procedural Elements for Computer Graphics	David F. Rogers	McGraw Hill	1/e, 2017
6	Computer Graphics	Donald D Hearn, M Pauline Baker	Pearson	2/e, 2002

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1, 2, 3	Computer Graphics By Prof. Samit Bhattacharya at IIT Guwahati https://onlinecourses.nptel.ac.in/noc20_cs90/preview
4	Web Based Technologies and Multimedia Applications by Prof. P. V. Suresh at Indira Gandhi National Open University https://onlinecourses.swayam2.ac.in/nou20_cs05/preview

SEMESTER S5

ADVANCED COMPUTER ARCHITECTURE

Course Code	PECST528	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)	PBCST404	Course Type	Theory

Course Objectives:

1. To introduce the advanced processor architectures including parallelism concepts in Programming of multiprocessor and multicomputers.
2. To provide detailed understanding about data flow in computer architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction – The impact of hardware and software technology trends Self review – Instruction set Architecture, Memory addressing, addressing modes Class of Computers, Concept of Computer Hardware and Organization (P15, 5th Edition) Measuring, Reporting and Summarizing Performance, Benchmarks – Desktop and Server Amdahl's Law, Processor Performance Equation ____ *Beyond the books* – Visit www.spec.org. Explore the High Performance Computing benchmarks and compare the results submitted by different vendors for the same benchmark. Are you able to appreciate the need for benchmarks to compare performance? What are retired benchmarks? Can you write a paper and publish results based on a retired benchmark?	9
2	Review the basic Concepts of Parallel Processing and Pipelining Instruction Level Parallelism, data dependencies and hazards Different types of dependences, Compiler Techniques for ILP, Branch Prediction – Correlating	9

	branch predictor Dynamic Scheduling – Idea, Introduction to Tomasulo's scheme. Register Renaming Hardware Speculation, Reorder Buffers Multiple issue and static scheduling, VLIW	
3	Data Level Parallelism. Vector Processors – How do they work, Memory Banks, Stride, Scatter Gather. SIMD-comparison with vector GPU, Comparison of loops in C vs CUDA NVIDIA GPU Memory structure Vector Processor vs GPU, Multimedia SIMD computers vs GPU Multiprocessor Architecture, Centralized shared memory architecture Cache coherence and snooping protocol (Implementation details – not required). Performance of Symmetric Shared-Memory Processors. Distributed Shared Memory and Directory based protocol – basics. Synchronization – Basic Hardware Primtives. Memory Consistency Models – Sequential and relaxed	**9**
4	Warehouse Scale Computers – Goals and requirements. Programming frameworks for Batch processing – Map reduce and Hadoop Computer Architecture of Warehouse-scale computers Moore's Law, Dennard Scaling, Dark Silicon and the transition towards Heterogeneous Architectures Asymmetric multi-core architecture – Static and Dynamic (Overall idea, example processors) Functional Heterogeneous Multicore architecture – GPUs, Accelerators, Reconfigurable Computing Beyond the textbook – Identify the processor used in your PC and mobile phone. Study about its architecture, is it homogeneous or heterogeneous, does it use GPUs, what information can you gather about it from the manufacturer's website – Discuss in the class	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Enumerate the different classes of computers and where they are used in everyday life.	**K2**
CO2	Compute the effect of hardware/software enhancements on the speedup of a processor using Amdahl's law.	**K3**
CO3	Interpret possible dependencies that can cause hazards in a given block of code.	**K3**
CO4	Summarize different strategies followed to ensure Instruction Level Parallelism.	**K2**
CO5	Compare different strategies followed to ensure Instruction Level Parallelism and different strategies followed to ensure Data Parallelism.	**K3**
CO6	Illustrate the need for memory consistency models and cache coherence protocols and explain the principle behind it.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3	3								3
CO6	3	3	3	3								3

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	Computer architecture: A Quantitative Approach.	Hennessy, J. and Patterson, D	Morgan Kaufman	5/e, 2012
2	The Dark Side of Silicon: Energy Efficient Computing in the Dark Silicon Era	Kanduri, Anil, et al.	Springer	1/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Architecture	Gérard Blanchet Bertrand Dupouy	Wiley	1/e, 2013
2	Advanced Computer Architectures	Sajjan C Shiva	Taylor & Fancis	1/e, 2018
3	Computer Architecture	Charles Fox	no starch press	1/e, 2024

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/103/106103206/

SEMESTER S5

DATA MINING

(Common to CS/CD/CM/CA/AM)

Course Code	**PECST525**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None		

Course Objectives:

1. To provide a thorough understanding of the key processes and concepts involved in data mining and data warehousing within application domains
2. To enable students to understand the different data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, text mining and web mining, and apply these techniques in real-world scenarios

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Data Mining Fundamentals :-** Data Mining - concepts and applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities Data warehouse - Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture	8
2	**Data Preprocessing :-** Data Preprocessing - Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation	9

	Data Reduction - Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.	
3	**Classification And Clustering :-** Classification - Introduction, Decision tree construction principle, Information Gain, Gini index, Decision tree construction algorithm - ID3, Neural networks, back propagation, Evaluation measures - accuracy, precision, recall, F1 score Clustering - Introduction to clustering, distance measures, Clustering Paradigms, Partitioning Algorithm - k means, Hierarchical Clustering, DBSCAN	**9**
4	**Association Rule Analysis And Advanced Data Mining : -** Association Rule Mining - Concepts, Apriori algorithm, FP Growth Algorithm Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Web Usage Mining- Preprocessing, Data structures, Pattern Discovery, Pattern Analysis Text Mining - Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Technique	**10**

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Students must be asked to identify problems involving large datasets and identify the right solution from the concepts already learned. A comparison of the results with a similar approach also need to be performed to assess the Knowledge Level 5.

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
• 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	Understand the key process of data mining and data warehousing concepts in application domains.	**K2**
CO2	Apply appropriate pre-processing techniques to convert raw data into suitable format for practical data mining tasks	**K3**
CO3	Illustrate the use of classification and clustering algorithms in various application domains	**K3**
CO4	Comprehend the use of association rule mining techniques	**K3**
CO5	Explain advanced data mining concepts and their applications in emerging domains	**K2**

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	PO12
CO1	2	2										2
CO2	3	3	3	3	2							2
CO3	3	3	3	3	2							2
CO4	3	3	3	3	2							2
CO5	2	2										2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Mining Concepts and Techniques	Jaiwei Han, Micheline Kamber	Elsevier	3/e, 2006
2	Data Mining: Introductory and Advanced Topics	Dunham M H	Pearson Education	1/e, 2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Data Mining	Pang-Ning Tan, Michael Steinbach	Addison Wesley	1/e, 2014
2	Data Mining: Concepts, Models, Methods, and Algorithms	Mehmed Kantardzic	Wiley	2/e, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/ykZ-_UGcYWg?si=qiqynQyjI1sNNiHE
2	https://youtu.be/NSxEiohAH5o?si=ZIJHMiRvpFcNQNMA
3	https://youtu.be/VsYKqOokgaE?si=rgndBZqpzB29LUGg
4	https://youtu.be/N_whCVtfL9M?si=VPMH9NP4vdAaiuPe

SEMESTER S5

FOUNDATIONS OF SECURITY IN COMPUTING

Course Code	PECAT595	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	none	Course Type	Theory

Course Objectives:

1. To provide the fundamental security principles including cryptography, authentication, and access control.
2. To enable the learners to Identify and mitigate threats and vulnerabilities in software, networks, and operating systems.
3. To provide practical skills in securing computing systems and managing security policies and incidents.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Modular Arithmetic:-** Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm[Text 1/Text 2] **Prime Numbers and Factorization:-**Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications. Factorization - Fermat's factorization, Pollard p-1 method. [Text 2]	9
2	**Symmetric Cipher Models**:- Substitution techniques - Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher, One Time Pad. Transposition techniques, Block Cipher principles- The Data Encryption Standard(DES), Strength of DES, Block Cipher Operation- Electronic Code Book, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode. Advanced Encryption Standard (AES)- Basic Structure, Transformation Functions, Key Expansion [Text 1]	9

3	**Public key Cryptography**: **-** Principles of Public key Cryptosystems, RSA Algorithms- Description of the Algorithm, Computational Aspects, The security of RSA, Diffie Hellman Key Exchange-The Algorithm, Key Exchange Protocols, Man-in –the- Middle Attack, Elliptic Curve Cryptography-Analog of Diffie Hellman Key Exchange, Elliptic Curve Encryption/Decryption, Security of Elliptic Curve Cryptography[Text 1]	**9**
4	**Operating system security**: – security in the operating system, Security in the design of the operating system. **Database security**: – Security requirements of databases, Reliability, and integrity, Database disclosure. **Cloud Security**:-Clod Computing Concepts, Moving to the Cloud, Cloud Security Tools and Techniques, Cloud Identity Management.[Text 3]	**9**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Do a project based on the algorithms studied and analyse the performance of the algorithms

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**
• 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	Apply concepts of modular arithmetic, including integer division, divisibility, GCD, and prime numbers.	**K3**
CO2	Apply mathematical concepts related to factorization methods, including Fermat's and Pollard's methods, to solve cryptographic problems.	**K3**
CO3	Assess various symmetric cipher models, including substitution and transposition techniques, as well as block ciphers like DES and AES.	**K5**
CO4	List the principles of public key cryptography, including RSA and Diffie-Hellman, and evaluate their security aspects.	**K4**
CO5	Model the security requirements in operating systems and databases, and analyze cloud security concepts, tools, and identity management techniques.	**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	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

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	Cryptography and Network Security Principles and Practice	William Stallings	Pearson Ed.	4/E,2005
2	Cryptography and Network Security	Behrouz A Forouzan	Tata McGraw-Hill.	3/E,2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Elementary Number Theory	G.A. Jones & J.M. Jones	Springer UTM	1/E, 2007
2	The Complete Reference: Information Security	Mark Rhodes-Ousley	McGraw-Hill	2/E,2012
3	Principles of Computer Security: CompTIA Security+ and Beyond	Wm.Arthur Conklin, Greg White	McGraw-Hill	2/E,2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/ZMDTndFMgks?si=c0ZpKrBTGljcD6Zy https://youtu.be/XBnUWjo3TgM?si=hZz0EsUeQd3XV_lu
2	https://youtu.be/QbczPuEphUY?si=4SuxgwFAAarvfN5x
3	https://youtu.be/7eI4YTjqO30?si=bn9tKAWuifgRae7I
4	https://youtu.be/i_7ofp7fK_E?si=qYAkK4YtqgXrKJ1S https://youtu.be/q_4VErC7bwA?si=6qfVdNHjYWYGnsru

SEMESTER S5

AI ALGORITHM LAB

(Common to CA/AI)

Course Code	PCCAL507	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	Practical

Course Objectives:

1. To implement and optimize search and game algorithms.
2. To write programs for constraint satisfaction and scheduling problems.
3. To enable the learners to build and evaluate machine learning and expert systems.

Expt. No.	Experiments
1	Implement basic search strategies 8-puzzle problem *
2	Implement variants of hill-climbing and genetic algorithms. *
3	Implement A* Algorithm *
4	Implement Mini-Max algorithm for game playing (Alpha-Beta pruning) *
5	Solve constraint satisfaction problems *
6	Implement Forward Chaining Algorithm *
7	Implement Naïve Bayes Models. *
8	The airline scheduling problem, where the objective is to schedule flights to maximize resource utilization while minimizing delays. Key factors include aircraft availability, crew schedules, and airport slot times. Constraints involve regulatory requirements, maintenance schedules, and airport capacities.
9	In a timetabling problem, variables are the classes or exams to be scheduled. Constraints include avoiding scheduling conflicts, ensuring that no two classes occur at the same time for a given student and meeting room availability. Possible values are the time slots and locations for each class.
10	Write a program to build and train a decision tree classifier using a library (e.g., scikit-learn). Evaluate the model using metrics such as accuracy and confusion matrix. Discuss pre-processing steps, training process, and performance evaluation.
11	Implement a Sudoku solver using backtracking or constraint propagation techniques. Describe how constraints are checked and how the algorithm searches for a valid solution.

	Provide examples of how the solver handles different Sudoku puzzles. *
12	Develop a simple expert system using a tool or language of your choice (e.g., Prolog, Python with an expert system library). Implement the system for a given problem and test its performance. *
13	Develop a program to construct a pruned game tree using Alpha-Beta pruning. Take the sequence, [5, 3, 2, 4, 1, 3, 6, 2, 8, 7, 5, 1, 3, 4] of MINIMAX values for the nodes at the cutoff depth of 4 plies. Assume that branching factor is 2, MIN makes the first move, and nodes are generated from right to left.
14	Implementation of Knowledge representation schemes *
15	Implement local search algorithms for CSP *
16	Implement travelling salesman problem *

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	Apply Search Algorithms to Solve Complex Problems	**K3**
CO2	Develop and Optimize Constraint Satisfaction Solutions.	**K3**
CO3	Implement and Evaluate Machine Learning Models	**K3**
CO4	Build and Test Expert Systems.	**K3**
CO5	Utilize Advanced Optimization Techniques	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

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	Introduction to AI and ES	Dan W. Patterson	Pearson	1/e, 2007
2	Artificial Intelligence	Kevin Night, Elaine Rich, and Nair B	McGraw Hill	3/e, 2018
3	Artificial Intelligence by Example	Dennis Rothman	Packt	1/e, 2018
4	Artificial Intelligence	Patrick H. Winston	Pearson	3/e, 2006

Video Links (NPTEL, SWAYAM…)

Module No.	Link ID
1	https://youtu.be/yMcZvZayJUA
2	https://youtu.be/ZOvRZ7UJMjk https://youtu.be/dtGRmhZ6Cuo
3	https://youtu.be/a2tqR2eUlek https://youtu.be/il20Q5tXp-A
4	https://youtu.be/0oqhN5tvLgA https://youtu.be/i3L4G1ZO7_E

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 S5

MACHINE LEARNING LAB

(Common to CS/CA)

Course Code	PCCSL508	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 give the learner a practical experience of the various machine learning techniques and be able to demonstrate them using a language of choice.

Expt. No.	Experiments
1	Implement linear regression with one variable on the California Housing dataset to predict housing prices based on a single feature (e.g., the average number of rooms per dwelling). Tasks: ● Load and preprocess the datase. ● Implement linear regression using both gradient descent and the normal equation. ● Evaluate the model performance using metrics such as Mean Squared Error (MSE) and R-squared. ● Visualize the fitted line along with the data points.
2	Implement polynomial regression on the Auto MPG dataset to predict miles per gallon (MPG) based on engine displacement. Compare polynomial regression results with linear regression. Tasks: ● Load and preprocess the dataset. ● Implement polynomial regression of varying degrees. ● Compare the polynomial regression models with linear regression using metrics such as MSE and R-squared. ● Visualize the polynomial fit.
3	Implement Ridge and Lasso regression on the Diabetes dataset. Compare the performance of these regularized models with standard linear regression. Tasks:

	● Load and preprocess the dataset. ● Implement Ridge and Lasso regression. ● Tune hyperparameters using cross-validation. ● Compare performance metrics (MSE, R-squared) with standard linear regression.
4	Estimate the parameters of a logistic regression model using MLE and MAP on the Breast Cancer Wisconsin dataset. Compare the results and discuss the effects of regularization. Tasks: ● Load and preprocess the dataset. ● Implement logistic regression with MLE. ● Apply MAP estimation with different regularization priors (L1 and L2 regularization). ● Compare the performance and parameter estimates with MLE and MAP.
5	Use MLE and MAP to estimate the parameters of a multinomial distribution on the 20 Newsgroups dataset. Explore the impact of different priors on the estimation. Tasks: ● Load and preprocess the dataset. ● Implement MLE for multinomial distribution parameter estimation. ● Apply MAP estimation with various priors (e.g., Dirichlet priors). ● Compare results and evaluate the effect of different priors.
6	Implement a logistic regression model to predict the likelihood of a disease using the Pima Indians Diabetes dataset. Compare the performance with and without feature scaling. Tasks: ● Load and preprocess the Pima Indians Diabetes dataset. ● Implement logistic regression for binary classification. ● Evaluate model performance with and without feature scaling. ● Analyze metrics such as accuracy, precision, recall, and F1-score.
7	Implement a Naïve Bayes classifier to categorize text documents into topics using the 20 Newsgroups dataset. Compare the performance of Multinomial Naïve Bayes with Bernoulli Naïve Bayes. Tasks: ● Load and preprocess the 20 Newsgroups dataset. ● Implement Multinomial Naïve Bayes and Bernoulli Naïve Bayes classifiers. ● Evaluate and compare the performance of both models using metrics such as accuracy and F1-score. ● Discuss the strengths and weaknesses of each Naïve Bayes variant for text classification.

8	Implement the K-Nearest Neighbors (KNN) algorithm for image classification using the Fashion MNIST dataset. Experiment with different values of K and analyze their impact on model performance. Tasks: ● Load and preprocess the Fashion MNIST dataset. ● Implement KNN for multi-class classification. ● Experiment with different values of K and evaluate performance. ● Discuss the impact of different K values on model accuracy and computational efficiency.
9	Implement a Decision Tree classifier using the ID3 algorithm to segment customers based on their purchasing behavior using the Online Retail dataset. Analyze the tree structure and discuss the feature importance. Tasks: ● Load and preprocess the Online Retail dataset. ● Implement Decision Tree using the ID3 algorithm. ● Visualize the decision tree and analyze feature importance. ● Discuss how the tree structure helps in understanding customer behavior.
10	Implement and compare Logistic Regression and Decision Trees on the Adult Income dataset for predicting income levels. Evaluate both models based on performance metrics and interpretability. Tasks: ● Load and preprocess the Adult Income dataset. ● Implement both Logistic Regression and Decision Trees. ● Compare the models based on metrics such as accuracy, precision, recall, and F1-score. ● Discuss the interpretability of both models and their suitability for the dataset.
11	Implement a Linear Support Vector Machine (SVM) to classify the Iris dataset. Visualize the decision boundary and discuss how the margin is determined. Tasks: ● Load and preprocess the Iris dataset. ● Implement a Linear SVM for binary classification (e.g., classify Setosa vs. Non-Setosa). ● Visualize the decision boundary and margin. ● Discuss the concept of the margin and how it influences classification.
12	Implement and compare the performance of SVM classifiers with linear, polynomial, and RBF kernels on the Fashion MNIST dataset. Analyze the advantages and disadvantages of each kernel type.

	Tasks: ● Load and preprocess the Fashion MNIST dataset. ● Implement SVM with linear, polynomial, and RBF kernels. ● Compare the classification performance for each kernel. ● Discuss the strengths and weaknesses of each kernel type.
13	Implement and train a Multilayer Feed-Forward Network (MLP) on the Wine Quality dataset. Experiment with different numbers of hidden layers and neurons, and discuss how these choices affect the network's performance. Tasks: ● Load and preprocess the Wine Quality dataset. ● Design and implement an MLP with varying architectures (different hidden layers and neurons). ● Train and evaluate the network. ● Discuss the impact of architecture choices on performance.
14	Implement and compare the performance of a neural network using different activation functions (Sigmoid, ReLU, Tanh) on the MNIST dataset. Analyze how each activation function affects the training process and classification accuracy. Tasks: ● Load and preprocess the MNIST dataset. ● Implement neural networks using Sigmoid, ReLU, and Tanh activation functions. ● Train and evaluate each network. ● Compare training times, convergence, and classification accuracy.
15	Implement and perform hyperparameter tuning for a neural network on the Fashion MNIST dataset. Experiment with different learning rates, batch sizes, and epochs, and discuss the impact on model performance. Tasks: ● Load and preprocess the Fashion MNIST dataset. ● Experiment with different hyperparameters (learning rate, batch size, epochs). ● Train and evaluate the network. ● Discuss how hyperparameter choices affect model performance.
16	Implement and compare hierarchical (agglomerative) and partitional (K-means) clustering algorithms on the Mall Customers dataset. Discuss the strengths and weaknesses of each method based on clustering results and evaluation metrics. Tasks: ● Load and preprocess the Mall Customers dataset. ● Apply both hierarchical (agglomerative) and K-means clustering. ● Compare results using metrics such as inertia, silhouette score, and clustering

	visualization. ● Discuss the advantages and disadvantages of each clustering method.
17	Implement and apply K-means clustering to the Digits dataset. Experiment with different numbers of clusters and evaluate the clustering results using metrics such as inertia and silhouette score. Analyze how the choice of K affects clustering performance. Tasks: ● Load and preprocess the Digits dataset. ● Implement K-means clustering with various numbers of clusters. ● Evaluate clustering performance using inertia and silhouette score. ● Analyze the impact of the number of clusters on clustering quality.
18	Implement bootstrapping and cross-validation on the Iris dataset. Compare the model performance metrics (e.g., accuracy, F1-score) obtained using these resampling methods. Discuss the advantages and disadvantages of each method. Tasks: ● Load and preprocess the Iris dataset. ● Implement bootstrapping to generate multiple samples and evaluate the model. ● Implement k-fold cross-validation and evaluate the model. ● Compare the performance metrics and discuss the pros and cons of each resampling method.
19	Implement bagging and boosting ensemble methods on the Titanic dataset. Compare the performance of both methods in terms of accuracy, precision, recall, and F1-score. Discuss how each method improves model performance and their respective strengths and weaknesses. Tasks: ● Load and preprocess the Titanic dataset. ● Implement bagging using a base classifier (e.g., decision tree) and evaluate performance. ● Implement boosting using a boosting algorithm (e.g., AdaBoost) and evaluate performance. ● Compare performance metrics and discuss the strengths and weaknesses of each method.
20	Investigate the bias-variance tradeoff using polynomial regression on the Boston Housing dataset. Plot the training and validation errors for various polynomial degrees and discuss the tradeoff between bias and variance. Tasks: ● Load and preprocess the Boston Housing dataset. ● Implement polynomial regression with varying degrees.

	● Plot training and validation errors for each degree. ● Discuss the bias-variance tradeoff and its impact on model performance.

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	Understand complexity of Machine Learning algorithms and their limitations;	**K2**
CO2	Understand modern notions in data analysis-oriented computing;	**K2**
CO3	Apply common Machine Learning algorithms in practice and implement their own.	**K3**
CO4	Performing experiments in Machine Learning using real-world data.	**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	PO12
CO1	3	3	3		3							3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3		3							3

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 Machine Learning	Ethem Alpaydin	MIT Press	4/e, 2020
2	Machine Learning using Python	Manaranjan Pradhan | U Dinesh Kumar	Wiley	1/e, 2019
3	Machine Learning: Theory and Practice	M.N. Murty, V.S. Ananthanarayana	Universities Press	1/e, 2024

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki | Wagner Meira	Cambridge University Press	1/e, 2016
2	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1/e, 1998

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105152/
2	https://archive.nptel.ac.in/courses/106/106/106106139/
3	https://nptel.ac.in/courses/106106202

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 6

COMPUTER SCIENCE AND ENGINEERING

(ARTIFICIAL INTELLIGENCE)

SEMESTER S6

AGENT BASED INTELLIGENT SYSTEMS

Course Code	PCCAT601	**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. distributed problem- solving strategies and coordination in multi-agent systems. To teach 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 can improve

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction**: Definitions, Foundations, History, Intelligent Agents, Problem Solving, Searching, Heuristics, Constraint satisfaction Problems, Game Playing. **Knowledge representation and reasoning:** Logical agents, First order logic, First Order Inference, Unification, Chaining Resolution Strategies, Knowledge Representation, Objects, Actions, Events.	**11**
2	**Planning Agents:** Planning Problem, State Space Search, Partial Order Planning Graphs, No deterministic Domains, Conditional Planning, continuous Planning, Multiagent Planning.	**11**
3	**Agents And Uncertainty:** Acting under uncertainty, Probability Notation, Bayes Rule and use Bayesian Networks, Other approaches, Time and Uncertainty, Temporal Models, Utility Theory, Decision Network, Complex Decisions.	**11**
4	**Higher Level Agents:** Knowledge in Learning, Relevance information, Statistical Learning Methods, Reinforcement Learning, Communication, Formal Grammar, Augmented Grammars Future of AI.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Define the algorithmic foundation of agents and multi agent systems.	**K2**
CO2	Explain theoretical foundations of agent based systems.	**K2**
CO3	Apply Bayesian networks for probabilistic reasoning.	**K3**
CO4	Use logical agents for interface design with first order logic	**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	PO12
CO1	3	3	3									2
CO2	3	3	3									2
CO3	3	3	3									2
CO4	3	3	3									2

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 S6

ROBOTICS AND AUTOMATION

Course Code	**PCCAT602**	**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 enable to students to understand the characteristics of Robotics and the working of actuators and sensors in various scenarios
2. To teach how robots use various sensors to perceive their environment, techniques for preparing raw sensory data for analysis and methods for dividing an image into meaningful regions or objects to simplify analysis.
3. To make students understand the position and orientation of Roberts ,its localization and various challenges during localization.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to robotics:-** Degrees of freedom, Robot types- Manipulators-Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots-wheeled, legged, aerial robots, underwater robots, surface water robots. Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.	**9**
2	**Sensors, Actuators and Control) Sensor classification**: touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non-contact type; Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors - Servos, Hydraulic &	**9**

	pneumatic actuators.	
3	**Robotic Vision**: Sensing, Pre-processing, Segmentation, Description, Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing. Representation of Transformations - Representation of a Pure Translation - - Pure Rotation about an Axis - Combined Transformations - Transformations Relative to the Rotating Frame. Basic understanding of Differential-Drive Wheeled Mobile Robot, Degree of mobility - different wheel configurations, holonomic and nonholonomic robots. Omnidirectional Wheeled Mobile Robots.	**9**
4	**Position and Orientation**: Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization - Continuous representations - Decomposition strategies - Current challenges in map representation. Probabilistic map-based localization (only Kalman method), Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition and various types of SLAM -, Path Planning-Graph search, deterministic graph search -, breadth first search - depth first search- Dijkstra' s algorithm, A*, D* algorithms, Potential field based path planning. Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches. Navigation Architectures - Modularity for code reuse and sharing - Control localization	**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
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● 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. **(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 concepts of manipulator and mobile robotics.	**K2**
CO2	Choose the suitable sensors, actuators and control for robot design	**K3**
CO3	Developing kinematic models of mobile robots and understanding robotic vision intelligence.	**K3**
CO4	Apply the localization and mapping methods in robotics.	**K3**
CO5	Plan the path and navigation of the robot by applying an artificial intelligence algorithm.	**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	PO12
CO1	3	3	3									2
CO2	3	3	3									2
CO3	3	3	3									2
CO4	3	3	3									2
CO5	3	3	3									2

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 Autonomous Mobile Robots	R Siegwart, IR Nourbakhsh, D Scaramuzza	MIT Press, USA	2/e, 2011
2	Embedded Robotics, Mobile Robot Design and Applications with Embedded Systems	Thomas Bräunl	Springer	2/e, 2006
3	Introduction to Mobile Robot Control	S.G. Tzafestas	Elsevier	1/e, 2014
4	Artificial Intelligence for Robotics	Francis X. Govers	Packt Publishing	1/e,2018
5	Introduction to Robotics_ Analysis, Control, Applications	Saeed B. Niku	Wiley	2/e, 2011
6	Industrial Robotics - Technology ,Programming and Applications	Mikell P Groover	McGraw Hill Education	2/e, 2017

Reference Book				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Robotics	John J. Craig	Pearson Education Inc., Asia,	3/e, 2005
2	Introduction to Robotics	S. K. Saha	TATA McGraw Hills Education	2/e, 2014
3	Robotics, Vision and Control_ Fundamental Algorithms in MATLAB	Peter Corke	Springer-Verlag Berlin Heidelberg	2/e, 2021

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1, 2, 3, 4	https://onlinecourses.nptel.ac.in/noc21_me76/preview https://nptel.ac.in/courses/107106090 https://onlinecourses.nptel.ac.in/noc23_me143/preview

SEMESTER S6

SOFTWARE TESTING

(Common to CS/CA/CM/CD/CR/AM/AD)

Course Code	**PECST631**	**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 Cultivate proficiency in software testing methodologies and techniques.
2. To Foster expertise in software testing tools and technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Testing & Automation:-** Introduction to Software Testing - Concepts, importance of testing, software quality, and real-world failures (e.g., Ariane 5, Therac 25); Software Testing Processes - Levels of thinking in testing; Testing Terminologies - Verification, validation, fault, error, bug, test cases, and coverage criteria; Types of Testing - Unit, Integration, System, Acceptance, Performance (stress, usability, regression), and Security Testing; Industry Trends - AI in test case automation, Introduction to GenAI in testing; Testing Methods - Black-Box, White-Box, and Grey-Box Testing; Automation in Testing - Introduction to automation tools (e.g., Selenium, Cypress, JUnit); Case Study- Automation of Unit Testing and Mutation Testing using JUnit.	**8**
2	**Unit Testing, Mutation Testing & AI-Driven Automation:-** Unit Testing- Static and Dynamic Unit Testing, control flow testing, data flow testing, domain testing; Mutation Testing- Mutation operators, mutants, mutation score, and modern mutation testing tools (e.g., Muclipse); JUnit Framework - Automation of unit testing, frameworks for testing in real-world projects; AI in Testing - GenAI for test case	**8**

	generation and optimization, impact on automation; Industry Tools - Application of AI-driven testing tools in automation and predictive testing; Case Study - Mutation testing using JUnit, AI-enhanced test case automation.	
3	**Advanced White Box Testing & Security Testing:-** Graph Coverage Criteria - Node, edge, and path coverage; prime path and round trip coverage; Data Flow Criteria - du paths, du pairs, subsumption relationships; Graph Coverage for Code - Control flow graphs (CFGs) for complex structures (e.g., loops, exceptions); Graph Coverage for Design Elements - Call graphs, class inheritance testing, and coupling data-flow pairs; Security Testing - Fundamentals, tools (OWASP, Burp Suite), and their role in protecting modern applications; Case Study - Application of graph based testing and security testing using industry standard tools.	**10**
4	**Black Box Testing, Grey Box Testing, and Responsive Testing:-** Black Box Testing - Input space partitioning, domain testing, functional testing (equivalence class partitioning, boundary value analysis, decision tables, random testing); Grey Box Testing - Introduction, advantages, and methodologies (matrix testing, regression testing, orthogonal array testing); Performance Testing - Network latency testing, browser compatibility, responsive testing across multiple devices (e.g., BrowserStack, LambdaTest); Introduction to PEX - Symbolic execution, parameterized unit testing, symbolic execution trees, and their application; GenAI in Testing - Advanced use cases for predictive and responsive testing across devices and environments; Case Study- Implementation of black-box, grey-box, and responsive testing using PEX and AI-driven tools.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Demonstrate the ability to apply a range of software testing techniques, including unit testing using JUnit and automation tools.	**K2**
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	**K3**
CO3	Explain and apply graph coverage criteria in terms of control flow and data flow graphs to improve code quality.	**K2**
CO4	Demonstrate the importance of black-box approaches in terms of Domain and Functional Testing	**K3**
CO5	Illustrate the importance of security, compatibility, and performance testing across devices.	**K3**
CO6	Use advanced tools like PEX to perform symbolic execution and optimize test case generation and also leverage AI tools for automated test case prediction and symbolic execution with PEX.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3	3							3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3		3							3
CO6	3	3	3	3	3							3

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 Software Testing.	Paul Ammann, Jeff Offutt	Cambridge University Press	2/e, 2016
2	Software Testing and Quality Assurance : Theory and Practice	Kshirasagar Naik, Priyadarshi Tripathy	Wiley	1/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Software Testing	Ron Patten	Pearson	2/e, 2005
2	Software Testing: A Craftsman's Approach	Paul C. Jorgensen	CRC Press	4/e, 2017
3	Foundations of Software Testing	Dorothy Graham, Rex Black, Erik van Veenendaal	Cengage	4/e, 2021
4	The Art of Software Testing	Glenford J. Myers, Tom Badgett, Corey Sandler	Wiley	3/e, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/101/106101163/
2	https://archive.nptel.ac.in/courses/106/101/106101163/
3	https://archive.nptel.ac.in/courses/106/101/106101163/
4	https://archive.nptel.ac.in/courses/106/101/106101163/

SEMESTER S6

INTRODUCTION TO BUSINESS ANALYTICS

Course Code	**PECAT632**	**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 enable the students to use business analytics to formulate and solve business problems and to support managerial decision making.
2. To make the students familiarize the practices needed to develop, report, and analyze business data.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Business Analytics:** Evolution, Scope, Models, Problem Solving with Analytics **Descriptive Analytics:** Data Visualization, Statistical methods for summarizing data – Frequency distribution for categorical and numerical data, Histogram, Cumulative relative frequency, Percentile and quartiles, Descriptive Statistical Measures- mean, median, mode, range, interquartile range, variance, standard deviation, correlation, covariance	**10**
2	**Probability Distributions:** Basic concepts of probability, Random Variables and Probability distribution, Discrete Probability distribution – binomial, Poisson, Continuous Probability Distribution – Uniform, Normal. Statistical Inference – Hypothesis testing procedure, Two-Tailed Test of Hypothesis for the Mean, Two-Sample Tests for Differences in Means	**9**
3	**Predictive:** Modelling relationships and trends in data, Modelling Relationships and Trends in Data, Simple Regression and Correlation: Introduction, Estimation using the regression line, Correlation Analysis. Multiple Regression: The k-variable multiple regression model, The F-test of a Multiple Regression model.	**9**

4	**Prescriptive:** - Linear Programming Problem- Formulation, Graphical solutions, Simplex method, Revised Simplex method and Sensitivity Analysis; Transportation Problem- Formulation and solution; Assignment Problem- Formulation and solution	8

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Apply statistical methods and data visualization techniques to explore, summarize, and interpret large datasets	**K3**
CO2	Apply probability and statistical inference to model business problems and assess risk.	**K3**
CO3	Build and evaluate predictive models using regression analysis and other statistical techniques to forecast trends, identify patterns, and support business planning.	**K3**
CO4	Formulate and solve optimization problems using linear programming and other quantitative methods	**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	PO12
CO1	3	3	3		3							2
CO2	3	3	3		3							2
CO3	3	3	3		3							2
CO4	3	3	3		3							2

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	Business Analytics	James R. Evans	Pearson Education Limited,	2/e, 2017

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Complete Business Statistics	Amir D. Aczel and J. Sounderpandian	Tata McGraw Hill	6/e, 2006
2	Operations Research: Applications and Algorithms	Wayne L. Winston	PWS-Kent Pub	4/e, 2004

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Business Analytics For Management Decision https://onlinecourses.nptel.ac.in/noc20_mg11/preview Business Intelligence & Analytics https://onlinecourses.nptel.ac.in/noc24_cs65/preview
2	
3	
4	

SEMESTER S6

AI FOR CYBER SECURITY

Course Code	PECAT633	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)	PCCAT502	Course Type	Theory

Course Objectives:

1. To explore AI techniques for enhancing cybersecurity.
2. To develop AI-based security solutions for threat detection and response.
3. To identify and mitigate AI-specific security risks and vulnerabilities.
4. To integrate AI tools with existing security infrastructure.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to AI and Cybersecurity :-** Introduction to AI - Definition and types of AI (narrow AI vs. general AI)- Historical context and evolution of AI; Basics of Machine Learning - Supervised learning: regression and classification-Unsupervised learning: clustering and dimensionality reduction-Reinforcement learning: basics and applications; Key Concepts and Terminology - Algorithms, models, and training-Overfitting and underfitting; Applications of AI in Cybersecurity - Case Studies: Examples of AI in real-world cybersecurity applications; Benefits and Limitations	8
2	**AI Techniques for Security :-** Anomaly Detection - Techniques and Algorithms: Statistical methods for anomaly detection-Machine learning models: Isolation Forest, One-Class SVM, etc.; Threat Intelligence and Prediction-Data Collection and Processing - Gathering and preprocessing threat data-Feature extraction and engineering; Predictive Analytics - Building and evaluating predictive	9

	models for threat forecasting-Case studies on threat intelligence systems; Behavioral Analysis-Techniques - Behavioral profiling and pattern recognition-Analysing user and system behavior to detect anomalies	
3	**Building AI Security Solutions :-** Designing Intrusion Detection Systems (IDS) - IDS types: network-based vs. host-based-Integrating AI techniques for enhanced detection; Automated Threat Response Mechanisms - Response strategies and automation workflows-Integration with threat detection systems; Integration with Existing Security Tools - Integration Techniques:-Connecting AI solutions with legacy security tools, Ensuring compatibility and effectiveness; Case Studies.	**10**
4	**Addressing AI Security Risks and Future Trends :-** AI Security Risks - Adversarial attacks: techniques and examples-Model poisoning and data privacy issues; Mitigating AI Security Risks; Strategies and Best Practices - Techniques for securing AI systems against adversarial attacks-Data protection and model validation strategies- Future Trends and Emerging Technologie - Emerging Technologies : Latest developments in AI and cybersecurity, Future directions and research areas, Impact of new technologies on cybersecurity.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Identify the core AI concepts and machine learning techniques that can be used in cyber security	**K2**
CO2	Apply AI for threat detection and cybersecurity enhancements.	**K3**
CO3	Explain ethical and legal issues in using AI applications	**K2**
CO4	Apply AI-driven security tools and solutions for data security	**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	PO12
CO1	3	2										2
CO2	2	3	3									2
CO3	2	2										2
CO4	2	2	3		3							2

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 Guide for Thinking Humans	Melanie Mitchell	Penguin Books	1/e,2019
2	Introduction to Machine Learning with Python	Andreas C. Müller, Sarah Guido	O'Reilly Media	1/e, 2016
3	AI in Cybersecurity: Applications, Risks, and Challenges	Noura Al Moubayed, Pardeep Kumar	CRC Press	1/e, 2020
4	Ethics of Artificial Intelligence and Robotics	Vincent C. Müller	Springer	1/e,2020
5	Anomaly Detection for Monitoring Systems: A Practical Guide	David M. Hawkins	Wiley	1/e, 2019
6	Threat Intelligence: A Practical Guide	Michael L. Santarcangelo	Syngress	1/e, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning with Python	Andreas C. Müller, Sarah Guido	O'Reilly Media	1/e, 2016
2	Machine Learning Yearning	Andrew Ng	Self-Published	1/e, 2018
3	Adversarial Machine Learning	Ian Goodfellow, Jonathon Shlens, Christian Szegedy	MIT Press	1/e, 2021
4	Artificial Intelligence: The Next Generation	Ben Goertzel, Cassio Pennachin	Wiley	1/e, 2020
5	Behavioral Cybersecurity: The Psychology of Cybersecurity	Chris L. Bader, Patrick W. O'Leary	CRC Press	1/e, 2021
6	Intrusion Detection and Prevention Systems	S. V. Raghavan	CRC Press	1/e, 2017
7	Automated Cyber Defense: Concepts and Techniques	Chris Eagle	CRC Press	1/e, 2019
8	Security Information and Event Management (SIEM) Implementation	David R. Miller	Syngress	1/e, 2018
9	AI Security: The Risks and Benefits of Artificial Intelligence	David K. Smith	CRC Press	1/e, 2021
10	AI Safety and Security	Roman Yampolskiy	Springer	1/e, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=WWva3v9Hhfk&pp=ygUlSW50cm9kdWN0aW9uIHRvIEFJIGFuZCBDeWJlcnNlY3VyaXR5IA%3D%3D https://onlinecourses.nptel.ac.in/noc24_cs81/preview
2	https://onlinecourses.nptel.ac.in/noc24_cs121/preview
3	https://onlinecourses.nptel.ac.in/noc24_cs85/preview
4	https://www.youtube.com/watch?v=PHWB1JSZdeA&pp=ygUuQWRkcmVzc2luZyBBSSBTZWN1cml0eSBSaXNrcyBhbmQgRnV0dXJlIFRyZW5kcw%3D%3D

SEMESTER S6

WIRELESS SENSOR NETWORKS

Course Code	**PECAT634**	**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)	PCCST501	**Course Type**	Theory

Course Objectives:

1. To learn sensor network fundamentals
2. To understand the different routing protocols used in wireless sensor networks and identify the design issues.
3. To learn the transport layer security and the security issues in wireless sensor networks.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Wireless Sensor Networks:** Introduction to wireless sensor networks (WSN), Network architecture and protocol stack, MAC access control – fundamental MAC protocols, MAC design for WSNs, MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols), IEEE 802.15.4, Zigbee	9
2	**Routing and Transport Layer:** Routing and data dissemination – Fundamentals and challenges, taxonomy of routing and data dissemination protocols, Overview of routing and data dissemination protocols – geographic adaptive fidelity, LEACH, Sensor protocols for information via negotiation, joint mobility and routing protocol. Transport protocols for WSNs, Operating systems for sensor networks – TinyOs, Contiki	10
3	**Security in WSNs**: Security requirements in WSNs, Security vulnerabilities in WSNs – DoS attacks, physical layer attacks, link layer, network layer, transport layer attacks, Attacks on secrecy and authentication, Security mechanisms for WSNs – cryptography in WSNs, Key management protocols, Defence against DoS attacks, Defence against routing attacks **-** TESLA, SPINS, Intrusion detection in WSNs.	10

4	**Infrastructure Establishment:** Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	7

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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 fundamentals of wireless sensor networks and the MAC mechanisms used in WSN	K2
CO2	Explain the transport layer functionalities and routing mechanisms used in wireless sensor networks	K2
CO3	Describe the security issues in wireless sensor networks	K2
CO4	Discuss the establishment of infrastructure of wireless sensor networks	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	PO12
CO1	3	3	3									2
CO2	3	3	3									2
CO3	3	3	3									2
CO4	3	3	3									2

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	Wireless Sensor Networks: A Networking Perspective	Jun Zheng, Abbas Jamalipour	John Wiley	1/e, 2009
2	Fundamentals of Wireless Sensor Networks - Theory and Practice	Waltenegus Dargie , Christian Poellabauer	John Wiley & Sons Publications	1/e, 2011
3	Wireless Sensor Networks- An Information Processing Approach	Feng Zhao & Leonidas J.Guibas	Elsevier	1/e, 2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Protocols and Architectures for Wireless Sensor Networks	Holger Karl, Andreas Willig	Wiley	1/e, 2005
2	Wireless Sensor Networks Technology, Protocols, and Applications	Kazem Sohraby, Daniel Minoli, & Taieb Znati	John Wiley	1/e, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106/105/106105160/
2	https://cse.iitkgp.ac.in/~smisra/course/wasn.html
3	https://archive.nptel.ac.in/courses/106/105/106105160/
4	https://codes.pratikkataria.com/infrastructure-establishment-wsn/#google_vignette

SEMESTER S6

DIGITAL IMAGE PROCESSING

(Common to CS/CM/CA/AM)

Course Code	**PECST636**	**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 foundational concepts of digital image representation, processing, and analysis, including image digitization, color theory, and various data structures, to effectively manipulate and analyze digital images.
2. To help the learner develop the ability to implement advanced image processing techniques, such as image segmentation, edge detection, and image compression, while critically evaluating the performance and quality of these methods in practical applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	The image, its representation and properties - Image representations, Image digitization, Sampling, Quantization, Digital image properties, Metric and topological properties of digital images, Histograms, Entropy, Visual perception of the image, Image quality, Noise in images; Color images - Physics of color, Color perceived by humans, Color spaces, Color constancy; Data structures for image analysis - Levels of image data representation, Traditional image data structures - matrices, Chains, Topological data structures - Relational structures, Hierarchical Data Structures, Pyramids, Quadtrees, Other pyramidal structures.	9
2	Image pre-processing - Pixel brightness transformations-, Position-dependent brightness correction, Gray-scale transformation, Geometric Transformations - Pixel coordinate transformations, Brightness interpolation. Local pre-processing, Image Smoothing, Edge detectors, Zero-crossings	8

	the second derivative,Scale in Image Processing, Canny Edge Detection, Parametric Edge Models, Edges Multi-spectral images,, Line detection by local pre-processing operators, Detection of corners(interest points), Image Restoration - Degradations that are easy to restore, Inverse Filtering, Wiener Filtering	
3	Image Segmentation - Thresholding, Threshold Detection Methods-Optimal thresholding, Multi-spectral thresholding, Edge-based segmentation, Edge Image Thresholding, Edge Relaxation, Border Tracing, Border Detection As Graph Searching, Border Detection As Dynamic Programming, Hough Transforms, Border Detection Using Border location information, Region construction from borders, Region-based segmentation - Region merging, Region Splitting - Splitting And Merging, Watershed segmentation Matching, Template Matching, Control Strategies Templating, Evaluation Issues In Segmentation	**9**
4	Image Transforms - Discrete Cosine Transform, Wavelet transform, Eigen-analysis, Singular value decomposition, Principal component analysis Radon Transform; Image Compression - Image data Properties, Discrete Image Transforms In Image data compression, Predictive compression methods, Vector quantization, Hierarchical and Progressive Compression methods, Comparison Of Compression Methods, JPEG and MPEG image compression JPEG still image compression, JPEG–2000 compression, MPEG full-motion video compression.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 Marks)**	• 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. **(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	Understand the properties of monochrome and colour images and the data structures for image analysis	**K2**
CO2	Apply different preprocessing techniques to visualize image enhancement	**K3**
CO3	Understand the concept of image segmentation and various techniques used for this.	**K2**
CO4	Understand the various transforms used for image processing	**K2**
CO5	Understand the concept of image compression and apply various image compression techniques.	**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	PO12
CO1	3	3	3									2
CO2	3	3	3	3								2
CO3	3	3	3	3								2
CO4	3	3	3	3								2
CO5	3	3	3	3								2

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	Image Processing, Analysis and Machine Vision	Milan Sonka, Vaclav Hlavac, Roger Boyle	Cengage	4/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamental of Digital Image Processing	Anil K. Jain	Pearson	1/e, 2015
2	Digital image Processing	Ralph Gonzalez, Richard Woods	Pearson	4/e, 2018
3	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	McGraw Hill	2/e, 2020

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105135/
2	https://archive.nptel.ac.in/courses/106/105/106105032/

SEMESTER S6

EMBEDDED SYSTEMS AND ITS APPLICATIONS

Course Code	**PECAT637**	**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 learn the design concepts of embedded systems
2. To gain architectural level knowledge about embedded systems
3. To understand the recent trends in embedded system design.
4. To learn how to use embedded systems in real-world applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Embedded Systems- complex systems and microprocessors- The Embedded System Design Process-Requirements, Specification, Architecture Design, Designing Hardware and Software Components design of hardware and software components- structural and behavioural description.	**8**
2	Hardware Software Co-Design and Program Modelling – Fundamental Issues. Design and Development of Embedded Product – Firmware Design and Development – Design Approaches, Firmware Development Languages.	**9**
3	Integration and Testing of Embedded Hardware and Firmware- Integration of Hardware and Firmware. Embedded System Development Environment – IDEs, Cross Compilers, Disassemblers, Decompilers, Simulators, Emulators and Debuggers. Embedded product development cycle (EDLC)-Different phases of EDLC, EDLC.	**9**
4	RTOS based Design – Basic operating system services. Interrupt handling in RTOS environment. Design Principles. Task scheduling models. How to Choose an RTOS. Recent Trends in Embedded Computing. Introduction to Embedded Systems in IT. IoT and Smart Devices	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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 basic idea about the embedded systems	**K2**
CO2	Describe the architectural design of the embedded system	**K2**
CO3	Identify the role of different software modules in the development of an embedded system	**K2**
CO4	Apply embedded systems 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	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3	3									3

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	Hardware/Software Co-Design: Principles and Practice	Staunstrup, J. Wolf, Wayne	Springer	1/e,2007
2	Embedded Systems: Architecture, Programming and Design	Raj Kamal	McGraw Hill	3/e, 2014
3	Introduction to Embedded Systems	Shibu K.V	McGraw Hill	1/e,2009

Reference Book				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computers as Components-Principles of Embedded Computer System Design	Wayne Wolf	Morgan Kaufmann	3/e,2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Embedded systems , IITDelhi https://www.youtube.com/watch?v=y9RAhEfLfJs&list=PL90187D2B8F5AC28F
4	Real time operating systems , IIT Khargpur https://www.youtube.com/playlist?list=PLJ5C_6qdAvBH-JNRIlupFb44miyx9M8JD

SEMESTER S6

CLOUD COMPUTING

(Common to CS/CA/CM/AM)

Course Code	PECST635	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To learn fundamentals of cloud and configure cloud environments, deploy virtual machines, and work with containerization tools, gaining practical skills.
2. To learn to identify and address common security threats in cloud environments, implementing best practices to ensure the safety and compliance of applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Limitations of Traditional Computing & solution, Three Layers of Computing, Factors behind Cloud Service Adoption; Evolution and Enabling Technologies of Cloud; Benefits and Challenges; [Text 2] Fundamental Concepts and Models - Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models; [Text 1] Introduction to Cloud Providers (AWS, Azure, Google Cloud). ***Handson*** - Cloud Account Setup and Virtual Machine Deployment - Create accounts on a cloud provider and deploy virtual machine instances, and document the process and inferences.	8
2	Cloud-Enabling Technology - Networks and Internet Architecture, Cloud Data Center Technology, Modern Virtualization, Multitenant Technology, Service Technology and Service APIs; Understanding Containerization - Influencers, Fundamental Virtualization and Containerization, Understanding Containers, Understanding Container Images, Multi-Container Types.[Text 1]	10

	Handson - Hypervisor and Containers installation - Install hypervisors and deploy VMs on local machines. Install any container platform and deploy applications.	
3	Resource Management - Resource Pooling, Sharing, Provisioning; Scaling in Cloud and the Strategies; Capacity Planning in Cloud Computing; Storage and File System - Challenges; Cloud Native File System, Deployment models, Storage Types, Popular Cloud Storages. High performance Computing Models.[Text 2] ***Handson*** - Use Map-reduce to implement basic big data applications such as word count.	**9**
4	Understanding Cloud Security - Basic Security Terminology, Basic Threat Terminology, Threat Agents, Common Threats; Other Considerations - Flawed Implementations, Security Policy Disparity, Contracts, Risk Management.[Text 1] ***Handson :*** Identify possible attacks of any selected cloud applications and suggest/implement solutions/policies for mitigation.	**7**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
5	**15**	**10**	**10**	**40**

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Ways of assessing at

1. Analyze level - Analyze performance of traditional models (Hardware, Application, Computing / security models) against that in the cloud.
2. Evaluate level - Derive conclusions on the cloud programming / computing / security models based on standard performance evaluation criteria.

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
• 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	Evaluate the limitations of traditional computing models and recognize the factors driving cloud service adoption and compare between various cloud delivery and deployment models.	**K5**
CO2	Demonstrate proficiency in cloud-enabling technologies, including modern virtualization and containerization	**K3**
CO3	Examine the resource management within the cloud, including resource pooling, scaling strategies, and storage management and utilize tools like MapReduce for processing big data applications.	**K4**
CO4	Identify potential security threats in cloud environments and apply appropriate security measures to mitigate these risks.	**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	PO12
CO1	3	3	3	3	3							3
CO2	3	3	3	3	2							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3								3

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	Cloud Computing : Concepts, Technology, Security, and Architecture	Thomas Erl	Pearson	2/e, 2023
2	Cloud Computing	Sandeep Bhowmik	Cambridge University Press	1/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Computing : Theory and Practice	Dan C. Marinescu	Morgan Kaufman	3/e, 2023
2	Cloud Computing: A Hands-On Approach	Arshdeep Bahga and Vijay Madisetti	Universities Press	1/e, 2014
3	Mastering Cloud Computing	Rajkumar Buyya, Christian Vecchiola S.Thamarai Selvi	Morgan Kaufman	1/e, 2013
4	Cloud Computing : A Practical Approach	Anthony T. Velte, Toby J. Velte, Robert Elsenpeter	McGraw Hill	1/e, 2010

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105167/

SEMESTER S6

MOBILE APPLICATION DEVELOPMENT

(Common to CS/CA/CB/CN)

Course Code	**PECST695**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To equip students with a thorough understanding of mobile application development fundamentals, including platforms (iOS and Android) and architectures (MVC, MVVM, BLoC).
2. To instill proficiency in Flutter and Dart: Enable students to use Flutter effectively for cross-platform development and the Dart programming language to create responsive, user-friendly mobile applications.
3. To prepare students for real-world scenarios by teaching app security, testing, CI/CD, and deployment processes, culminating in the development and deployment of a complete mobile application project.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of Mobile Application Development:** Introduction to Mobile Application Development, Overview of Mobile Platforms: iOS and Android, Introduction to Flutter: History, Features, and Benefits, Setting Up the Flutter Development Environment, Mobile App Architectures (MVC, MVVM, and BLoC), Basics of Dart Programming Language, Introduction to Git and Version Control **Assignments/Projects:** Set up the Flutter environment and create a simple "Hello World"	9

	application. (*Use Git: cloning, committing, pushing, and pulling*) *Milestone 1*: Develop a basic app with a simple UI and basic functionality.	
2	**User Interface Design and User Experience:** Principles of Mobile UI/UX Design, Designing Responsive UIs with Flutter, Using Flutter Widgets: StatelessWidget and StatefulWidget, Layouts in Flutter: Container, Column, Row, Stack, Navigation and Routing in Flutter, Customizing UI with Themes and Styles, Introduction to Material Design and Cupertino Widgets **Assignments/Projects:** Design and implement a user interface using Flutter widgets. *Milestone 2*: Enhance the project from Module 1 with a multi-screen UI, navigation, and customized themes.	**9**
3	**Advanced Flutter Development:** State Management in Flutter: Provider, Riverpod, and BLoC Networking in Flutter: HTTP Requests, JSON Parsing, RESTful APIs Data Persistence: SQLite, SharedPreferences, Hive Asynchronous Programming with Dart: Futures, async/await, and Streams Integrating Device Features: Camera, GPS, Sensors Working with Firebase: Authentication, Firestore, Cloud Functions **Assignments/Projects:** Develop an app with state management and data persistence. *Milestone 3*: Enhance the project with state management, data persistence, and integration with a RESTful API or Firebase.	**9**
4	**Industry Practices and App Deployment:** Advanced UI Components and Animations, App Security Best Practices, Testing and Debugging Flutter Applications, Continuous Integration/Continuous Deployment (CI/CD) with Flutter, Publishing Apps to Google Play Store and Apple App Store, Industry Trends and Future of Mobile Development with Flutter **Assignments/Projects:** Add advanced UI components and animations to the project, Implement	**9**

	security measures in the Flutter application, Conduct thorough testing and debugging of the developed app. *Milestone 4*: Complete the project, integrating all features and preparing it for deployment.	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Analyze

Key Actions: Differentiate, Organize, Attribute

Metrics and Examples:

1. Code Review and Refactoring:
    a. Task: Students are given a piece of code to analyze and refactor for better performance or readability.
    b. Metric: Ability to identify inefficient or redundant code and provide optimized solutions.

    Example: Analyzing a complex UI widget tree and reorganizing it for better performance and maintainability.

2. Design Pattern Identification:
    a. Task: Students are asked to identify and apply appropriate design patterns for given scenarios.
    b. Metric: Correct identification and application of design patterns like Singleton, Factory, or BLoC in their projects.

    Example: Analyzing an app's state management needs and choosing between Provider and BLoC patterns.

3. Bug Diagnosis:
    a. Task: Students are given a buggy piece of code to analyze and debug.
    b. Metric: Ability to use debugging tools and techniques to locate and fix bugs.

    Example: Analyzing asynchronous code to identify and resolve race conditions or memory leaks.

Evaluate

Key Actions: Check, Critique, Judge

Metrics and Examples:

1. Code Quality Assessment:
    a. Task: Students review each other's code and provide constructive feedback.
    b. Metric: Ability to critically evaluate code quality based on readability, efficiency, and adherence to best practices.

    Example: Peer review sessions where students critique the structure and efficiency of each other's Flutter code.

2. UI/UX Design Evaluation:
    a. Task: Students evaluate the user interface and user experience of their peers' applications.
    b. Metric: Ability to judge UI/UX designs based on usability, accessibility, and aesthetics.

    Example: Conducting usability testing sessions and providing feedback on navigation flow, design consistency, and user engagement.

3. Project Presentation and Defense:
    a. Task: Students present their projects and justify their design and implementation choices
    b. Metric: Ability to articulate design decisions, defend architectural choices, and respond to critical questions.

    Example: End-of-module presentations where students explain their choice of state management, navigation strategy, and performance optimizations.

Integration into the Syllabus - Example Use Cases

Basic Mobile Application Development

- Analyze: Evaluate different mobile app architectures (MVC, MVVM, BLoC) and choose the best fit for a given project scenario.
- Evaluate: Critically assess the setup and configuration of the Flutter development environment for potential improvements.

User Interface Design and User Experience

- Analyze: Analyze the responsiveness and usability of designed UIs, identifying potential bottlenecks.
- Evaluate: Critique the effectiveness of navigation and routing within the app.

Advanced Flutter Development

- Analyze: Break down the integration process of advanced features (state management, networking) and evaluate their impact on app performance.
- Evaluate: Judge the robustness of data persistence solutions and asynchronous programming implementations.

Industry Practices and App Deployment

- Analyze: Analyze the app's security measures and their effectiveness in protecting user data.
- Evaluate: Evaluate the completeness and readiness of the app for deployment based on industry standards and best practices.

Example Evaluation Rubrics

Analyze:

Criterion	**Excellent (4)**	**Good (3)**	**Satisfactory (2)**	**Needs Improvement (1)**
Identification of Code Inefficiencies	Identifies all inefficiencies and provides optimal solutions	Identifies most inefficiencies and provides good solutions	Identifies some inefficiencies with basic solutions	Struggles to identify inefficiencies or provide solutions
Application of Design Patterns	Correctly applies design patterns with a clear rationale	Applies design patterns with minor issues	Applies design patterns with significant issues	Incorrectly applies or fails to apply design patterns

Evaluate:

Criterion	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
Code Quality Assessment	Provides thorough, insightful feedback with constructive suggestions	Provides good feedback with some constructive suggestions	Provides basic feedback with limited constructive suggestions	Provides minimal or unhelpful feedback
UI/UX Design Evaluation	Provides detailed critique with actionable insights	Provides good critique with some actionable insights	Provides basic critique with limited actionable insights	Provides minimal or no critique

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	2 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. 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 mobile application development using Flutter and different mobile platforms.	**K2**
CO2	Apply principles of effective mobile UI/UX design, Create responsive user interfaces using Flutter features.	**K3**
CO3	Experiment effectively with state in Flutter application, networking and data persistence.	**K4**
CO4	Apply security best practices in mobile app development, test, and debug Flutter applications effectively.	**K5**
CO5	Set up CI/CD pipelines for Flutter projects and deploy mobile apps to Google Play Store and Apple App Store.	**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	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	3	3	3	3	3							3

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	Flutter Cookbook	Simone Alessandria	Packt	2/e, 2023
2	Flutter for Beginners	Alessandro Biessek	Packt	1/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Flutter in Action	Eric Windmill	Manning	1/e, 2019
2	Flutter and Dart: Up and Running	Deepti Chopra, Roopal Khurana	BPB	1/e, 2023
3	Managing State in Flutter Pragmatically	Waleed Arshad	Packt	1/e, 2021
4	Ultimate Flutter Handbook	Lahiru Rajeendra Mahagamage	Orange House	1/e, 2023

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://www.youtube.com/watch?v=VPvVD8t02U8

SEMESTER S6

INTRODUCTION TO DEEP LEARNING

Course Code	**PBCAT604**	**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)	PCCST503	**Course Type**	Theory

Course Objectives:

1. To teach the basics of neural networks along with advanced topics, including recurrent neural networks, long short-term memory cells, and convolutional neural networks.
2. To enable the students to complete programming solutions for real world problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Neural Networks Introduction to Human and Artificial Intelligence:** History of AI, Forms of learning - Supervised and unsupervised learning, Perceptron Learning rule, Bio-inspired learning, Artificial Neural Networks, Backpropagation, Multi-layer Perceptron model, Activation Functions Loss functions, Optimization, Training Neural Networks - gradient descent, stochastic gradient descent, momentum, weight initialization, batch normalization, hyper parameter optimization, parameter updates, model ensembles	**10**
2	**Overview of deep learning**: deep feedforward networks, and training deep models, including optimization techniques such as Gradient Descent (GD), GD with momentum, Stochastic GD, AdaGrad, RMSProp, and Adam. Regularization methods -L1 and L2, early stopping, dataset augmentation, parameter sharing and tying, input noise injection, ensemble methods, dropout, and parameter initialization.	**12**
3	**Convolutional Neural Networks**: convolution layer, pooling layer, fully connected layer, Conv Net, Case study of ImageNet challenge: LeNet, AlexNet, VGG, Google Net, ResNet, Inception Net, Efficient Net etc. Regularization Techniques, Data Augmentation: zooming, rotation,	**12**

	cropping, blurring, noise addition, self-supervision techniques, semi-supervised and weakly supervised learning, adversarial training Transfer Learning, freezing the input layers, fine tuning output layers	
4	**Deep Unsupervised Learning and Recent Trends**: Auto encoders (standard, sparse, denoising, contractive, etc.), Variational Autoencoders, Adversarial Generative Adversarial Networks, Auto encoder and DBM , Multi- task Deep Learning, Multi-view Deep Learning	**10**

Suggestion on Project Topics

- Applications of Deep Learning to Computer Vision
- Applications of Deep Learning to NLP

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
• 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	Explain the fundamental principles of neural networks and discuss the practical challenges associated with them.	**K2**
CO2	Explain the common regularization and optimization methods used in deep neural networks	**K2**
CO3	Use Deep Neural Networks with Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) for tasks such as object detection, image segmentation, and text-related issues.	**K3**
CO4	Determine which deep learning algorithms are best suited for different types of learning tasks across various domains.	**K3**
CO5	Implement deep learning algorithms and solve real-world 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	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3		3							3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning	Ian Good fellow and Yoshua Bengio and Aaron Courville	MIT Press	1/e, 2016
2	Neural networks and deep learning - Vol 2	Nielsen, Michael A	Determination press	1/e, 2015
3	Pattern Recognition and Machine Learning	Bishop, C., M.	Springer	1/e, 2006
4	Deep Learning with Python	Francois Chollet	Manning Publications	2/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Neural Networks: A Classroom Approach	Satish Kumar	Tata McGraw-Hill Education	1/e, 2005
2	Artificial Neural Networks	Yegnanarayana, B	PHI Learning	1/e, 2009

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Fundamental principles of neural networks NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1
2	Overview of deep learning, deep feedforward networks NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1
3	Convolutional Neural Network NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1
4	Autoencoders NPTEL :: Computer Science and Engineering - NOC:Deep Learning- Part 1

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 S6

DATA STRUCTURES

Course Code	OECST611	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)	-	**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; Polynomial representation using Arrays, Sparse matrix (*Tuple representation*); Stacks and Queues - Stacks, Multi-Stacks, Queues, Circular Queues;	**9**
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.	**9**
3	**Trees and Graphs** Trees :- Representation Of Trees; Binary Trees - Types and Properties, Binary Tree Representation, Tree Operations, Tree Traversals; Binary Search Trees - Binary Search Tree Operations; Graphs :- Definitions; Representation of Graphs; Depth First Search and Breadth First Search.	**9**

4	**Sorting and Searching** Sorting Techniques :- Selection Sort, Insertion Sort, Quick Sort, Merge Sort; Searching Techniques - Linear Search, Binary Search, Hashing - Hashing functions : Division; Collision Resolution : Linear probing, Open hashing.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

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 Leisesrson, 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 S6

DATA COMMUNICATION

(Common to CS/CM/CD/CA)

Course Code	**OECST612**	**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 understand the details of data communication at the lower level and the associated issues.
2. To gain insight into the important aspects of data communication and computer networking systems and to apply the in practical applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Communication model - Simplex, Half duplex, Full duplex transmission. Periodic analog signals - Sine wave, Amplitude, Phase, Wavelength, Time and frequency domain, Bandwidth. Analog & digital data and signals. Transmission impairments - Attenuation, Delay distortion, Noise. Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula. Guided transmission media - Twisted pair, Coaxial cable, Optical fiber. Unguided media - Radio waves, Terrestrial microwave, Satellite microwave, Infrared. Wireless propagation - Ground wave propagation, Sky wave propagation, Line-of-Sight (LoS) propagation.	**10**
2	Digital data to digital signal – Non-Return-to-Zero (NRZ), Return-to-Zero (RZ), Multilevel binary, Biphase. Analog data to digital signal - Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to analog signal - Amplitude Shift Keying (ASK), Frequency Shift	**9**

	Keying (FSK), Phase Shift Keying (PSK). Analog data to analog signal - Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).	
3	Multiplexing - Frequency Division Multiplexing (FDM), Wavelength Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread spectrum techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).	**8**
4	Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming distance, Hamming code. Basic principles of switching - Circuit switching, Packet switching, Message switching.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Identify the characteristics of signals for analog and digital transmissions so as to define the associated real world challenges.	**K3**
CO2	Select transmission media based on characteristics and propagation modes.	**K3**
CO3	Choose appropriate signal encoding techniques for a given scenario	**K3**
CO4	Illustrate multiplexing and spread spectrum technologies	**K2**
CO5	Use error detection, correction and switching techniques in data communication	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	2								3
CO3	3	3		2								3
CO4	3	3	3	2								3
CO5	3	3	3	2								3

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	Data Communications and Networking	Forouzan B. A	McGraw Hill	6/e, 2019
2	Data and Computer Communication	William Stallings	Pearson	10/e, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mobile Communications	Schiller J	Pearson	2/e, 2009
2	Fundamentals of Networking and Communication	Curt M. White	Cengage	7/e, 2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105082

SEMESTER S6

FOUNDATIONS OF CRYPTOGRAPHY

Course Code	**OECST613**	**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. Develop a foundational understanding of mathematical concepts in cryptography,
2. Gain comprehensive knowledge of cryptographic methods.
3. Understand the principles and need for computer security.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Integer Arithmetic – Divisibility, Greatest Common Divisor Euclid's and Extended Euclid's Algorithm for GCD; Modular Arithmetic – Operations, Properties, Polynomial Arithmetic; Algebraic Structures – Group Ring Field.	9
2	Prime numbers and Prime Factorisation - Primitive Roots, Existence of Primitive Roots for Primes, Fermat's Theorem, Primality Testing, Euler's Theorem, Euler's Totient Function, Discrete Logarithms, Modular Arithmetic, Chinese Remainder Theorem.	9
3	Principles of security - Types of Security attacks, Security services, Security Mechanisms; Cryptography - Introduction, cryptographic notations, substitution techniques, Transposition Techniques, limitations of classical cryptography.	9
4	Symmetric key Ciphers - Block Cipher principles & Algorithms- DES, AES, Differential and Linear Cryptanalysis; Asymmetric Key Ciphers- RSA, ECC; Hash Functions - MD5, SHA-1.	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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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 integer arithmetic operations including divisibility and GCD algorithms, modular arithmetic operations and properties, polynomial arithmetic, and algebraic structures such as groups, rings, and fields.	**K2**
CO2	Describe the number theory concepts essential for cryptographic applications and mathematical problem-solving.	**K2**
CO3	Explain the security principles, types of attacks, and protective measures, alongside a thorough understanding of cryptographic techniques and their applications in securing data.	**K2**
CO4	Discuss symmetric and asymmetric key cryptography, including block cipher principles, algorithms, public key cryptosystems, and hash functions	**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	PO12
CO1	2	2										2
CO2	2	2										2
CO3	2	2										2
CO4	2	2										2

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	Cryptography & Network Security	Behrouz A. Forouzan	McGraw Hill	3/e, 2007
2	Security in Computing	Charles P. Pfleeger, Shari L. Pfleeger, Jonathan Margulies	Prentice Hall	5/e, 2015
3	Introduction to Cryptography: Principles and Applications	H. Delfs, H. Knebl	Springer	1/e, 2002
4	A Classical Introduction to Cryptography: Applications for Communications Security	Serge Vaudenay	Springer	1/e, 2009

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography and Network Security	William Stallings	Pearson Education	7/e,2017

Video Links (NPTEL, SWAYAM…)

Module No.	Link ID
1	https://archive.nptel.ac.in/courses/111/101/111101137/
2	https://nptel/courses/video/106105031/L17.html
3	https://onlinecourses.nptel.ac.in/noc22_cs90/preview

SEMESTER S6

MACHINE LEARNING FOR ENGINEERS

(Common to CS/CA/CD/CM/CR/AD/AM/AI)

Course Code	**OECST614**	**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 the basic concepts and algorithms in machine learning.
2. To discuss the standard and most popular supervised and unsupervised learning algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to ML** Machine Learning vs. Traditional Programming, Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. **Basics of parameter estimation** - maximum likelihood estimation (MLE) and maximum aposteriori estimation (MAP), Bayesian formulation. **Supervised Learning** Feature Representation and Problem Formulation, Role of loss functions and optimization **Regression** - Linear regression with one variable, Linear regression with multiple variables - solution using gradient descent algorithm and matrix method.	**10**
2	**Classification** - Naïve Bayes, KNN **Generalisation and Overfitting** - Idea of overfitting, LASSO and RIDGE	**8**

	regularization, Idea of Training, Testing, Validation **Evaluation measures** – Classification - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC). Regression - Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination.	
3	**Neural Networks (NN) -** Perceptron, Neural Network - Multilayer feed-forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm. **Decision Trees** – Information Gain, Gain Ratio, ID3 algorithm	**8**
4	**Unsupervised Learning** **Clustering** - Similarity measures, Hierarchical Clustering - Agglomerative Clustering, partitional clustering, K-means clustering **Dimensionality reduction** - Principal Component Analysis, Multidimensional scaling **Ensemble methods** - bagging, boosting **Resampling methods** - Bootstrapping, Cross Validation. Practical aspects - Bias-Variance trade-off	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	Illustrate Machine Learning concepts and basic parameter estimation methods	**K2**
CO2	Demonstrate supervised learning concepts (regression, classification)	**K3**
CO3	Illustrate the concepts of Multilayer neural network and Decision trees	**K3**
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques	**K3**
CO5	Use appropriate performance measures to evaluate machine learning models	**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	PO12
CO1	3	3	3	3								2
CO2	3	3	3	3	2							2
CO3	3	3	3	3	2							2
CO4	3	3	3	3	2							2
CO5	3	3	3	3	2							2

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 Machine Learning	Ethem Alpaydin	MIT Press	2/e, 2010
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki, | Wagner Meira	Cambridge University Press	1/e, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Machine Learning	Tom Mitchell	McGraw-Hill	1997
2	Applied Machine Learning	M Gopal	Pearson	2/e, 2018
3	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1995
4	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	1/e, 2012
5	The Elements Of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer	2/e, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/fC7V8QsPBec?si=8kqBn-_7x1RG5V1J
2	https://youtu.be/g__LURKuIj4?si=Xj10NPfMfpQSOhVx
3	https://youtu.be/yG1nETGyW2E?si=ySlxpeWuFAUQBf7-
4	https://youtu.be/zop2zuwF_bc?si=W7TpSHLdi4rykva4

SEMESTER S6

OBJECT ORIENTED PROGRAMMING

(Common to CS/CA/CD/CM/AM/AD)

Course Code	**OECST615**	**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 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 - Java programming Environment and Runtime Environment (Command Line & IDE); Java compiler; Java Virtual Machine; Primitive Data types and Wrapper Types; Casting and Autoboxing; Arrays; Strings; Vector class; Operators - Arithmetic, Bitwise, Relational, Boolean Logical, Assignment, Conditional (Ternary); Operator Precedence; Control Statements - Selection Statements, Iteration Statements and Jump Statements; Functions; Command Line Arguments; Variable Length Arguments; Classes; Abstract Classes; Interfaces; OOP Concepts - Data abstraction, encapsulation, inheritance, polymorphism, Procedural and object oriented programming paradigm; Microservices; Object Oriented	10

	Programming in Java - Declaring Objects; Object Reference; Introduction to Methods; Constructors; Access Modifiers; ***this*** keyword.	
2	Polymorphism - Method Overloading, Using Objects as Parameters, Returning Objects, Recursion; Static Members, Final Variables, Inner Classes. Inheritance - Super Class, Sub Class, Types of Inheritance, The ***super*** keyword, protected Members, Calling Order of Constructors; Method Overriding, Dynamic Method Dispatch, Using ***final*** with Inheritance.	**8**
3	Packages and Interfaces – Packages - Defining a Package, CLASSPATH, Access Protection, Importing Packages; Interfaces - Interfaces v/s Abstract classes, defining an interface, implementing interfaces, accessing implementations through interface references, extending interface(s); Exception Handling - Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause, Multiple catch Clauses, Nested ***try*** Statements, ***throw***, ***throws*** and ***finally***, Java Built-in Exceptions, Custom Exceptions.	**9**
4	Swings fundamentals – Overview of AWT, Swing v/s AWT, Swing Key Features, Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings– JFrame, JLabel, The Swing Buttons, JTextField; Event handling – Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model; Developing Database Applications using JDBC – JDBC overview, Types, Steps, Common JDBC Components, Connection Establishment.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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 process of developing 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.	**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	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3	3		3							3
CO4	3	3	3		3							3
CO5	3	3	3		3							3

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	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)

SEMESTER S6

ROBOTICS LAB

Course Code	PCCAL607	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)	PCCAL308	Course Type	Lab

Course Objectives :

1. To expose the students to the common sensor and actuator interfacing, setting up mobile robots and familiarising intelligent systems.

Expt. No.	Experiments
PART A	
1	Familiarisation of Arduino IDE,Arduino microcontroller I/O interfacing(LED, LCD,Serial Monitor)
2	Interfacing IR and Ultrasonic sensor with Arduino
3	Interfacing DC motors with arduino - speed and direction control
4	Interfacing Servo Motors with Arduino - angle of rotation
5	Familiarisation of Rasberry Pi and its I/O interfacing
6	Mobile Robot assembly
7	Networking with Arduino using BLE
PART B	
8	Writing a Simple Publisher and Subscriber, Simple Service and Client, Recording and playing back data, Reading messages from a bag file(Python/C++)
9	Localization of a mobile robot using LIDAR (ROS)
10	Implementing a weather station using Raspberry pi
11	Line following Robot using IR sensor
12	Image Recognition using ESP32 CAM module
13	Obstacle avoidance of a mobile robot while moving to a point.
14	Navigation simulation using turtlebot in ROS

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	Interface different peripherals to Arduino and Raspberry Pi.	**K3**
CO2	Assemble a mobile robot with different sensors and actuators	**K3**
CO3	Implement localisation of mobile robots.	**K3**
CO4	Build intelligence in robots using standard algorithms.	**K3**
CO5	Implement Robot navigation.	**K3**

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

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										2
CO2	2	2										3
CO3	2	2	3		3							3
CO4	2	3	3	3	3							3
CO5	2	3	3	3	3							3

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Autonomous Mobile Robots	Siegwart, Roland	MIT Press,	2/e, 2004
2	Robotics, Vision and Control: Fundamental Algorithms in MATLAB	Peter Corke	Springer	2/e, 2017
3	Introduction to Robotics	John G Craig	Pearson	3/e, 2004
4	Introduction to Robotics	SK Saha	McGraw Hill	1/e, 2004
5	Robotics and Control	RK Mittal and I J Nagrath	Tata McGraw Hill	1/e, 2003
6	Robotic Tactile Sensing	Dahiya, Ravinder S., Valle, Maurizio	Springer	1/e, 2013

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1,2,3,4	https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/ https://onlinecourses.nptel.ac.in/noc21_me76/preview https://nptel.ac.in/courses/107106090 https://onlinecourses.nptel.ac.in/noc23_me143/preview

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 7

COMPUTER SCIENCE AND ENGINEERING

(ARTIFICIAL INTELLIGENCE)

SEMESTER S7

FORMAL METHODS IN SOFTWARE ENGINEERING

(Common to CS/CR/CM/CA/AD/AM)

Course Code	**PECST741**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	2:1:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To enable the learners to apply formal methods for modelling, validation, and verification of software systems.
2. To familiarize with a series of advanced tools that address challenges faced in design, coding, and verification.
3. To provide an introduction to the theoretical aspects of these tools, as well as hands-on exploration.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction :-** Stages in software development; software defects –causes of software defects; techniques for dealing with software defects-Testing and verification, formal methods and tools.	**9**
2	**Ensuring reliability in the design phase :-** Conceptual modelling, the tool Alloy, conceptual modelling in Alloy, Analysing Alloy models, Fixing bugs in modelling, How Alloy works? Show that the Konigsberg Bridge Problem has no solution.	**9**
3	**Verification by Model Checking :-** Verifier for Concurrent C (VCC): a Hoare-Triple- based tool for Verifying Concurrent C, intra procedure verification of programs, ghost statements.	**9**
4	**Program Verification:-** Inter-procedure verification of programs in VCC, function contracts, pure functions, loop invariants, proving total correctness of programs in VCC.	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 need and use of formal methods and tools in software engineering.	**K2**
CO2	Demonstrate conceptual modelling of systems using *Alloy*.	**K3**
CO3	Illustrate the process of proving correctness of code using Hoare-Triple based weakest precondition analysis	**K3**
CO4	Demonstrate program verification using VCC.	**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	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	2	3	2	3	2	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	3	3	3	-	-	-	-	-	-	-

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 Abstractions	Daniel Jackson	MIT Press	2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Verifying C Programs: A VCC Tutorial, Working draft, version 0.2	E. Cohen, M. A., Hillebrand, S. Tobies, M. Moskal, W. Schulte		2015
2	The VCC Manual, Working draft, version 0.2			2016.

Links	
No.	**Link ID**
1	Tutorial for Alloy Analyzer 4.0 https://alloytools.org/tutorials/online/

SEMESTER S7

WEB PROGRAMMING

(Common to CS/CA/CM/CD/CR/AD/AM)

Course Code	**PECST742**	**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 knowledge and skills required to create, style, and script web pages using HTML5, CSS, JavaScript, and related technologies.
2. To provide hands-on experience with modern web development tools and frameworks such as React, Node.js, JQuery, and databases, enabling students to design and build dynamic, responsive, and interactive web applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Creating Web Page using HTML5 -** Introduction, First HTML5 example, Headings, Linking, Images, Special Characters and Horizontal Rules, Lists, Tables, Forms, Internal Linking, meta Elements, HTML5 Form input Types, Input and datalist Elements and autocomplete Attribute, Page-Structure Elements; **Styling Web Page using CSS -** Introduction, Inline Styles, Embedded Style Sheets, Linking External Style Sheets, Positioning Elements:, Absolute Positioning, z-index, Positioning Elements: Relative Positioning, span, Backgrounds, Element Dimensions, Box Model and Text Flow, Media Types and Media Queries, Drop-Down Menus; **Extensible Markup Language** - Introduction, XML Basics, Structuring Data, XML Namespaces, Document Type Definitions (DTDs), XML Vocabularies	**9**
2	**Scripting language -** Client-Side Scripting, Data Types, Conditionals, Loops, Arrays , Objects , Function Declarations vs. Function Expressions , Nested Functions , The Document Object Model (DOM) - Nodes and NodeLists, Document Object, Selection Methods, Element Node Object, Event Types	**9**

	Asynchronous JavaScript and XML - AJAX : Making Asynchronous Requests , Complete Control over AJAX , Cross-Origin Resource Sharing **JavaScript library - jQuery** - jQuery Foundations - Including jQuery, jQuery Selectors, Common Element Manipulations in jQuery, Event Handling in jQuery	
3	**JavaScript runtime environment : Node.js -** The Architecture of Node.js, Working with Node.js, Adding Express to Node.js; **Server-side programming language : PHP** - What Is Server-Side Development? Quick tour of PHP, Program Control , Functions , Arrays , Classes and Objects in PHP , Object-Oriented Design ; **Rendering HTML : React -** ReactJS Foundations : The Philosophy of React, What is a component? Built- in components, User-defined components - Types of components, Function Components, Differences between Function and Class Components	**9**
4	**SPA** – Basics, Angular JS; **Working with databases -** Databases and Web Development, SQL, Database APIs, Accessing MySQL in PHP; **Web Application Design -** Real World Web Software Design, Principle of Layering , Software Design Patterns in the Web Context, Testing; **Web services** - Overview of Web Services - SOAP Services, REST Services, An Example Web Service, Web server - hosting options	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Develop structured web pages with HTML5 and style them using CSS techniques, including positioning, media queries, and the box model.	**K3**
CO2	Write client-side scripts using JavaScript and utilize jQuery for DOM manipulation, event handling, and AJAX requests to create responsive and interactive user interfaces.	**K3**
CO3	Build and deploy server-side applications using Node.js, Express, and PHP, and integrate databases using SQL to store and retrieve data for dynamic content generation.	**K3**
CO4	Utilize React for building component-based single-page applications (SPAs), understanding the fundamental principles of component architecture, and leveraging AngularJS for web application development.	**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	PO12
CO1	3	3	3	-	3	-	-	-	-	-	-	3
CO2	3	3	3	-	3	-	-	-	-	-	-	3
CO3	3	3	3	-	3	-	-	-	-	-	-	3
CO4	3	3	3	-	3	-	-	-	-	-	-	3

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 Web Development	Randy Connolly, Ricardo Hoar	Pearson	1/e, 2017
2	Building User Interfaces with ReactJS - An Approachable Guide	Chris Minnick	Wiley	1/e, 2022
3	Internet & World Wide Web - How to Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson	1/e, 2011

4	SPA Design and Architecture: Understanding Single Page Web Applications	Emmit Scott	Manning Publications	1/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Hand Book On Web Development : From Basics of HTML to JavaScript and PHP	Pritma Jashnani	Notion press	1/e, 2022
2	Advanced Web Development with React	Mohan Mehul	BPB	1/e, 2020
3	JavaScript Frameworks for Modern Web Development	Tim Ambler, Sufyan bin Uzayr, Nicholas Cloud	Apress	1/e, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106222/
2	https://archive.nptel.ac.in/courses/106/106/106106156/

SEMESTER S7

BIOINFORMATICS

Course Code	PECST743	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 understand the fundamental concepts in Molecular Biology, Genomics, Proteomics and Modelling.
2. To introduce bio macromolecules such as genes and proteins, different biological databases, and tools and algorithms for biological data processing, analysis and interpretation, and the elements of the systems approach to Molecular Biology.

SYLLABUS

Module	Syllabus Description	Contact Hours
1	**Molecular Biology Primer (3 hours)** Genes, DNAs, RNAs, Proteins, Genomics, Sequencing techniques, Bioinformatics overview and scope **Sequence Alignment (6 hours)** Global and local sequence alignment-dynamic programming algorithms, edit distance, similarity, Needleman Wunsch Algorithm, Smith Waterman Algorithm	**9**
2	**Biological Databases and Data Formats (3 hours)** Genomic and Sequence Data Formats, GenBank, EMBL-Bank, and DDBJ, PROSITE, NCBI- Database Searching: BLAST, FASTA **Phylogenetics (6 hours)** Phylogenetic Tree basics and Construction Methods, UPGMA, Neighbour joining, Parsimonous trees, Additive trees, Bootstrapping	**9**
3	**Combinatorial Pattern Matching (9 hours)** Combinatorial Pattern Matching, Repeat finding, Keyword Trees, Suffix Trees, Heuristic similarity search algorithms, Approximate Pattern Matching	**9**

4	**R FOR BIOINFORMATICS** Variables, Data types, control flow constructs, String manipulation, Pattern Matching, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation, packages for sequence alignment, FASTA, BLAST (Bioconductor, msa, Biostrings etc.) **Indicative Laboratory/Microproject Tasks** Biological Databases, Sequence alignment: BLAST family of programs, FASTA, ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Related Programs in R.	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	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	Understand the Basics of Bioinformatics	**K2**
CO2	Use various biological databases and apply sequence alignment techniques	**K3**
CO3	Use molecular phylogenetics to identify evolutionary relationships among various biological species	**K3**
CO4	Apply the concept of combinatorial pattern matching in bioinformatics	**K3**
CO5	Use R language and packages to solve bioinformatics problems	**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	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	3	-	-	-	-	-	-	-	2
CO4	3	3	3	3	-	-	-	-	-	-	-	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2

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	An Introduction to Bioinformatics Algorithms,	N. C. Jones and P. A. Pevzner,	MIT Press, 2004	1/e, 2004
2	Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools	Supratim Choudhuri	Academic Press	1/e, 2014
3	R Programming for Bioinformatics	Robert Gentleman	CRC Press	1/e, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Bioinformatics	T. K. Attwood and D. J. Parry-Smith,	Pearson Education	1/e, 2003
2	Analysis of Biological Networks,	B. Junker and F. Schreiber,	Wiley Publishers	1/e, 2007
3	Heterogeneous Information Networks - Principles & Methodologies	Y. Sun and J. Han, Mining	Morgan & Claypool Publishers	1/e, 2012
4	Multilayer Social Networks,	M. E. Dickison et al,	Cambridge University Press	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/102/106/102106065/
2	https://onlinecourses.swayam2.ac.in/cec21_bt04/preview

SEMESTER S7

INFORMATION SECURITY

(Common to CS/CM/CA/AM)

Course Code	**PECST744**	**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)	PECST637	**Course Type**	Theory

Course Objectives:

1. To learn the essentials of confidentiality, integrity and apply access control mechanisms to the user information
2. To understand threats and Vulnerabilities and design security frameworks
3. To learn how to maintain the accuracy and completeness of data as it is transmitted over the network with total security

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Information Security - CIA triad , OSI Security Architecture, Security Goals, Security Services and Mechanisms, Threats, Attacks- Malicious code, Brute force, Timing attack, Sniffers; Access Control Mechanisms - Access Control, Access control matrix, Access control in OS-Discretionary and Mandatory access control, Role-based access control.	9
2	Software Vulnerabilities - Buffer and Stack Overflow, Cross-site Scripting (XSS) and vulnerabilities, SQL Injection and vulnerabilities, Phishing; Malwares - Viruses, Worms and Trjans, Topological worms, Trapdoors, Salami attack, Man-in-the-middle attacks, Covert channels.	9
3	Introduction to security of information storage - Processing, and Transmission. Information Security Management - The ISO Standards relating to Information Security - Other Information Security Management Frameworks - Security Policies - Security Controls - The Risk Management Process - Regulations and legal frameworks; Authentication - User Authentication, Token Based, Biometric Authentication, Remote User Authentication, Multifactor Authentication.	9

4	Security in Networks - Threats in networks, Network Security Controls - Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP, S/MIME.	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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 goals, services and mechanisms related to information security.	**K2**
CO2	Identify the different types of threats and attacks and the design strategies to mitigate the attacks	**K2**
CO3	Describe the information security practices within an organization, ensuring data protection and compliance with industry standards and legal requirements.	**K2**
CO4	Discuss the skills to enhance network security, protect data in transit, and respond to potential threats effectively	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

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	Network security and Cryptography	B. Menezes	Cengage	1/e, 2010
2	Cryptography And Network Security Principles And Practice	William Stallings	Pearson	5/e, 2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cryptography and Network Security	B. A. Forouzan, D. Mukhopadhyay	McGraw Hill	3/e, 2015
2	Network Security Essentials: Applications and Standards	William Stallings	Prentice Hall.	4/e, 2011
3	Information System Security	Nina Godbole	Wiley	2/e, 2017

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106129/
2	https://nptel.ac.in/courses/106106199

SEMESTER S7

PROGRAMMING IN R

Course Code	PECAT746	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	None	Course Type	Theory

Course Objectives:

1. To equip students with the knowledge and skills required to utilize R for data analysis and visualization.
2. To enable students to apply R programming techniques in statistical modelling and data science projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to R:**The R Environment – Overview, Command Line Interface, and Batch processing. R Packages. Basic Data Types – Vectors, Lists, Data Frames, Matrices, and Arrays. Control Statements – If-Else, Switch, For loops, While loops. Functions – Writing and using functions, Scope of variables, Function arguments, Returning values.	9
2	**Data Import, Cleaning, and Preprocessing:**Data Import and Export – Reading and writing data from/to Text files, CSV, Excel, and other software. Database Connections – Connecting to databases and importing data using packages. Handling Missing Data – NA, NULL values. Data Cleaning and Preprocessing – Detecting and removing duplicates, Handling outliers, Data transformation and normalization, combining data sets, Binning Data, Subsets, summarizing functions.	9
3	**Statistical Analysis and Data Visualization:**Introduction to Data analytics, Summary statistics, Statistical Tests – Continuous Data and Discrete Data.	9

	Common distributions-type arguments. Probability distributions – Normal distributions. R Graphics – Overview, Customizing Charts, Graphical parameters, Basic Graphics functions. Lattice Graphics – Lattice functions, Customizing Lattice Graphics, Ggplot.	
4	**Machine Learning with R:**Basic concepts, Supervised vs. Unsupervised learning, Simple regression, and classification models. Building linear models - model fitting, predict values using models, Analyzing the fit, Refining the model. Regression – Types, Unusual observation and corrective measures, Comparison of models. Case Studies and Applications – Real-world applications of R in various fields like finance, healthcare, and social sciences.	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 R programming environment for data analysis and visualization.	**K2**
CO2	Utilize R tools to import, clean, and manipulate data effectively.	**K3**
CO3	Perform statistical analysis and interpret the results using R visualization.	**K3**
CO4	Use basic machine learning models and perform predictive analysis using R.	**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	PO12
CO1	3	2			3							3
CO2	3	2	3	3	3							3
CO3	3	2	3	3	3							3
CO4	3	2	3	3	3							3

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	R in a Nutshell	Joseph Adler	O'reilly	2/e, 2012
2	The Art of R Programming	Norman Matloff	O'reilly	1/e, 2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	R for Everyone- Advanced analytics and graphics	Jared P Lander	Addison Wesley data analytics series, Pearson	1/e, 2016
2	R for Data Science	Hadley Wickham, Garrett Grolemund	O'Reilly Media	1/e, 2016
3	Machine Learning with R	Brett Lantz	Packt Publishing	1/e, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/111/104/111104100/
2	https://nptel.ac.in/courses/110106064

SEMESTER S7

BIOMEDICAL ELECTRONICS

Course Code	**PECAT747**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Mins.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To gain fundamental knowledge of biopotential acquisition and analysis
2. To develop an understanding of signal conditioning principles for biomedical applications
3. To become familiar with the measurement of various physiological parameters

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	**Basic Theories of Measurement:** Categories of Measurement- primary, secondary, territory measurements, Factors in Making Measurements, Measurement Errors, Categories of Errors, Dealing with Measurement Errors, Error Contribution Analysis.	**8**
2	**Electrodes,Sensors and Transducers:** Signal Acquisition, Transduction, Tactics and Signals Processing for Improved Sensing, Medical Surface Electrodes, Microelectrodes, Strain Gauges, Quartz Pressure Sensors, Matching Sensors to Circuits, Temperature, Capacitive, and Inductive Transducers **Bioelectric Ampifiers**: Multiple-Input Circuits, Signal Processing Circuits, Practical Op-Amps, Isolation Amplifiers, Chopper Stabilized Amplifiers, Input Guarding, Working of isolation amplifiers, (transformer, capacitive and optical isolation), isolated DC amplifier and AC carrier amplifier. (Circuit diagram and working only)	**10**

3	**Measurement of Parameters:** Measurements of blood flow- radiographic techniques, indicator dye method, thermal convection, magnetic blood flow meter, ultrasonic blood flow meter. Measurement of blood pressure, heart rate measurement, study of brain signals, respiratory and other measurements- spirometer, measurement of deafness, Electroretinogram, electrooculogram.	9
4	**Recording Systems**: Basic recording systems, Biomedical recorders- ECG, VCG, PCG, EEG, Patient Monitoring systems- system concepts, Biomedical telemetry- basics, telemedicine- basic concepts and essential parameters **Modern Imaging Systems**: X-ray machines and digital radiography, X-ray computer tomography, Nuclear medical imaging systems, MRI, Ultrasound imaging systems, thermal imaging systems (only basics and principals)	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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 basis of measuring, recording and monitoring in biomedical fields.	**K2**
CO2	Describe the various measuring parameter in human body	**K2**
CO3	Summarize the various recording systems, telemetry and concepts of telemedicine	**K2**
CO4	Identify the various modern imaging techniques used in the biomedical fields	**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	PO12
CO1	3	3	3	3								2
CO2	3	3	3	3								2
CO3	3	3	3	3								2
CO4	3	3	3	3								2

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	Handbook Of Biomedical Instrumentation	Dr R. S. Khandpur	McGraw Hill Education (India)	3/E, 2014
2	Electronics in medicine and biomedical instrumentation	Nandini k Jog	PHI learning Pvt.	2/E, 2013

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Biomedical Equipment Technology	J. J. Carr and J. M. Brown	Pearson	4/E,2002
2	HandBook of Biomedical Instrumentation	R.S. Khandhpur	McGraw Hill	3/E, 2014
3	Principles of Applied Biomedical Instrumentation	L.A. Geddes and L.E.Baker	Wiley	3/E, 2008
4	Principles of Medical Electronics and io-medical Instrumentation	C. Rajarao and S.K. Guha	Universities press	1/E, 2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1, 2, 3,4	https://onlinecourses.swayam2.ac.in/nou23_bt05/preview https://archive.nptel.ac.in/courses/102/105/102105090/

SEMESTER S7

REAL TIME SYSTEMS

(Common to CS/CM/CA/AM)

Course Code	**PECST748**	**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)	PCCST402, PCCST403	**Course Type**	Theory

Course Objectives:

1. To enable the learners to familiarize with the concepts of Real Time systems
2. To teach different task scheduling algorithms in uniprocessor and multiprocessor environments.
3. To learn the features of real-time communications, real-time databases and real time OS.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Real-Time systems: Basic concepts, applications of Real-Time systems, basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems: hard, firm, soft, timing constraints, modelling timing constraints.	**6**
2	Real-Time task scheduling: Basic concepts, clock driven scheduling, table driven scheduling, cyclic, schedulers, hybrid schedulers, event driven scheduling, EDF Scheduling, RMA, DMA, resource sharing among RT tasks, Priority inversion, Priority Inheritance Protocol, Highest Locker Protocol, Priority Ceiling Protocol, Scheduling Real-Time tasks in multiprocessor and distributed systems, Fault tolerant scheduling of tasks, clocks in distributed Real-Time systems.	**12**
3	Commercial Real-Time Operating Systems: Time services, Features of real-time operating systems, UNIX and Windows as RTOS, POSIX, PSOS, VRTX, QNX, RT Linux, Lynx, other RTOS, benchmarking RT OS, Real-Time OS: OS services, I/O subsystem, Network OS.	**8**
4	RT communications: QoS framework, models, Real-Time Communication in a LAN, IEEE 802.4, RETHER, Communication over Packet Switched Networks, Routing algorithms, RSVP, rate control; RT databases - Applications, characteristics of temporal data, Concurrency control, Commercial RT	**10**

	databases, Special topics in Real-Time systems.	

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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 various Real Time applications, services, design considerations and architectures	**K2**
CO2	Develop efficient algorithms for real-time task scheduling in uniprocessor and multiprocessor environments	**K3**
CO3	Identify the limitations of a non real-time operating system in running a real-time application	**K2**
CO4	Identify and address the important issues in real-time communications	**K2**
CO5	Understand the concepts of use real-time databases	**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	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	3	2									3

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	Real-Time Systems: Theory and Practice	Rajib Mall	Pearson Education,	1/e, 2007
2	Real-Time Systems	Jane W. S. Liu	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	Real-Time Systems Design and Analysis, Wiley	Philip A. Laplante, Seppo J. Ovaska	Wiley	1/e, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1, 2, 3, 4	https://onlinecourses.nptel.ac.in/noc22_cs104/preview

SEMESTER S7

COMPUTER VISION

Course Code	**PECST745**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To cover the basics of image formation, key computer vision concepts, methods, techniques, pattern recognition, and various problems in designing computer vision and object recognition systems.
2. To enable the learners to understand the fundamentals of computer vision and machine learning models to develop applications in computer vision.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals in Computer Vision :-** Camera Calibration- Pinhole camera model, Geometric Image Features - Curves, Surfaces, Analytical Image Features - Elements of Analytical Euclidean Geometry, Geometric Camera Parameters, Stereopsis - Binocular Camera Geometry, Epipolar Constraint, Binocular Reconstruction, Local Methods for Binocular Fusion, Global Methods for Binocular Fusion.	9
2	**Features and Filters :-** Linear Filters- Linear Filters and Convolution, Shift Invariant Linear Systems. Estimating Derivatives with Finite Differences, Noise, Edges and Gradient-based Edge Detectors Image Gradients - Computing the Image Gradient, Gradient Based Edge and Corner Detection. Filters as Templates - Normalized Correlation and Finding Patterns.	9
3	**Machine Learning for Computer Vision :-**	9

	Machine Learning - Introduction, Dataset for Machine Perception- Labelled and Unlabelled Data, Basics of Classification and Clustering, Multi-Class Perspective. Machine Learning for Computer Vision -Machine Learning -Deep Learning Use Cases. Machine Learning Models for Vision - Image Vision-Pretrained Model, Transfer Learning, Fine-Tuning, Convolutional Networks, Convolutional Filters, Stacking Convolutional Layers, Pooling Layers - AlexNet, VGG19, , Modular architecture - ResNet, Neural Architecture Search Design - NASNet	
4	**Segmentation and Object detection :-** Segmentation Using Clustering Methods - Human vision- Grouping and Gestalt, Applications- Shot Boundary Detection, Background Subtraction, Image Segmentation by Clustering Pixels- Simple Clustering Methods, Clustering and Segmentation by K-means Object detection - YOLO, Segmentation-Mask R-CNN and Instance Segmentation, U-Net and Semantic Segmentation, Model Quality Metrics ***A case study to compare performance of various models on a suitable dataset.***	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Understand the basic concepts and terminologies like Camera Calibration, Stereopsis in computer vision	**K2**
CO2	Apply filters for feature extraction and for finding patterns.	**K3**
CO3	Build different machine learning models for computer vision	**K3**
CO4	Implement segmentation and object detection models	**K3**
CO5	Analyze different machine learning models for segmentation/object detection.	**K4**

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**	**PO12**
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3	3	3							3

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	Computer vision: A modern approach	Forsyth, David, and Jean Ponce	Prentice hall	2011
2	Emerging topics in computer vision	Medioni, Gerard and Sing Bing Kang	PHI	2004
3	Practical Machine Learning for Computer Vision	Valliappa Lakshmanan, Martin Görner, Ryan Gillard	O'Reilly Media	2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer vision: algorithms and applications	Szeliski, Richard	Springer Science & Business Media	2010
2	Image Segmentation: Principles, Techniques, and Applications	Tao Lei, Asoke K. Nandi	John Wiley & Sons	2022
3	Deep Learning in Computer Vision Principles and Applications	Ali Ismail Awad, Mahmoud Hassaballah	CRC Press	2020

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Computer Vision and Image Processing - Fundamentals and Applications by Prof. M. K. Bhuyan at IIT Guwahati https://onlinecourses.nptel.ac.in/noc23_ee39/preview
2 **3**	Computer Vision by Prof. Jayanta Mukhopadhyay at IIT Kharagpur https://onlinecourses.nptel.ac.in/noc19_cs58/preview
4	Deep Learning for Computer Vision by Prof. Vineeth N Balasubramanian at IIT Hyderabad https://onlinecourses.nptel.ac.in/noc21_cs93/preview
5	COVID-Net Open Source Initiative - COVIDx CT-3 Dataset https://www.kaggle.com/datasets/hgunraj/covidxct

SEMESTER S7

ADVANCED COMPUTER NETWORKS

Course Code	**PECST751**	**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 a comprehensive understanding of advanced networking concepts, including MPLS, VPNs, Data Center Networks, and Software-Defined Networking (SDN).
2. To impart the skills necessary to analyze, design, and evaluate complex networking architectures, addressing the challenges and emerging trends.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of Computer Networking Fundamentals - OSI and TCP/IP Models, Layers and Protocols, IP Addressing and Subnetting, Routing Protocols - RIP, OSPF, BGP; QoS in IP networks - Random Early Detection, Protocols for QoS support - RSVP, RTP, Multiprotocol Label Switching (MPLS): Overview and Use Cases; Network Security Basics - Firewalls, ACLs, and NAT; Working of NAT; Virtual Private Networks (VPNs) - Types and Architectures; Overview of Data Center Networks: Key Components and Topologies;	**8**
2	DLL switching - Overview, VLANs, Inter-VLAN Routing; Spanning Tree Protocol (STP) - IEEE 802.1D, Rapid Spanning Tree Protocol (RSTP) - IEEE 802.1w, Multiple Spanning Tree Protocol (MSTP) - IEEE 802.1s, STP Enhancements - BPDU Guard, Root Guard, and Loop Guard; Data Center Network Architectures - Traditional vs. Modern Data Center Designs (Spine-Leaf, Clos Networks), Ethernet Fabrics and TRILL; Data Center Design Considerations - Scalability, Redundancy, and Latency.	**9**
3	SDN Architecture and Components - Control Plane, Data Plane, and Application Plane; OpenFlow Protocol and its Role in SDN; SDN Controllers - Ryu, OpenDaylight, and ONOS; SDN Use Cases - Traffic	**9**

	Engineering, Network Function Virtualization (NFV) - NFV Concepts, Virtualizing Network Functions and Services; NFV Infrastructure (NFVI) and Management (MANO); Service Function Chaining (SFC); NFV in Telecom Networks.	
4	Data Center Interconnect (DCI) - Technologies for Data Center Interconnection(VPLS, OTV, and VXLAN), DCI Design and Deployment Considerations; Intent-Based Networking (IBN) - Introduction to Intent-Based Networking; Content Distribution on the Internet - Architectures for Information-Centric Networking; Content Naming, Routing and Caching, Security in Named Data Networking; Network Automation and Orchestration; Automation Tools - Ansible, Terraform; Orchestration Frameworks - Kubernetes.	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 and critically analyze advanced networking protocols and technologies, including MPLS, VPNs, and SDN, and their applications in modern networks	**K3**
CO2	Demonstrate an understanding of data center network architectures, including the design considerations and protocols that ensure scalability, redundancy, and efficiency.	**K3**
CO3	Use Software-Defined Networking (SDN) and Network Function Virtualization (NFV) to automate and optimize network operations.	**K3**
CO4	Explain emerging trends such as Intent-Based Networking (IBN) and network automation, applying this knowledge to modernize and innovate networking solutions.	**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	PO12
CO1	3	3	3	2								3
CO2	3	3	3	2								3
CO3	3	3	3	2								3
CO4	3	2	3									3

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	Computer Networking: A Top-Down Approach	James F. Kurose, Keith W. Ross	Pearson	8/e, 2022
2	Data Center Virtualization Fundamentals: Understanding Techniques and Designs for Highly Efficient Data Centers with Cisco Nexus, UCS, MDS, and Beyond	Gustavo A. A. Santana	CISCO Press	1/e, 2013
3	MPLS and VPN Architectures	Jim Guichard, Ivan Pepelnjak, Jeff Apcar	CISCO Press	1/e, 2000
4	High-speed networks and Internet: Performance and Quality of Service	William Stallings	Pearson	2/e, 2002
5	Software Defined Networks: A Comprehensive Approach	Paul Goransson, Chuck Black, Timothy Culver	Morgan Kaufman	2/e, 2016
6	Information-Centric Networking (ICN): Content-Centric Networking (CCNx) and Named Data Networking (NDN) Terminology	B. Wissingh, C. Wood, A. Afanasyev, L. Zhang, D. Oran, C. Tschudin	RFC 8793	2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Networking: Understanding Cloud-based Data Centre Networks	Gary Lee	Morgan Kaufman	1/e, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106243/

SEMESTER S7

RESPONSIBLE ARTIFICIAL INTELLIGENCE

Course Code	**PECST752**	**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 impart the ideas of fairness, accountability, bias, and privacy as fundamental aspects of responsible AI.
2. To teach the principles of interpretability techniques including simplification, visualization, intrinsic interpretable methods, and post hoc interpretability for AI models.
3. To give the learner understanding of the ethical principles guiding AI development, along with privacy concerns and security challenges associated with AI deployment.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Foundations of Responsible AI :-** Introduction to Responsible AI- Overview of AI and its societal impact; Fairness and Bias - Sources of Biases, Exploratory data analysis, limitation of a dataset, Preprocessing, inprocessing and postprocessing to remove bias.	7
2	**Interpretability and explainability:-** Interpretability - Interpretability through simplification and visualization, Intrinsic interpretable methods, Post Hoc interpretability, Explainability through causality, Model agnostic Interpretation. Interpretability Tools - SHAP (SHapley Additive exPlanation), LIME(Local Interpretable Model-agnostic Explanations)	10
3	**Ethics, Privacy and Security :-** Ethics and Accountability -Auditing AI models, fairness assessment, Principles for ethical practices. Privacy preservation - Attack models, Privacy-preserving Learning, Differential privacy- Working, The Laplace Mechanism, Introduction to	10

	Federated learning. Security - Security in AI Systems, Strategies for securing AI systems and protecting against adversarial attacks	
4	**Future of Responsible AI and Case Studies : -** Future of Responsible AI - Emerging trends and technologies in AI ethics and responsibility. Case Studies - Recommendation systems, Medical diagnosis, Computer Vision, Natural Language Processing.	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Identify and describe key aspects of responsible AI such as fairness, accountability, bias, and privacy.	**K2**
CO2	Describe AI models for fairness and ethical integrity.	**K2**
CO3	Understand interpretability techniques such as simplification, visualization, intrinsic interpretable methods, and post hoc interpretability.	**K2**
CO4	Comprehend the ethical principles, privacy concerns, and security challenges involved in AI development and deployment.	**K3**
CO5	Understand responsible AI solutions for practical applications, balancing ethical considerations with model performance.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

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	Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way	Virginia Dignum	Springer Nature	1/e, 2019
2	Interpretable Machine Learning	Christoph Molnar	Lulu	1/e, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	ResponsibleAI Implementing Ethical and Unbiased Algorithms	Sray Agarwal, Shashin Mishra	Springer Nature	1/e, 2021

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/3-xhMXeYIcg?si=x8PXrnk0TabaWxQV
2	https://youtu.be/sURHNhBMnFo?si=Uj0iellJs3oLOmDL [SHAP and LIME] https://c3.ai/glossary/data-science/lime-local-interpretable-model-agnostic-explanations/ https://shap.readthedocs.io/en/latest/ https://www.kaggle.com/code/bextuychiev/model-explainability-with-shap-only-guide-u-need
3	https://www.youtube.com/live/DA7ldX6OIG4?si=Dk4nW1R1zi_UMG_4
4	https://youtu.be/XlYhKwRLerc?si=IeU7C0BLhwn9Pvmi Case Studies https://www.kaggle.com/code/teesoong/explainable-ai-on-a-nlp-lstm-model-with-lime https://www.kaggle.com/code/victorcampelo/using-lime-to-explaining-the-preditions-from-ml

SEMESTER S7

FUZZY SYSTEMS

(Common to CS/CA)

Course Code	**PECST753**	**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 understand the concepts of fuzziness and its use in building better solutions to problems.
2. To understand the basic concepts of fuzzy sets, fuzzy relations, fuzzy logic and building of fuzzy approximation-based solutions.

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	**Basic Fuzzy Set Theory :-** Introduction - Uncertainty, Imprecision and Vagueness. Crisp vs Fuzzy sets. Representation of Fuzzy sets. Membership Functions – Types, Basic operations - dilation, concentration, normalization, Linguistic hedges. Properties of fuzzy set - Level Sets - Alpha cut representation. Operations on fuzzy sets- fuzzy complement, fuzzy intersection, fuzzy union, aggregation operations	**9**
2	**Fuzzy Relations :-** Operations on Fuzzy relations: union, intersection, complement, cartesian product. Fuzzy composition- Max- min**,** Max – product. Extension Principle-Fuzzy arithmetic – fuzzy numbers, arithmetic operations on fuzzy numbers. Fuzzy Reasoning – Generalized Modus Ponens (GMP) and Generalized Modus Tollens (GMT).	**9**

3	**Fuzzification and Defuzzification Methods :-** Fuzzy inference – Zadeh rule, Mamdani rule. Development of membership Functions – Intuition, Inference, Rank ordering, Inductive reasoning. Defuzzification to Scalars - Max membership principle, Centroid method, Weighted average method, Mean max membership, Center of sums, Center of largest area, First (or last) of maxima.	**9**
4	**Fuzzy Inference Systems :-** Approximate Reasoning, Fuzzy (Rule-Based) Systems – Multiple conjunctive antecedents, Multiple disjunctive antecedents, Aggregation of fuzzy rules, Graphical Techniques of Inference. Fuzzy Controllers -Mamdani FIS, Larsen Model.	**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
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● 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. **(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 fuzzy logic based problem solving	**K2**
CO2	Summarize the concepts of crisp sets, crisp relations, crisp logic with fuzzy sets, fuzzy relations and fuzzy logic	**K3**
CO3	Develop fuzzy systems by selecting appropriate membership functions, fuzzification and defuzzification methods	**K3**
CO4	Develop solutions using graphical and rule-based methods	**K3**
CO5	Make use of fuzzy logic inference to solve real world problems	**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	PO12
CO1	3	1	1									2
CO2	3	1	1									2
CO3	3	3	2	1								2
CO4	3	3	2	1								2
CO5	3	3	2	2	1							2

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	Fuzzy Logic with Engineering Applications	Timothy J. Ross	John Wiley and Sons	3/e, 2010
2	Fuzzy Sets and Fuzzy Logic: Theory and Applications	George J. Klir and Bo Yuan	Pearson	1/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems	Guanrong Chen, Trung Tat Pham	CRC Press	1/e, 2019
2	Discrete Mathematics and Its Applications with Combinatorics and GraphTheory	Kenneth H. Rosen	MGH	7/e, 2011
3	Discrete Mathematical Structures with Applications to Computer Science	Trembly J.P, Manohar R	TataMc Graw Hill	1/e, 2003
4	Discrete Mathematical Structures	Bernard Kolman, Robert C. Busby, Sharan Cutler Ross,	Pearson	1/e, 2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108104157

SEMESTER S7

DIGITAL FORENSICS

(Common with CS/CM/CA/CD/CR/AI/AM/AD)

Course Code	**PECST754**	**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 impart the fundamental knowledge on incident management and reporting.
2. To provide a good understanding on devices, operating systems, network and mobile forensics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Digital Forensics - Principles in Digital Forensics; Stages in Digital Forensics Investigation- Forensics Imaging & Cloning, Concept of Chain of Custody, Digital Evidence Handling at Crime Scene, Collection/Acquisition and Preservation of Digital Evidence, Processing & Analysis, Compilation of Findings & Reporting; Expansion of Stages in Digital Investigation. Types of Storage Media - Hard Disk Drives (HDD), Solid State Drives (SSD), USB Flash Drives, Optical Discs, Memory Cards, Cloud Storage, Drive Geometry, Cylinders, Heads, and Sectors, Logical Block Addressing (LBA); Expansion of Types of Storage Medium. Overview of File Systems - Introduction to File Systems, File Systems in Digital Forensics, FAT (File Allocation Table), Structure and Characteristics : FAT12, FAT16, FAT32, NTFS (New Technology File System), Structure and Characteristics, Master File Table (MFT), EXT (Extended File System), EXT2, EXT3, EXT4, Journaling in EXT3 and EXT4, HFS (Hierarchical File System), HFS and HFS+ Structure and Characteristics, Metadata and Attributes ***Tools suggested*** : Hex Viewer , FTK Imager , OS Forensics	**10**
2	Windows Forensics - OS Artefacts, Registry Analysis, Analysis of USB	**9**

	Connections, Event Logs, Applications, Slack Space, Overwritten Files, Data Recovery Techniques, Volatile and Non-Volatile Data, Hibernation file analysis, Pagefile analysis, prefetch files, thumbnails, Timestamps, File Signatures, File System Analysis Tools, Techniques for Recovering Deleted Files, File Carving; Memory Forensics - RAM dump and analysis; Linux and MAC Forensics; Anti Forensics Methods - Steganography, Encryption, Alternate Data Streams. ***Tools suggested*** : Hex Viewer, FTK Imager, Autopsy, RegRipper, Volatility, Dumpit	
3	Mobile Forensics - Introduction to Mobile Forensics, Mobile Forensics Fundamentals, Understanding Mobile Device Storage, Android, iOS, Windows OS Artifacts, ADB (Android Debug Bridge), APK Files, Techniques for Acquiring Data from Mobile Devices, Rooting, Jailbreaking. Analysis of Application Files - Social Media Files, Understanding and Analyzing APK Files, Messages, Malware Analysis, Cloud Data in Mobile Forensics, Analyzing Backups and Cloud Data, Advanced Data Recovery Techniques (Bypassing Encryption, Password Cracking), Challenges in Mobile Forensics. ***Tools suggested*** : MobileCheck, BlueStacks(Android Emulator), SQLite Database viewer	**9**
4	Network Forensics - Introduction to Network Forensics, Overview of Network Architectures and Protocols, Capturing and Analyzing Network Traffic using Wireshark/Tcpdump, Log Analysis, Email and Web Forensics, Email Header Analysis; Endpoint Security systems - Intrusion Detection Systems, Firewall, Router Forensics, NAS, Proxy, VPN; Public Key Infrastructure Systems; Digital Signature - Concepts of Public Key and Private Key, Certification Authorities and Their Role, Creation and Authentication of Digital Signature. ***Tools Suggested :*** Wireshark , Apache Log Viewer	**8**

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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Perform forensics analysis of hard disk, Network, and mobile phones.	**K3**
CO2	Experiment with the network traffic dump.	**K3**
CO3	Examine the analyse logs of the systems and identify the anomalies.	**K3**
CO4	Plan an onsite triage in case of an incident.	**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	PO12
CO1	3	3	3									2
CO2	3	3	3		3							2
CO3	3	3	3		3							2
CO4	3	3	3		3							2

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	Digital Forensics and Incident Response	Gerard Johansen	Packt	2/e, 2020
2	Guide to Computer Forensics and Investigations	Bill Nelson, Amelia Phillips, Christopher Steuart	Cengage	6/e, 2020
3	Practical Mobile Forensics	Rohit Tamma, Oleg Skulkin , Heather Mahalik, Satish Bommisetty	Packt	4/e, 2020
4	Mobile Forensics - Advanced Investigative Strategies	Oleg Afonin, Vladimir Katalov	Packt	1/e, 2016
5	Network Forensics : Tracking Hackers Through Cyberspace	Sherri Davidoff, Jonathan Ham	Pearson	1/e, 2013
6	File system forensic analysis	Brian Carrier	Addison-Wesley	1/e, 2005
7	Windows Forensics: The Field Guide for Corporate Computer Investigations	Chad Steel	Wiley	1/e, 2006
8	Android Forensics: Investigation, Analysis and Mobile Security for Google Android	Andrew Hoog	Syngress	1/e, 2011

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
2	https://www.swgde.org/documents/published-by-committee/quality-standards/
3	https://csrc.nist.gov/pubs/sp/800/101/r1/final

SEMESTER S7

GAME THEORY AND MECHANISM DESIGN

Course Code	**PECST756**	**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 a general purpose tool to analyze strategic behavior in multi-agent interaction
2. To discuss the mathematical details of analyzing and designing strategic interactions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Game Theory - Competitive equilibrium, Rationality; Strategic Games - Dominance, Nash equilibrium, Maxmin strategies, elimination of dominated strategies, preservation of pure Nash equilibrium (PSNE), matrix games, relation between maxmin and PSNE in matrix games Mixed strategies, mixed strategy Nash equilibrium (MSNE), finding MSNE, MSNE characterization theorem, algorithm to find MSNE	**8**
2	Correlated equilibrium (CE) - Computing CE, extensive form games, subgame perfection, limitations of subgame perfect Nash equilibrium; Imperfect information extensive form games (IIEFG) - strategies in IIEFGs, equivalence of strategies in IIEFGs, perfect recall, Equilibrium in IIEFG; Game theory application - P2P file sharing; Bayesian games - strategy and utility in Bayesian games, equilibrium in Bayesian games.	**11**
3	Introduction to mechanism design - revelation principle, introduction and proof of Arrow's impossibility result, introduction to social choice setup; Introduction and proof of Gibbard-Satterthwaite theorem, domain restriction, median voter theorem; Task sharing domain, uniform rule, mechanism design with transfers, examples of quasi-linear preferences, Pareto optimality and Groves payments	**9**
4	Introduction to VCG mechanism, VCG in Combinatorial allocations,	**8**

	applications to Internet advertising, slot allocation and payments in position auctions, pros and cons of VCG mechanism; Affine maximizers, single object allocation, Myerson's lemma, optimal mechanism design; Single and multi-agent optimal mechanism design, examples of optimal mechanisms	

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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Differentiate between different types of games Identify various equilibria within games	**K3**
CO2	Identify strategic interactions.	**K3**
CO3	Describe the basic concepts of non-cooperative and cooperative games.	**K2**
CO4	Apply the concepts in different game scenarios.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

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	An Introduction to Game Theory	Martin Osborne	Cambridge University Press	1/e, 2004
2	Game Theory and Mechanism Design	Y. Narahari	World Scientific and IISc Press	1/e, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Game Theory 101: The Complete Textbook	William Spaniel	Self	1/e,
2	Game Theory - An Introduction	Steven Tadelis	Princeton University Press	1/e, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/101/106101237/
2	https://www.masfoundations.org/

SEMESTER S7

HIGH PERFORMANCE COMPUTING

(Common to CS/CR/CM/CD/CA/AM/AD)

Course Code	**PECST757**	**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 Gain an understanding of the modern processor architectures.
2. To Give an introduction to parallel programming using OpenMP and MPI.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Modern processors:** Stored-program computer architecture- *General-purpose cache-based microprocessor architecture* - Performance metrics and benchmarks -Moore's Law - Pipelining - Super scalarity - SIMD - *Memory hierarchies* - Cache , Cache mapping, Prefetch, Multicore processors - Multithreaded processors - *Vector processors* - Design principles - Maximum performance estimates - Programming for vector architectures.	9
2	**Parallel computers** - Taxonomy of parallel computing paradigms - *Shared-memory computers* - Cache coherence - UMA, ccNUMA, Distributed-memory computers - Hierarchical (hybrid) systems - *Networks* - Basic performance characteristics of networks, Buses, Switched and fat-tree networks - Mesh networks - Hybrids.	9
3	**Shared-memory parallel programming with OpenMP**:- *Short introduction to OpenMP* - Parallel execution - Data scoping - OpenMP worksharing for loops - Synchronization, Reductions, Loop scheduling, Tasking,Miscellaneous, Case study: OpenMP-parallel Jacobi algorithm	9

4	**Distributed-memory parallel programming with MPI**:- Message passing - *A short introduction to MPI*, A simple example, Messages and point-to-point communication, Collective communication, Nonblocking point-to-point communication, Virtual topologies. *Example-MPI parallelization of a Jacobi solver* - MPI implementation - Performance properties.	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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Describe parallel computing architectures supported by modern processors.	**K2**
CO2	Classify parallel computing paradigms and network topologies.	**K2**
CO3	Implement shared-memory parallel programming with OpenMP.	**K3**
CO4	Design and implement parallel algorithms using distributed-memory parallel programming with MPI	**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	PO12
CO1	3	2										3
CO2	3	2										3
CO3	3	3	3	2								3
CO4	3	3	3	2								3

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 High Performance Computing for Scientists and Engineers	Georg Hager Gerhard Wellein	CRC Press	1/e, 2011
2	High Performance Computing: Modern Systems and Practices	Thomas Sterling, Maciej Brodowicz, Matthew Anderson	Morgan Kaufmann	1/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Parallel and High-Performance Computing	Robert Robey Yuliana Zamora	Manning Publications	1/e, 2021
2	High-Performance Computing	Charles Severance Kevin Dowd	O'Reilly Media	2/e, 1998
3	Computer Architecture And Parallel Processing	Kai Hwang Faye Alaye Briggs	McGraw-Hill	1/e, 1984
4	Computer Architecture: A Quantitative Approach	John L. Hennessy David A. Patterson	Morgan Kaufman	6/e, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106108055
2	https://nptel.ac.in/courses/106108055
3	https://nptel.ac.in/courses/106108055
4	https://nptel.ac.in/courses/128106014

SEMESTER S7

PROGRAMMING LANGUAGES

(Common to CS/CR/CM/CA/AD/AM)

Course Code	**PECST758**	**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 enable the students understand various constructs and their respective comparisons in different high-level languages so that he can choose a suitable programming language for solving a particular problem
2. To develop the student's ability to understand the salient features and paradigms in the landscape of programming languages.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - The Origins of Programming Languages, Abstractions in Programming Languages, Computational Paradigms, Language Definition, Language Translation, The Future of Programming Languages; Language Design Criteria - Historical Overview, Efficiency, Regularity, Security, Extensibility, C++: An Object-Oriented Extension of C, Python: A General-Purpose Scripting Language; Syntax and Analysis Parsing: Lexical Structure of Programming Languages, Context-Free Grammars and BNFs, Parse Trees and Abstract Syntax Trees, Ambiguity, Associativity, and Precedence, EBNFs and Syntax Diagrams, Parsing Techniques and Tools, Lexics vs. Syntax vs. Semantics, Case Study: Building a Syntax Analyzer for TinyAda;	9
2	Basic Semantics- Attributes, Binding, and Semantic Functions, Declarations, Blocks, and Scope, The Symbol Table, Name Resolution and Overloading, Allocation, Lifetimes, and the Environment, Variables and Constants, Aliases, Dangling References, and Garbage, Case Study: Initial Static Semantic Analysis of TinyAda. Data Types - Data Types and Type Information, Simple Types, Type Constructors, Type Nomenclature in Sample Languages, Type Equivalence,	9

	Type Checking, Type Conversion, Polymorphic Type Checking, Explicit Polymorphism, Case Study: Type Checking in TinyAda.	
3	Expressions and Statements - Expressions, Conditional Statements and Guards, Loops and Variations on WHILE, The GOTO Controversy and Loop Exits, Exception Handling, Case Study: Computing the Values of Static Expressions in TinyAda. Procedures and Environments- Procedure Definition and Activation, Procedure Semantics, Parameter-Passing Mechanisms, Procedure Environments, Activations, and Allocation, Dynamic Memory Management, Exception Handling and Environments, Case Study: Processing Parameter Modes in TinyAda.	**9**
4	Abstract Data Types and Modules- The Algebraic Specification of Abstract Data Types, Abstract Data Type Mechanisms and Modules, Separate Compilation in C, C++ Namespaces, and Java Packages, Ada Packages, Modules in ML, Modules in Earlier Languages, Problems with Abstract Data Type Mechanisms, The Mathematics of Abstract Data Types.	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Understand the history of programming languages and introduce abstraction, the concept of different language paradigms, and an overview of language design criteria.	**K1**
CO2	Describe how the syntactic structure of a language can be precisely specified using context-free grammar rules in Backus-Naur form (BNF).	**K2**
CO3	Explain the abstractions of the operations that occur during the translation and execution of programs.	**K2**
CO4	Apply the data types in various languages	**K3**
CO5	Apply procedure activation and parameter passing; and exceptions and exception handling.	**K4**

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	PO12
CO1	2	2	2									3
CO2	2	3	2									3
CO3	3	2	2									3
CO4	3	3	3									3
CO5	3	3	3									3

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	Programming languages: principles and practices.	Kenneth C Louden	Cengage Learning	3/e, 2011
2	Concepts of programming languages.	Sebesta R W.	Pearson	12/e, 2023
3	Programming languages: concepts and constructs.	Sethi R	Pearson	2/e, 2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programming Languages: Principles and Paradigms	Allen Tucker, Robert Noonan	McGraw-Hill	2/e, 2017
2	Principles of programming languages.	Gilles Dowek.	Springer	1/e, 2009.
3	Principles of Programming Languages	Rajiv Chopra	Wiley	1/e, 2019

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/102/106102067/

SEMESTER S7

INTERNET OF THINGS

(Common to CS/CM/CA)

Course Code	PECST755	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with an understanding of IoT architecture, protocols, and integration techniques that enable device-to-device, device-to-cloud, and cloud-to-cloud communications.
2. To enable students with the ability to create and implement IoT solutions using platforms like Raspberry Pi, cloud-based services, and analytics tools to develop real-world IoT applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Why IoT? Trends in IT Space, Internet of Things Era, Device-to-Device/Machine-to-Machine Integration, Device-to-Cloud (D2C) Integration, IoT Platform as a Service (PaaS), Cloud-to-Cloud (C2C) Integration, IoT Key Application Domains, Emerging IoT Flavors; IoT Ecosystem - Architecture for IoT, Mobile Technologies, Mobile Application Development Platforms, LPWAN.	10
2	Infrastructure and Service Discovery Protocols - Layered Architecture for IoT, Protocol Architecture of IoT, Infrastructure Protocols, Device or Service Discovery for IoT, Protocols & products for IoT Service Discovery; Integration Technologies and Tools - Smart Enterprises and Environments, Sensor and Actuator Networks, The IoT Device Integration Concepts, Standards, and Implementations, The Device Integration Protocols and Middleware, The Protocol Landscape.	12
3	Platforms for IoT Applications and Analytics - The IoT Building Blocks, Usecases, M2M Application Platform, IoT Architectural Building Blocks, Data Analytics Platforms, IoT Data Virtualization Platforms and capabilities, The IoT Edge Data Analytics; Clouds for IoT Applications and Analytics - Reflecting the Cloud Journey, The Key Motivations for Cloud-Enabled Environments, IoT and Cloud-Inspired Smarter Environments, Hybrid,	10

	Federated, and Special-purpose cloud, The Emergence of Edge/Fog Clouds, SDN and SDS.	
4	Introduction to Raspberry Pi, Creating your first project, Creating a Sensor to Measure Ambient Light, Creating an Actuator for Controlling Illumination, Publishing Information Using MQTT & HTTP, Creating Web Pages for Your Devices.	**12**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
5	**15**	**10**	**10**	**40**

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Students must be assessed to analyze various data collection, analytics, and actuation used in various IoT applications. Evaluation of the technologies and recommendation based on parameters should be done to propose appropriate technologies.

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**
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	Understand IoT trends, architecture layers, and key technologies, including Device-to-Device, Device-to-Cloud, and Cloud-to-Cloud integration.	**K2**
CO2	Identify and differentiate between various IoT infrastructure, service discovery, and integration protocols, as well as their roles in IoT ecosystems.	**K3**
CO3	Develop simple IoT projects using Raspberry Pi, integrating sensors, actuators, and protocols such as MQTT and HTTP to create interactive systems.	**K3**
CO4	Evaluate cloud and edge computing models, including hybrid and federated environments, and apply these concepts to build scalable and efficient IoT applications.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3

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	The Internet of Things	Pethuru Raj, Anupama C. Raman	CRC Press	1/e, 2017
2	Mastering Internet of Things	Peter Waher	Pact	1/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things : Architecture and Design Principles	Raj Kamal	McGraw Hill	2/e, 2023
2	Internet of Things : Principles and Paradigms	Rajkumar Buyya Amir Vahid Dastjerdi	Morgan Kaufman	1/e, 2016
3	Introduction to IoT	Sudip Misra, Anandarup Mukherjee, Arijit Roy	Cambridge University Press	1/e, 2021

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105166/

SEMESTER S7

CYBER SECURITY

Course Code	**OECST721**	**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 teach the basic attacks, threats and vulnerabilities related to cyber security
2. To make the learner aware of cyber crimes and cyber laws
3. To give concepts of the malwares and its protection mechanisms in systems and mobile devices

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Cyber Security :-** Basic Cyber Security Concepts, Layers of Security, Vulnerability, Threats, Computer Criminals, CIA Triad, Motive of Attackers, Active attacks, Passive attacks, Software attacks, Hardware attacks, Cyber Threats and its Classifications- Malware, Social Engineering, DoS/DDoS, Insider Threats, Advanced Persistent Threats (APTs), Data Breaches and Information Theft.	**9**
2	**Cybercrime and CyberLaw :-** Cybercrime, Classification of Cybercrimes, The legal perspectives- Indian perspective, Global perspective, Categories of Cybercrime. Fundamentals of cyber law, Outline of legislative framework for cyber Law, History and emergence of cyber law, Outreach and impact of cyber law, Major amendments in various statutes.	**9**
3	**Malwares and Protection against Malwares :-** Virus, Worms, Trojans, Spyware, Adware, Key-logger, Ransomware, Common Methods of Malware Propagation- Email Attachments, Malicious Websites, Removable Media, File Sharing Networks, Malvertising, Protection against Malware- Antivirus/Antimalware Software, Regular Software Updates, Email Filtering, Web Filtering, Data Backup and Recovery, Strong Passwords and Multi-Factor Authentication (MFA).	**9**

4	**Mobile App Security :-** Security Implications of Mobile Apps, Mobile App Permission Management and Best Practices, Risks of Location-Based Social Networks, Data Security on Mobile Devices- Importance of Data Security on Mobile Devices to Protect Sensitive Information, Risks of Unencrypted Data Storage and Communication on Mobile Platforms, Benefits of Device Encryption, Secure Messaging Apps, and Encrypted Storage Solutions.	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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 attacks, security mechanisms and services to user information	**K2**
CO2	Identify the cybercrimes and discuss the cyber laws against the crimes	**K2**
CO3	Discuss the malwares and the protection mechanisms against malwares	**K3**
CO4	Describe the issues and solutions related with mobile applications	**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	PO12
CO1	2	3										2
CO2	2	3	2									2
CO3	2	3	2									2
CO4	2	3	2									2

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	Computer Security: Principles and Practices	William Stallings	Pearson	5/e, 2011
2	Cyber Security- Understanding Cyber Crimes, Computer Forensics and Legal Perspectives	Nina Godbole, Sunit Belapure	Wiley	1/e, 2011
3	Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives	B.B.Gupta, D.P Agrawal, Haoxiang Wang.	CRC Press	1/e, 2018
4	Cyber Security Essentials	James Graham, Richard Howard, Ryan Otson	Auerbach	1/e, 2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/111/101/111101137/
2	https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044
3	https://www.coursera.org/learn/data-security-privacy#modules
4	https://nptel.ac.in/courses/106105217
	https://archive.nptel.ac.in/courses/106/106/106106156/

SEMESTER S7

CLOUD COMPUTING

Course Code	**OECST722**	**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 understand the core principles, architecture, and technologies that underpin cloud computing, including virtualization, data storage, and cloud services.
2. To equip students with the skills to use cloud computing tools effectively, implement cloud-based applications, and address security challenges within cloud environments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Cloud Computing, Types of Cloud, Working of Cloud Computing, Cloud Computing Architecture - Cloud Computing Technology, Cloud Architecture, Cloud Modelling and Design.	**8**
2	Virtualization - Foundations, Grid, Cloud And Virtualization, Virtualization And Cloud Computing; Data Storage And Cloud Computing - Data Storage, Cloud Storage, Cloud Storage from LANs to WANs.	**9**
3	Cloud Computing Services - Cloud Computing Elements, Understanding Services and Applications by Type, Cloud Services; Cloud Computing and Security - Risks in Cloud Computing, Data Security in Cloud, Cloud Security Services.	**10**
4	Cloud Computing Tools - Tools and Technologies for Cloud, Apache Hadoop, Cloud Tools; Cloud Applications - Moving Applications to the Cloud, Microsoft Cloud Services, Google Cloud Applications, Amazon Cloud Services.	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Articulate the fundamental concepts of cloud computing, its types, and how cloud computing architecture operates.	**K2**
CO2	Understand and describe the foundations of virtualization, its relationship with cloud computing.	**K2**
CO3	Describe various cloud computing services, understand the different service models, and identify potential risks.	**K3**
CO4	Demonstrate proficiency in using cloud computing tools such as Apache Hadoop, and deploy applications using popular cloud platforms.	**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	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									2
CO2	2	2	2	2								2
CO3	2	2	2	2								2
CO4	2	2	2	2								2

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	Cloud Computing: A Practical Approach for Learning and Implementation	A.Srinivasan, J.Suresh	Pearson	1/e, 2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Computing : Concepts, Technology, Security, and Architecture	Thomas Erl	Pearson	2/e, 2023
2	Cloud Computing	Sandeep Bhowmik	Cambridge University Press	1/e, 2017
3	Cloud Computing: A Hands-On Approach	Arshdeep Bahga and Vijay Madisetti	Universities Press	1/e, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_cs14/preview

SEMESTER S7

SOFTWARE ENGINEERING

Course Code	OECST723	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	**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. **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. *Case study:* SRS for College Library Management Software	9
2	**Software design -** Software architecture and its importance, Software architecture patterns: Component and Connector, Layered, Repository, Client-Server, Publish-Subscribe, Functional independence – Coupling and Cohesion *Case study:* Ariane launch failure **Object Oriented Software Design -** UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram,	10

	Sequence diagram *Case Studies*: Voice mail system, ATM Example **Software pattern -** Model View Controller, Creational Design Pattern types – 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), *Case study* – Netflix. **Software maintenance and its types-** Adaptive, Preventive, Corrective and Perfective maintenance. Boehm's maintenance models (both legacy and non-legacy)	**10**
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, Organisational structures, Scheduling using Gantt chart. Software Configuration Management and its phases, Software Quality Management – ISO 9000, CMM, Six Sigma for software engineering.	**7**

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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

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	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 Modelling 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
2	https://archive.nptel.ac.in/courses/106/105/106105182/

SEMESTER S7

COMPUTER NETWORKS

Course Code	OECST724	**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 Introduce the core concepts of computer networking.
2. To Explore routing protocols and their role in network communication

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Computer Networks:- Introduction, Network Components, Network Models, ISO/OSI, TCP/IP, Physical Topology, Overview of the Internet, Protocol layering; Physical Layer-Transmission media (copper, fiber, wireless), Datagram Networks, Virtual Circuit networks, Performance.	7
2	Data Link Layer:- Error Detection and Correction - Introduction, Hamming Code, CRC, Checksum; Framing-Methods, Flow Control- Noiseless Channels, Noisy Channels; Medium Access Control- Random Access, Controlled Access; Wired LANs - IEEE Standards, Ethernet, IEEE 802.11;	11
3	Network Layer:- Logical Addressing- IPv4 and IPv6 Addresses; Internet Protocol- IPV4 and IPv6; Unicast Routing Protocols- Distance Vector Routing, Link State Routing Multicast Routing Protocols.	9
4	Transport Layer:- Transport Layer Protocols- UDP, TCP; Congestion Control- Open Loop Vs Closed Loop Congestion Control, Congestion Control in TCP; Application Layer - Application Layer Paradigms, Client-server applications, World Wide Web and HTTP, FTP. Electronic Mail, DNS; Peer-to-peer paradigm - P2P Networks.	8

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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Comprehend the OSI and TCP/IP models, the functioning of different network layers, and the protocol stack used in computer networks.	**K2**
CO2	Evaluate various transmission media (copper, fiber, wireless), error detection/correction methods, and medium access control mechanisms in both wired and wireless LANs.	**K2**
CO3	Demonstrate a working knowledge of IPv4 and IPv6 addressing schemes, routing protocols (unicast and multicast), and apply them to network scenarios.	**K3**
CO4	Summarize UDP and TCP protocols, explain congestion control mechanisms, and understand client-server and peer-to-peer applications like HTTP, FTP, DNS, and P2P networks.	**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	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

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	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networks, A Systems Approach	L. L. Peterson and B. S. Davie	Morgan Kaufmann	5/e, 2011
2	TCP/IP Architecture, design, and implementation in Linux	Sameer Seth M. Ajaykumar Venkatesulu	Wiley	1/e, 2008
3	Computer Networks	Andrew Tanenbaum	Pearson	6/e, 2021
4	Computer Networking: A Top-Down Approach Featuring Internet	J. F. Kurose and K. W. Ross	Pearson Education	8/e, 2022

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://nptel.ac.in/courses/106/105/106105183/

SEMESTER S7

MOBILE APPLICATION DEVELOPMENT

(Common to CS/CA/CM/CD/CR/AI/AM/AD)

Course Code	**OECST725**	**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)	GXEST204 / OECST615	**Course Type**	Theory

Course Objectives:

1. To impart a Comprehensive Mobile Development Knowledge
2. To give Proficiency in Flutter and Dart, UI/UX Design Skills
3. To present the Industry Practices and Deployment such as app security, testing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of Mobile Application Development:** Introduction to Mobile Application Development, Overview of Mobile Platforms: iOS and Android, Introduction to Flutter: History, Features, and Benefits, Setting Up the Flutter Development Environment*, Mobile App Architectures (MVC, MVVM, and BLoC), Basics of Dart Programming Language.	9
2	**User Interface Design and User Experience:** Principles of Mobile UI/UX Design, Designing Responsive UIs with Flutter, Using Flutter Widgets: Stateless Widget and StatefulWidget, Layouts in Flutter: Container, Column, Row, Stack, Navigation and Routing in Flutter, Customizing UI with Themes and Styles.	9
3	**Advanced Flutter Development:** State Management in Flutter: Provider, Riverpod, and BLoC	9

	Networking in Flutter: HTTP Requests, JSON Parsing, RESTful APIs Data Persistence: SQLite, Shared Preferences, Hive Asynchronous Programming with Dart: Futures, async/await, and Streams	
4	**Industry Practices and App Deployment:** Advanced UI Components and Animations, App Security Best Practices, Testing and Debugging Flutter Applications, Publishing Apps to Google Play Store and Apple App Store, Industry Trends and Future of Mobile Development with Flutter	**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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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 basics of mobile application development and different mobile platforms and the environment setup.	**K2**
CO2	Apply principles of effective mobile UI/UX design, develop responsive user interfaces using Flutter widgets.	**K3**
CO3	Experiment effectively with state in Flutter applications. networking and data persistence in Flutter apps.	**K3**
CO4	Apply security best practices in mobile app development and debug Flutter applications effectively.	**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	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3

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	Flutter Cookbook	Simone Alessandria	Packt	2/e, 2023
2	Flutter for Beginners	Alessandro Biessek	Packt	1/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Flutter in Action	Eric Windmill	Manning	1/e, 2019
2	Flutter and Dart: Up and Running	Deepti Chopra, Roopal Khurana	BPB	1/e, 2023

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://www.youtube.com/watch?v=VPvVD8t02U8

SEMESTER 8

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence)

SEMESTER S8

SOFTWARE ARCHITECTURES

Course Code	PECST861	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 develop a comprehensive understanding of software architecture principles and patterns.
2. To provide the ability to design and analyze software architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Architecture:** Definition and Importance, Architecture in the Life Cycle, Role of the Architect vs. Engineer, Requirements engineering: Stakeholders, Concerns, and Types of Requirements, Use Cases and Tactics.	8
2	**Architectural Patterns and Styles:** Architectural Patterns- Overview of Patterns and Styles, Applying Patterns and Choosing a Style. Patterns for Enterprise Applications: Enterprise Applications and Layered Patterns, Concurrency Problems.	8
3	**Components, Contracts, and Service-Oriented Architectures:** Component Software- Nature of Components and Reuse, UML and Components Design by Contract- Contracts, Polymorphism, Inheritance, and Delegation Service-Oriented Architectures- Standards, Technologies, and Security.	9
4	**Architecture Evaluation and Description:** Describing Architectures and Viewpoints, Evaluating Architectures. Architectural Description Languages (ADLs)- Overview and Applications.	7

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Understand the foundational concepts of software architecture, including the roles of stakeholders and the importance of requirements engineering.	**K2**
CO2	Apply architectural patterns and styles to design software systems, particularly in enterprise contexts.	**K3**
CO3	Understand the principles of component-based software design and the use of contracts in ensuring reliable software systems.	**K2**
CO4	Apply architectural description techniques to document and evaluate software architectures.	**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	PO12
CO1	3	2	2									3
CO2	3	3	3		2							3
CO3	3	2	2		2							3
CO4	3	3	3		2							3

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 Architecture	A.Bijlsma, B.J.Heeren, E.E.Roubtsova,S. Stuurman	Free Technology Academy	1/e, 2011
2	Software Architecture 1	Mourad Chabane Oussalah	Wiley	1/e, 2014

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Head First Software Architecture: A Learner's Guide to Architectural Thinking	Raju Gandhi, Mark Richards, Neal Ford	Oreilly	1/e, 2024

Video Links (NPTEL, SWAYAM…)

No.	Link ID
1	https://www.youtube.com/playlist?list=PL4JxLacgYgqTgS8qQPC17fM-NWMTr5GW6

SEMESTER S8

NATURAL LANGUAGE PROCESSING

(Common to CS/CA/CD)

Course Code	PECST862	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 natural language processing (NLP) and language models, focusing on the principles and techniques of prompt engineering to effectively guide and optimize AI-driven outputs.
2. practical skills necessary to design, implement, and evaluate prompt engineering strategies across various applications, while considering the ethical implications and challenges associated with AI-generated content.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to NLP:** Introduction to Natural Language Processing - Various stages of traditional NLP – Challenges - Basic Text Processing techniques - Common NLP Tasks. N-gram Language Models - Naive Bayes for Text Classification, and Sentiment Analysis – Evaluation-Precision, Recall and F-measure-Test sets and cross validation.	7
2	**Traditional NLP Techniques**: Annotating Linguistic Structures - Context-Free Grammars, Constituency Parsing, Ambiguity, CYK Parsing, Dependency Parsing - Transition-Based Dependency Parsing, Graph-Based Dependency Parsing, Evaluation.	7
3	**Neural Networks for NLP:** Word representations - Lexical Semantics, Vector Semantics, TF-IDF, Pointwise Mutual Information (PMI), Neural Word embeddings - Word2vec, GloVe, Contextual Word Embeddings. Evaluating Vector Models - Feedforward Neural Networks for Text Classification	10

4	**Advanced NLP and Applications:** Sequence Modelling - Recurrent Neural Networks, RNNs as Language Models, RNNs for NLP tasks, Stacked and Bidirectional RNN architectures, Recursive Neural Networks, LSTM & GRU, Common RNN NLP Architectures, Encoder-Decoder Model with RNNs, Attention models, Transformers. NLP Applications - Machine Translation, Question Answering and Information Retrieval, Introduction to Large Language Models.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Understand the foundational concepts of NLP and apply that to do text processing.	**K3**
CO2	Utilize word representations and evaluate vector models for NLP	**K3**
CO3	Analyse and implement advanced linguistic annotation and parsing techniques	**K4**
CO4	Apply advanced sequence modeling techniques using Neural Networks	**K3**
CO5	Apply NLP techniques in machine translation, question answering, and information retrieval.	**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	PO12
CO1	3	3								3		
CO2	3	3			3							
CO3	3	3									3	
CO4	3	3	3		3							
CO5	3	3	3			3						

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	Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition	Dan Jurafsky and James H. Martin.	Pearson	2006
2	Introduction to Natural Language Processing	Jacob Eisenstein	MIT Press	2019
3	Natural Language Processing with Transformers	Lewis Tunstall, Leandro von Werra, and Thomas Wolf	O'Reilly	2022

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep learning for Natural Language Processing	Stephan Raaijmakers	Manning	2022
2	Natural Language Processing with PyTorch	Delip Rao and Brian McMahan	O'Reilly	2019
3	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	2016

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc19_cs56

SEMESTER S8

NETWORK SECURITY PROTOCOLS

Course Code	**PECAT863**	**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)	PCCST501	**Course Type**	Theory

Course Objectives:

1. To explore various network and system security protocols.
2. To teach the authentication protocols, firewalls and security protocols from different layers such as data link, network, transport and application.
3. To enable the learners in effective use of security protocols for securing network applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Authentication protocols:-** Message Authentication Requirements, Authentication functions, Message authentication codes-Hash functions, Digital signatures, Authentication Protocols – Mutual authentication, One way authentication. Kerberos – Kerberos Version 4, Kerberos Version 5.X.509 Authentication service. Public Key Infrastructure (PKI) – Trust models, Revocation.	8
2	**Electronic Mail Security-** Pretty Good Privacy (PGP) – Operational Description, Cryptographic keys and key rings, Message format, PGP message generation, PGP message reception, Public key management. S/MIME – Functionality, Messages, Certificate processing, Enhanced security services.	8
3	**Network Layer Security and Web Security-**Internet Protocol Security (IPSec) – Overview, IP security architecture, Authentication Header (AH), Encapsulating Security Payload (ESP), Combining Security Associations, Key management. Internet Key Exchange (IKE) - Phases. Web Security – Web security considerations. Secure Socket Layer and Transport Layer Security (SSL/TLS) – SSL Architecture, SSL protocols	10

4	**Application Layer Security and System Security**-Hypertext Transfer Protocol Secure (HTTPS) –Connection initiation, Closure. Secure Shell (SSH) –Transport layer protocol, User authentication protocol, Connection protocol.Secure Electronic Transaction (SET) – Overview, Features, Participants, Dual signature, Payment processing. Firewalls – Firewall characteristics, Types of Firewalls, Firewall configurations, Encrypted Tunnels, Trusted systems – Data access control, The concept of Trusted Systems, Trojan horse defense.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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 authentication protocols, X.509 authentication service and Public Key Infrastructure (PKI).	**K2**
CO2	Identify the security mechanism in E-mail security services	**K2**
CO3	Summarize the network and transport layer security services provided in a secure communication scenario	**K2**
CO4	Describe application layer security protocols	**K2**
CO5	Explain the concepts of system security and firewalls	**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	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

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	Cryptography and Network Security –vPrinciples and Practices	William Stallings	Pearson Education	4/e, 2022.
2	Network Security: Private Communication in a Public World	C.Kaufman,R.Perlman and M.Speciner	Addison-Wesley Professional	3/e,2022.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cryptography and Network Security	Behrouz A Forouzan, Debdeep Mukhopadhyay	McGraw Hill Education (India) Private Limited	3/e, 2015
2	Network Security Essentials: Applications and Standards	William Stallings	McGraw Hill	6/e, 2018
3	Network security : the complete reference.	Bragg, Roberta	McGraw-Hill/Osborne.	1/ e, 2004

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1, 2, 3, 4	https://nptel.ac.in/courses/106/106/106106221/ https://nptel.ac.in/courses/106/105/106105031/ https://nptel.ac.in/courses/111/103/111103020/

SEMESTER S8

BIG DATA ANALYTICS

Course Code	**PECAT864**	**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 understand the basic concepts of big data analytics. This course covers mathematics for data analytics, predictive and descriptive analytics of data, Big data and its applications
2. To equip the students to do analytics on Structured, Unstructured Data.
3. To introduce the student to Data Analytics with R programming. It enables the learners to perform data analysis on a real world scenario using appropriate tools

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Mathematics for Data Analytics** -Descriptive statistics - Measures of central tendency and dispersion, Association of two variables -Discrete variables, Ordinal and Continuous variable, Probability calculus - probability distributions, Inductive statistics - Point estimation, Interval estimation, Hypothesis Testing - Basic definitions, t- test	**9**
2	**Introduction to Data Analytics and Big Data Analytics-** Analytics Process Model, Analytical Model Requirements. Data Analytics Life Cycle overview. Basics of data collection, sampling, preprocessing and dimensionality reduction. Big Data Overview – State of the practice in analytics, Example Applications - Credit Risk Modeling, Business Process Analytics.	**8**
3	**Predictive and Descriptive Analytics** :-Supervised Learning - Classification, Naive Bayes, KNN, Linear Regression. UnsupervisedLearning - Clustering, Hierarchical algorithms – Agglomerative algorithm, Partitional algorithms - K- Means. Association Rule Mining - Apriori algorithm	**9**

4	**R programming for Data Analysis –** Data Analysis Using R - Introduction to R - R Graphical User Interfaces, Data Import and Export, Attribute and Data Types, Descriptive Statistics, Exploratory Data Analysis - Visualization Before Analysis, Dirty Data, Visualizing a Single Variable, Examining Multiple Variables, Data Exploration Versus Presentation, Statistical Methods for Evaluation	**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
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● 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. **(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	Illustrate mathematical concepts of data analytics	**K3**
CO2	Explain basic concepts of data analytics and big data	**K2**
CO3	Illustrate various predictive and descriptive analytic algorithms	**K3**
CO4	Describe key concepts and applications of Big Data Analytics	**K2**
CO5	Use R programming tool to perform data analysis and visualization	**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	PO12
CO1	3	2										2
CO2	3	2										2
CO3	3	3			2							2
CO4	3	2										2
CO5	3	3			3							3

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	Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends	Bart Baesens	John Wiley & Sons	1/e, 2013.
2	EMC Education Services, Data Science and Big Data Analytics: Discovering, Analysing, Visualizing and Presenting Data	David Dietrich	John Wiley & Sons	1/e, 2015
3	Data Mining Concepts and Techniques	JaiweiHan, MichelineKamber	Elsevier	3/e, 2006
4	Introduction to Statistics and Data Analysis	Christian Heumann, Michael Schomaker	Springer	1/e, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Mining: Introductory and Advanced Topics	Margaret H. Dunham	Pearson	1/e, 2012
2	Intelligent Data Analysis	Michael Berthold, David J. Hand	Springer	1/e, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	http://acl.digimat.in/nptel/courses/video/111104120/L12.html
2	https://www.youtube.com/playlist?list=PLRueFtKLr0QN7MmQ8pdpQerOe_s8vGJG4
3	http://www.digimat.in/nptel/courses/video/110104086/L05.html
4	https://www.youtube.com/watch?v=pJj1T35kaGo

SEMESTER S8

SPEECH AND AUDIO PROCESSING

(Common to CS/CA/CM/CD/CR/AD/CC/CG)

Course Code	**PECST866**	**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)	PECST636	**Course Type**	Theory

Course Objectives:

1. To get familiarised with speech processing and audio processing concepts.
2. To equip the student to apply speech processing techniques in finding solutions to day-to-day problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Speech Production :- Acoustic theory of speech production; Source/Filter model - Pitch, Formant; Spectrogram- Wide and narrow band spectrogram; Discrete model for speech production; Short-Time Speech Analysis; Windowing; STFT; Time domain parameters (Short time energy, short time zero crossing Rate, ACF); Frequency domain parameters - Filter bank analysis; STFT Analysis.	**9**
2	Mel-frequency cepstral coefficient (MFCC)- Computation; Pitch Estimation ACF/AMDF approaches; Cepstral analysis - Pitch and Formant estimation using cepstral analysis; *LPC Analysis* - LPC model; Auto correlation method - Levinson Durbin Algorithm	**9**
3	Speech Enhancement :- Spectral subtraction and Filtering, Harmonic filtering, Parametric resynthesis; Speech coding - fundamentals, class of coders : Time domain/spectral domain/vocoders, Sub band coding, adaptive transform coding, phase vocoder; Speaker Recognition :- Speaker verification and speaker identification, log-likelihood; Language identification - Implicit and explicit models; Machine learning models in Speaker Recognition.	**9**

4	Signal Processing models of audio perception - Basic anatomy of hearing System, Basilar membrane behaviour; Sound perception - Auditory Filter Banks, Critical Band Structure, Absolute Threshold of Hearing; Masking - Simultaneous Masking, Temporal Masking; Models of speech perception.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	To recall various steps in the speech production process	**K2**
CO2	To summarise various speech processing approaches	**K2**
CO3	To develop speech-processing applications in various domains	**K3**
CO4	To analyse the speech processing model for audio perception	**K4**

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	PO12
CO1	3	3	3	2		2	2					3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3	2			2					3

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	Speech Communications: Human & Machine	Douglas O'Shaughnessy	IEEE Press	2/e, 1999
2	Discrete-Time Speech Signal Processing: Principles and Practice	Thomas F. Quatieri	Prentice Hall	1/e, 2001
3	Fundamentals of Speech Recognition	Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana	Pearson	1/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Theory and Application of Digital Processing of Speech Signals	Rabiner and Schafer	Prentice Hall	1/e, 2010
2	Speech and Audio Signal Processing: Processing and Perception Speech and Music	Nelson Morgan and Ben Gold	John Wiley & Sons	2/e, 2011

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://youtu.be/Xjzm7S__kBU?si=j11bk3F7gocYjhfg

SEMESTER S8

STOCHASTIC DECISION MAKING

Course Code	PECAT867	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)	Probability and statistics	Course Type	Theory

Course Objectives:

1. To enable the learners to model and manage uncertainty and randomness in various real-world scenarios, such as finance, engineering, and operations research.
2. To equip the learners to make more informed decisions that optimize expected outcomes, balancing risk and reward.
3. To enable the learners to make the prediction of future states or outcomes based on probabilistic models, which is crucial for planning and strategy in uncertain environments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Stochastic process**: Overview of stochastic processes and their relevance. **Discrete-Time Stochastic Processes:** Markov chains: States, transition matrices, steady-state analysis. Examples and practical applications **Continuous-Time Stochastic Processes:** Poisson processes continuous-time Markov chains. Basic properties and applications	9
2	**Markov Decision Processes (MDPs): Introduction to MDPs-** Components of MDPs: States, actions, rewards, and policies. Bellman equations and value functions. **Solution Methods for MDPs-** Dynamic programming methods: Value iteration, policy iteration.	9

	Advanced Topics in MDPs- Approximate solutions for large MDPs Policy gradients and actor-critic methods.	
3	**Stochastic Optimization: Introduction to Stochastic Optimization-** Formulations and types of stochastic optimization problems. Basic principles and illustrative examples **Stochastic Gradient Descent** : Algorithmic details, convergence, practical considerations. Comparison with deterministic optimization methods.	**9**
4	**Applications and Case Studies:** Real-world applications: Finance, AI, robotics. Analysis of practical challenges and case studies **Applications in AI and Robotics-** Stochastic decision-making in AI: Natural language processing, autonomous systems. Case studies in robotics: Path planning, adaptive control **Applications in Finance and Operations Research** Financial modeling: Risk management, portfolio optimization Operations research applications: Inventory management, queuing systems.	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Examine and apply fundamental concepts of stochastic processes, including both discrete and continuous-time models, to practical applications.	**K3**
CO2	Develop and solve decision-making problems using Markov Decision Processes (MDPs), and apply advanced solution techniques, including approximate methods, to address complex scenarios.	**K3**
CO3	Formulate and solve stochastic optimization problems, and apply these techniques to address real-world scenarios effectively	**K3**
CO4	Demonstrate and analyze the application of advanced stochastic decision-making methods to solve complex real-world problems across various fields.	**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	PO12
CO1	2	2	2									2
CO2	2	2	2									2
CO3	2	2	2									2
CO4	2	2	2									2

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	Stochastic Processes: Theory for Applications	Robert G. Gallager	Cambridge University Press	1/E,2014
2	Reinforcement Learning: An Introduction	Richard S. Sutton and Andrew G. Barto	MIT Press	2/E, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Stochastic Processes	Sheldon M. Ross	Wiley.	2/E, 1996.
2	Introduction to Stochastic Processes	Paul R. Halmos	Dover Publications	1/E, 2010
3	Stochastic Optimization: Algorithms and Applications	J.M. J. Van den Berg, J. W. P. M. Van den Berg, and J. J. C. C. Jansen	Springer	1/E, 2012
4	Dynamic Programming and Optimal Control	Dimitri P. Bertsekas	Athena Scientific	4/E, 2019
5	Markov Chains: From Theory to Implementation and Experimentation	Paul A. Gagniuc	Wiley	1/E, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/111102014
2	https://archive.nptel.ac.in/courses/111/102/111102098/
3	https://archive.nptel.ac.in/courses/110/104/110104024/ https://archive.nptel.ac.in/courses/111/105/111105039/
4	https://archive.nptel.ac.in/courses/108/104/108104112/

SEMESTER S8

INTRODUCTION TO REINFORCEMENT LEARNING

Course Code	**PECAT868**	**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)	PCCST503	**Course Type**	Theory

Course Objectives:

1. To provide a comprehensive introduction to the concepts and methods of reinforcement learning.
2. To understand the mathematical foundations of reinforcement learning.
3. To develop skills in implementing reinforcement learning algorithms and apply the techniques to solve real-world problems.
4. To explore advanced topics and recent developments in reinforcement learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Reinforcement Learning**: Overview, History, and Applications of Reinforcement Learning, Differences from Supervised and Unsupervised Learning. Basic Concepts: Agents, Environments, Rewards, and Policies.	9
2	**Markov Decision Processes (MDPs) and Dynamic Programming (DP)**: Definition and Properties, Value Functions, Bellman Equations, Policy Evaluation, Improvement, Policy Iteration, Value Iteration, Asynchronous DP, Efficiency of DP Algorithms.	9
3	**Monte Carlo Methods and Temporal Difference (TD) Learning**: Monte Carlo Prediction, Monte Carlo Control, Off-policy Prediction and Control, TD Prediction, Q-Learning, SARSA, Eligibility Traces	9
4	**Function Approximation and Advanced Topics**: Linear Function Approximation, Neural Networks for Function Approximation, Deep Q-Networks (DQN), Policy Gradient Methods, Actor-Critic Methods, Applications of Reinforcement Learning in Games, Robotics, and Other Domains.	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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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 fundamental concepts of reinforcement learning.	**K2**
CO2	Apply mathematical tools to analyze reinforcement learning problems.	**K3**
CO3	Implement basic reinforcement learning algorithms and compare the performance	**K3**
CO4	Apply advanced techniques and recent developments in the real world scenario	**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	PO12
CO1	3	2										2
CO2	3	3	2									3
CO3	3	3	2									3
CO4	2	3	2									3
CO5	2	3	2									3

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	Reinforcement Learning: An Introduction	Richard S. Sutton, Andrew G. Barto	MIT Press	2/e, 2018
2	Deep Reinforcement Learning Hands-On	Maxim Lapan	Packt Publishing	2/e, 2020
3	Reinforcement Learning: State-of-the-Art	Marco Wiering, Martijn van Otterlo	Springer	1/e, 2012

Reference 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	3/e, 2010
2	Algorithms for Reinforcement Learning	Csaba Szepesvári	Morgan & Claypool	1/e, 2010
3	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Introduction to Reinforcement Learning https://nptel.ac.in/courses/106106182
2	Markov Decision Processes and Dynamic Programming https://nptel.ac.in/courses/106105198
3	Monte Carlo Methods and Temporal Difference Learning https://nptel.ac.in/courses/106105197
4	Function Approximation and Advanced Topics https://nptel.ac.in/courses/106105194

SEMESTER S8

NEXT GENERATION INTERACTION DESIGN

(Common to CS/CR/CM/CA/CD/AM/AD/CN/CC/CI/CG)

Course Code	**PECST865**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None		

Course Objectives:

1. To provide a comprehensive understanding of the principles of interaction design and their application in augmented reality (AR) and virtual reality (VR) environments.
2. To equip learners with practical skills in developing, prototyping, and evaluating AR/VR applications, focusing on user-centered design and advanced interaction techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Interaction Design and AR/VR :-** Fundamentals of Interaction Design - Principles of interaction design, Human-computer interaction (HCI) basics, User experience (UX) design principles; Introduction to AR and VR - Overview of AR and VR technologies (Key differences and Application), Overview of AR/VR hardware (headsets, controllers, sensors), Software tools and platforms for AR/VR development.	**8**
2	**User-Centered Design and Prototyping :-** Understanding User Needs and Context - User research methods, Personas and user journey mapping, Contextual inquiry for AR/VR, Designing for AR/VR Environments, Spatial design principles, Immersion and presence in AR/VR, User interface (UI) design for AR/VR; Prototyping and Testing - Rapid prototyping technique, Usability testing methods, Iterative design and feedback loops.	**8**
3	**Advanced Interaction Techniques :-** Gesture - Designing for gesture-based interaction, Implementing gesture controls in AR/VR applications; Voice - Voice recognition technologies, Integrating voice commands in AR/VR; Haptic Feedback and Sensory Augmentation - Understanding haptic feedback and tactile interactions; Eye Gaze - Designing and integrating Eye Gaze in VR; Spatial Audio;	**11**

	Microinteraction; Motion capture and tracking technologies; Natural Language Interaction and conversational interfaces; Type of IoT sensors and uses.	
4	**Implementation, Evaluation, and Future Trends :-** Developing AR/VR Projects - Project planning and management, Collaborative design and development, Case studies of successful AR/VR projects; Evaluating AR/VR Experiences - Evaluation methods and metrics, Analyzing user feedback, Refining and improving AR/VR applications; Future Trends and Ethical Considerations- Emerging technologies in AR/VR, Ethical implications of AR/VR, Future directions in interaction design for AR/VR.	**9**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	***Internal Ex***	***Evaluate***	***Analyse***	***Total***
5	**15**	**10**	**10**	**40**

Criteria for Evaluation(Evaluate and Analyse): 20 marks

- The students must be directed to measure the quality of the interfaces / GUI based on various techniques such as user testing.
- The students may be assessed based on their ability to analyze various performance of the interfaces /GUIs.

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 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	Apply fundamental interaction design principles and human-computer interaction (HCI) concepts to create effective and intuitive user experiences in AR/VR applications.	**K3**
CO2	Demonstrate proficiency in using AR/VR hardware and software tools for the development and prototyping of immersive environments.	**K3**
CO3	Conduct user research and apply user-centered design methodologies to tailor AR/VR experiences that meet specific user needs and contexts.	**K4**
CO4	Implement advanced interaction techniques such as gesture controls, voice commands, haptic feedback, and eye gaze in AR/VR applications to enhance user engagement and immersion.	**K3**
CO5	Evaluate AR/VR projects, utilizing appropriate evaluation methods and metrics, and propose improvements based on user feedback and emerging trends in the field.	**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	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	3	3	3	3								3

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	Augmented Reality - Theory, Design and Development	Chetankumar G Shetty	McGraw Hill	1/e, 2023
2	Virtual Reality and Augmented Reality: Myths and Realities	Ralf Doerner, Wolfgang Broll, Paul Grimm, and Bernhard Jung	Wiley	1/e, 2018
3	Augmented Reality: Principles and Practice	Dieter Schmalstieg and Tobias Hollerer	Pearson	1/e, 2016
4	Human–Computer Interaction	Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale	Pearson	3/e, 2004
5	Evaluating User Experience in Games: Concepts and Methods	Regina Bernhaupt	Springer	1/e, 2010
6	Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics	Bill Albert, Tom Tullis	Morgan Kaufman	2/e, 2013
7	The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything	Robert Scoble and Shel Israel	Patrick Brewster	1/e, 2016
8	Augmented Reality and Virtual Reality: The Power of AR and VR for Business	M. Claudia tom Dieck and Timothy Jung	Springer	1/e, 2019

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	Interaction Design https://archive.nptel.ac.in/courses/107/103/107103083/
2	Virtual Reality https://archive.nptel.ac.in/courses/106/106/106106138/
3	Augmented Reality https://www.youtube.com/watch?v=WzfDo2Wpxks

SEMESTER S8

INTRODUCTION TO ALGORITHM

(Common to CS/CA/CM/CD/CR/AD/AM)

Course Code	**OECST831**	**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 proficiency in analysing algorithm efficiency and solve a variety of computational problems, including sorting, graph algorithms.
2. To provide an understanding in algorithmic problem-solving techniques, including Divide and Conquer, Greedy Strategy, Dynamic Programming, Backtracking, and Branch & Bound algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Algorithm Analysis Time and Space Complexity- Asymptotic notation, Elementary operations and Computation of Time Complexity-Best, worst and Average Case Complexities- Complexity Calculation of simple algorithms Recurrence Equations: Solution of Recurrence Equations – Iteration Method and Recursion Tree Methods	**9**
2	Trees - Binary Trees – level and height of the tree, complete-binary tree representation using array, tree traversals (Recursive and non-recursive), applications. Binary search tree – creation, insertion and deletion and search operations, applications; Graphs – representation of graphs, BFS and DFS (analysis not required), Topological Sorting.	**9**
3	Divide and Conquer - Control Abstraction, Finding Maximum and Minimum, Costs associated element comparisons and index comparisons, Binary Search, Quick Sort, Merge Sort - Refinements; Greedy Strategy - Control Abstraction, Fractional Knapsack Problem, Minimum Cost Spanning Trees – PRIM's Algorithm, Kruskal's Algorithm, Single Source Shortest Path Algorithm - Dijkstra's Algorithm.	**9**
4	Dynamic Programming - The Control Abstraction- The Optimality Principle -	**9**

	Matrix Chain Multiplication, Analysis; All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm; The Control Abstraction of Backtracking – The N-Queens Problem. Branch and Bound Algorithm for Travelling Salesman Problem.	

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Identify algorithm efficiency using asymptotic notation, compute complexities, and solve recurrence equations	**K3**
CO2	Use binary trees and search trees, and apply graph representations, BFS, DFS, and topological sorting	**K3**
CO3	Use divide and conquer to solve problems like finding maximum/minimum, binary search, quick sort, and merge sort	**K3**
CO4	Apply greedy strategies to solve the fractional knapsack problem, minimum cost spanning trees using Prim's and Kruskal's algorithms, and shortest paths with Dijkstra's algorithm.	**K3**
CO5	Understand the concepts of Dynamic Programming, Backtracking and Branch & Bound	**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	PO12
CO1	3	3	3									1
CO2	2	3	2	2								2
CO3	3	3	3	2								2
CO4	2	2										2
CO5	2	3	2									2

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	T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein	Prentice-Hall India	4/e, 2022
2	Fundamentals of Computer Algorithms	Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran	Universities Press	2/e, 2008

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

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105164/

SEMESTER S8

WEB PROGRAMMING

Course Code	OECST832	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)	GXEST203	Course Type	Theory

Course Objectives:

1. To equip students with the knowledge and skills required to create, style, and script web pages using HTML5, CSS, JavaScript, and related technologies.
2. To provide hands-on experience with modern web development tools and frameworks such as React, Node.js, JQuery, and databases, enabling students to design and build dynamic, responsive, and interactive web applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Creating Web Page using HTML5 -** Introduction, First HTML5 example, Headings, Linking, Images, Special Characters and Horizontal Rules, Lists, Tables, Forms, Internal Linking, meta Elements, HTML5 Form input Types, Input and datalist Elements and autocomplete Attribute, Page-Structure Elements; **Styling Web Page using CSS -** Introduction, Inline Styles, Embedded Style Sheets, Linking External Style Sheets, Positioning Elements:, Absolute Positioning, z-index, Positioning Elements: Relative Positioning, span, Backgrounds, Element Dimensions, Box Model and Text Flow, Media Types and Media Queries, Drop-Down Menus; **Extensible Markup Language -** Introduction, XML Basics, Structuring Data, XML Namespaces, Document Type Definitions (DTDs), XML Vocabularies	9
2	**Scripting language -** Client-Side Scripting, Data Types, Conditionals, Loops, Arrays , Objects , Function Declarations vs. Function Expressions , Nested Functions , The Document Object Model (DOM) - Nodes and NodeLists, Document Object, Selection Methods, Element Node Object, Event Types **Asynchronous JavaScript and XML -** AJAX : Making Asynchronous Requests , Complete Control over AJAX , Cross-Origin Resource Sharing	9

	JavaScript library - jQuery - jQuery Foundations - Including jQuery, jQuery Selectors, Common Element Manipulations in jQuery, Event Handling in jQuery	
3	**JavaScript runtime environment : Node.js -** The Architecture of Node.js, Working with Node.js, Adding Express to Node.js; **Server-side programming language : PHP** - What Is Server-Side Development? Quick tour of PHP, Program Control , Functions , Arrays , Classes and Objects in PHP , Object-Oriented Design ; **Rendering HTML : React -** ReactJS Foundations : The Philosophy of React, What is a component? Built- in components, User- defined components - Types of components, Function Components, Differences between Function and Class Components	**9**
4	**SPA** – Basics, Angular JS; **Working with databases** - Databases and Web Development, SQL, Database APIs, Accessing MySQL in PHP; **Web Application Design** - Real World Web Software Design, Principle of Layering , Software Design Patterns in the Web Context, Testing; **Web services** - Overview of Web Services - SOAP Services, REST Services, An Example Web Service, Web server - hosting options	**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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Develop structured web pages with HTML5 and style them using CSS techniques, including positioning, media queries, and the box model.	**K3**
CO2	Write client-side scripts using JavaScript and utilize jQuery for DOM manipulation, event handling, and AJAX requests to create responsive and interactive user interfaces.	**K3**
CO3	Build and deploy server-side applications using Node.js, Express, and PHP, and integrate databases using SQL to store and retrieve data for dynamic content generation.	**K3**
CO4	Utilize React for building component-based single-page applications (SPAs), understanding the fundamental principles of component architecture, and leveraging AngularJS for web application development.	**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	PO12
CO1	3	3	3		3							3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3		3							3

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 Web Development	Randy Connolly, Ricardo Hoar	Pearson	1/e, 2017
2	Building User Interfaces with ReactJS - An Approachable Guide	Chris Minnick	Wiley	1/e, 2022
3	Internet & World Wide Web - How to Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson	1/e, 2011
4	SPA Design and Architecture: Understanding Single Page Web Applications	Emmit Scott	Manning Publications	1/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Hand Book On Web Development : From Basics of HTML to JavaScript and PHP	Pritma Jashnani	Notion press	1/e, 2022
2	Advanced Web Development with React	Mohan Mehul	BPB	1/e, 2020
3	JavaScript Frameworks for Modern Web Development	Tim Ambler, Sufyan bin Uzayr, Nicholas Cloud	Apress	1/e, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106222/
2	https://archive.nptel.ac.in/courses/106/106/106106156/

SEMESTER S8

SOFTWARE TESTING

Course Code	OECST833	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 Cultivate proficiency in software testing methodologies and techniques.
2. To Foster expertise in software testing tools and technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Testing & Automation:-** Introduction to Software Testing - Concepts, importance of testing, software quality, and real-world failures (e.g., Ariane 5, Therac 25); Software Testing Processes - Levels of thinking in testing; Testing Terminologies - Verification, validation, fault, error, bug, test cases, and coverage criteria; Types of Testing - Unit, Integration, System, Acceptance, Performance (stress, usability, regression), and Security Testing; Industry Trends - AI in test case automation, Introduction to GenAI in testing; Testing Methods - Black-Box, White-Box, and Grey-Box Testing; Automation in Testing - Introduction to automation tools (e.g., Selenium, Cypress, JUnit); Case Study- Automation of Unit Testing and Mutation Testing using JUnit.	8
2	**Unit Testing, Mutation Testing & AI-Driven Automation:-** Unit Testing- Static and Dynamic Unit Testing, control flow testing, data flow testing, domain testing; Mutation Testing- Mutation operators, mutants, mutation score, and modern mutation testing tools (e.g., Muclipse); JUnit Framework - Automation of unit testing, frameworks for testing in real-world projects; AI in Testing - GenAI for test case generation and optimization, impact on automation; Industry Tools - Application of AI-driven testing tools in automation and predictive testing; Case Study - Mutation testing using JUnit, AI-enhanced test case automation.	8

3	**Advanced White Box Testing & Security Testing:-** Graph Coverage Criteria - Node, edge, and path coverage; prime path and round trip coverage; Data Flow Criteria - du paths, du pairs, subsumption relationships; Graph Coverage for Code - Control flow graphs (CFGs) for complex structures (e.g., loops, exceptions); Graph Coverage for Design Elements - Call graphs, class inheritance testing, and coupling data-flow pairs; Security Testing - Fundamentals, tools (OWASP, Burp Suite), and their role in protecting modern applications; Case Study - Application of graph based testing and security testing using industry standard tools.	10
4	**Black Box Testing, Grey Box Testing, and Responsive Testing:-** Black Box Testing - Input space partitioning, domain testing, functional testing (equivalence class partitioning, boundary value analysis, decision tables, random testing); Grey Box Testing - Introduction, advantages, and methodologies (matrix testing, regression testing, orthogonal array testing); Performance Testing - Network latency testing, browser compatibility, responsive testing across multiple devices (e.g., BrowserStack, LambdaTest); Introduction to PEX - Symbolic execution, parameterized unit testing, symbolic execution trees, and their application; GenAI in Testing - Advanced use cases for predictive and responsive testing across devices and environments; Case Study- Implementation of black-box, grey-box, and responsive testing using PEX and AI-driven tools.	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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Demonstrate the ability to apply a range of software testing techniques, including unit testing using JUnit and automation tools.	**K2**
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	**K3**
CO3	Explain and apply graph coverage criteria in terms of control flow and data flow graphs to improve code quality.	**K2**
CO4	Demonstrate the importance of black-box approaches in terms of Domain and Functional Testing	**K3**
CO5	Illustrate the importance of security, compatibility, and performance testing across devices.	**K3**
CO6	Use advanced tools like PEX to perform symbolic execution and optimize test case generation and also leverage AI tools for automated test case prediction and symbolic execution with PEX.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3	3							3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3		3							3
CO6	3	3	3	3	3							3

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 Software Testing.	Paul Ammann, Jeff Offutt	Cambridge University Press	2/e, 2016
2	Software Testing and Quality Assurance: Theory and Practice	Kshirasagar Naik, Priyadarshi Tripathy	Wiley	1/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Software Testing	Ron Patten	Pearson	2/e, 2005
2	Software Testing: A Craftsman's Approach	Paul C. Jorgensen	CRC Press	4/e, 2017
3	Foundations of Software Testing	Dorothy Graham, Rex Black, Erik van Veenendaal	Cengage	4/e, 2021
4	The Art of Software Testing	Glenford J. Myers, Tom Badgett, Corey Sandler	Wiley	3/e, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/101/106101163/
2	https://archive.nptel.ac.in/courses/106/101/106101163/
3	https://archive.nptel.ac.in/courses/106/101/106101163/
4	https://archive.nptel.ac.in/courses/106/101/106101163/

SEMESTER S8

INTERNET OF THINGS

Course Code	OECST834	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)	NA	Course Type	Theory

Course Objectives:

1. To give an understanding in the Internet of Things, including the components, tools, and analysis through its fundamentals and real-world applications.
2. To enable the students to develop IoT solutions including the softwares and programming of Raspberry Pi hardware.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to IoT - Physical Design of IoT, Logical Design of IoT, IoT levels and Deployment templates, Domain Specific IoT- Home automation, Energy, Agriculture, Health and lifestyle.	9
2	IoT and M2M-M2M, Difference between IoT and M2M, Software Defined Networking, Network Function virtualization, Need for IoT System Management, Simple Network Management Protocol (SNMP), NETCONF, YANG; LPWAN - LPWAN applications, LPWAN technologies, Cellular (3GPP) and Non 3GPP standards, Comparison of various protocols like Sigfox, LoRA, LoRAWAN, Weightless, NB-IoT, LTE-M.	9
3	Developing IoT - IoT design methodology, Case study on IoT system for weather monitoring, Motivations for using python, IoT-system Logical design using python, Python Packages of Interest for IoT - JSON, XML, HTTPlib & URLLib, SMTPLib	9
4	Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi, Interfacing an LED and switch with Raspberry Pi, Other IoT devices- PcDino, Beagle bone Black, Cubieboard, Data Analytics for IoT	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
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	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. **(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	Understand domain-specific applications and apply the principles of IoT, including physical and logical design and deployment templates	**K2**
CO2	Use the principles of IoT and M2M, their differences, and key concepts like SDN, NFV, and essential management protocols.	**K3**
CO3	Develop and apply IoT design methodology, utilize Python for logical system design, and leverage key Python packages through practical case studies.	**K3**
CO4	Experiment using Raspberry Pi with Python to control LEDs and switches, interface with other IoT devices.	**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	PO12
CO1	3	3	3							2		3
CO2	3	3	3							2		3
CO3	3	3	3	2						2		3
CO4	3	3	3	2						2		3

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	Internet of Things - a Hands On Approach.	Arshdeep Bahga, Vijay Madisetti	Universities Press	1/e, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things : Architecture and Design Principles	Rajkamal	McGraw Hill	2/e, 2022
2	The Internet of Things –Key applications and Protocols	Olivier Hersent, David Boswarthick, Omar Elloumi	Wiley	1/e, 2012
3	IoT fundamentals : Networking technologies, Protocols and use cases for the Internet of things	David Hanes Gonzalo. Salgueiro, Grossetete, Robert Barton	Cisco Press	1/e, 2017

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105166/
2	https://archive.nptel.ac.in/courses/108/108/108108179/

SEMESTER S8

COMPUTER GRAPHICS

Course Code	OECST835	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 Objective:

1. To provide strong technological concepts in computer graphics including the three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basics of Computer graphics -** Basics of Computer Graphics and its applications. Video Display devices - LED, OLED, LCD, PDP and FED and reflective displays. Random and Raster scan displays and systems. **Line and Circle drawing Algorithms -** Line drawing algorithms- Bresenham's algorithm, Liang-Barsky Algorithm, Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's Circle drawing algorithm.	**10**
2	**Geometric transformations -** 2D and 3D basic transformations - Translation, Rotation, Scaling, Reflection and Shearing, Matrix representations and homogeneous coordinates. **Filled Area Primitives -** Scan line polygon filling, Boundary filling and flood filling.	**10**
3	**Transformations and Clipping Algorithms -** Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms.	**8**
4	**Three dimensional graphics -** Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm.	**8**

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
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 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. **(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	Understand the principles of computer graphics and displays	**K2**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	**K3**
CO3	Illustrate 2D and 3D basic transformations and matrix representation	**K3**
CO4	Demonstrate different clipping algorithms and 3D viewing pipeline.	**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	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3

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	Computer Graphics : Algorithms and Implementations	D. P. Mukherjee, Debasish Jana	PHI	1/e, 2010
2	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4/e, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Flat Panel Displays	Jiun-Haw Lee, I-Chun Cheng, Hong Hua, Shin-Tson Wu	Wiley	1/e, 2020
2	Computer Graphics and Multimedia	ITL ESL	Pearson	1/e, 2013
3	Computer Graphics	Zhigang Xiang and Roy Plastock	McGraw Hill	2/e, 2000
4	Principles of Interactive Computer Graphics	William M. Newman and Robert F. Sproull	McGraw Hill	1/e, 2001
5	Procedural Elements for Computer Graphics	David F. Rogers	McGraw Hill	1/e, 2017
6	Computer Graphics	Donald D Hearn, M Pauline Baker	Pearson	2/e, 2002

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1.	Computer Graphics By Prof. Samit Bhattacharya at IIT Guwahati https://onlinecourses.nptel.ac.in/noc20_cs90/preview