SEMESTER 3

COMPUTER SCIENCE AND ENGINEERING

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 Hr. 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

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	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9th edition, 2016
2	Introduction to Probability Models	Sheldon M. Ross	Academic Press	13th 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 Mins
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 the 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 =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	Classify formal languages into regular, context-free, context-sensitive, and unrestricted languages.	**K2**
CO2	Develop finite state automata, regular grammar, and regular expression.	**K3**
CO3	Model push-down automata and context-free grammar representations for context-free languages.	**K3**
CO4	Construct Turing Machines to accept recursive and recursively enumerable languages.	**K3**
CO5	Describe the notions of decidability and undecidability of problems, the 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. Graphs :- Definitions; Representation of Graphs; Depth First Search and	11

	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,	**10**

	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.	

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. E • ach 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

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

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

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

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

PBL Course Elements

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

Assessment and Evaluation for Project Activity

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

1. **Project Planning and Proposal (5 Marks)**
    - Clarity and feasibility of the project plan
    - Research and background understanding
    - Defined objectives and methodology
2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**
    - Individual contribution to the presentation
    - Effectiveness in answering questions and handling feedback
3. **Involvement in the Project Work and Team Work (3 Marks)**
    - Active participation and individual contribution
    - Teamwork and collaboration
4. **Execution and Implementation (10 Marks)**
    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result
5. **Final Presentation (5 Marks)**
    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions
6. **Project Quality, Innovation, and Creativity (3 Marks)**
    - Overall quality and technical excellence of the project
    - Innovation and originality in the project
    - Creativity in solutions and approaches

SEMESTER 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 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.	**11**
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…)	
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	6

	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: 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	-

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	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:

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

DIGITAL LAB

(Common to CS/CM/AM/CN)

Course Code	**PCCSL308**	**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 enable the learner to design and implement basic digital logic circuits using logic gates and ICs.
2. To familiarize digital system design using HDL.

Expt. No.	**EXPERIMENTS** **(All HDL based experiments should be done using Verilog HDL. At Least three experiments of PART A & B together should be implemented on a breadboard . Use any open source circuit simulation software or web based logic simulator softwares for the rest of the experiments (refer to https://circuitverse.org, https://simulator.io, https://www.logiccircuit.org)**
	Part A **(All experiments in this part are mandatory. These experiments give an introduction to the digital design by familiarising the basic gates and combinational circuits on breadboard / circuit simulation softwares along with their HDL based realisation.)**
A1.	Study of basic digital ICs and verification of Boolean theorems using digital logic gates.
A2..	Familiarisation of the working of circuit simulation software. a. Realize the basic logic gates and analyze their waveforms b. Realize a given Boolean function using basic gates and verify the waveform with the truth table.
A3.	Familiarisation of Verilog HDL - Modelling of the basic gates using a. gate level modelling

	b. behavioural modelling c. structural modelling d. dataflow modelling
A4.	Realization of an SOP and its corresponding POS expression using NAND gates alone and NOR gates alone (to be do on breadboard and simulated using software)
A5.	Model a given Boolean function (SOP and POS) in Verilog using a. continuous assignment with logical operators b. continuous assignment with conditional operators c. using gate level primitives
	Part B **(All experiments to be done using any circuit simulation softwares.)**
B1.	Design and implement a combinational logic circuit for arbitrary functions (any two) a) Code converters b) Half adder, full adder, half subtractor, full subtractor c) Multiplexer, Demultiplexer,Encoder, Decoder
B2.	Design and implement combinational circuits using MSI devices: (any three) 1. 4-bit adder and subtractor using MSI device IC 7483. 2. Parity generator / checker using MSI device IC 74180 3. Magnitude Comparator using MSI device IC 7485 4. Implement a boolean function using MUX IC
B3.	Study of D flip flop and JK flip flops using ICs
B4.	To design and implement the following shift registers using D flip flops (i) Serial in serial out (ii) Serial in parallel out (iii) Parallel in serial out (iv) Parallel in parallel out
B5.	Design and implement an asynchronous counter - 3 bit up counter, 3-bit down counter, 3 bit up down counter with mode control, mod-N counter
B6.	Design and implement a synchronous counter - 3 bit up counter, 3-bit down counter, sequence generator.
	PART C **using Verilog HDL** *For the all the experiments in part C:* 1. *Write Verilog program code in the IDE/Software (Other open source or online softwares such as Icarus Verilog / EDAplayground may be used)*

	2. *Simulate the code using a test bench or by giving input values.* 3. *Synthesize the design and verify the waveforms*
C1.	Model a 4:1 MUX, 1:4 DEMUX, 4 to 2 encoder, and 2 to 4 decoder and a 7-Segment Display Decoder in Verilog using a. continuous assignment with logical operators b. continuous assignment with conditional operators
C2.	Design and synthesize the behavioural model for a D flip flop in Verilog HDL
C3.	Design and synthesize the behavioural model for a synchronous counter in Verilog
C4.	Design a Verilog HDL behavioral model to implement a finite-state machine - a serial bit sequence detector

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 and construct combinational logic circuits.	**K3**
CO2	Develop modular combinational circuits with MUX,DEMUX and decoder.	**K3**
CO3	Experiment with synchronous and asynchronous sequential circuits.	**K3**
CO4	Model and implement FSM.	**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	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
3	Verilog HDL Synthesis: A Practical Primer	J Bhasker	Star Galaxy Publishing	1/e, 1998

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	Fundamentals of Digital Logic with Verilog Design	Stephen Brown, Zvonko Vranesic	McGrawHill	3/e, 2014

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://nptel.ac.in/courses/117105080
2	https://archive.nptel.ac.in/courses/108/103/108103179/
3	https://www.youtube.com/watch?v=JU0RKPe7AhA (Introduction to CircuitVerse)

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

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:

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

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	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,*	**11**

	Preemption and Context Switching (Book 2, Ch 4)	
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)	**10**

	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)*	

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

CODING THEORY

(Common to CS/CM/AM/CI)

Course Code	**PECST414**	**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 students to some of the classical methods in coding theory
2. To give the concept of code construction through the mathematical foundations and examples.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Binary block codes, Minimum distance, Error-detecting capability and error-correcting capability. Introduction to linear block codes, generator matrix and parity check matrix. Properties of linear block codes: Syndrome, error detection. Distance properties of linear block codes. Single parity check codes, Hamming codes, Reed Muller codes.	9
2	Cyclic Codes : Generator and Parity-Check Matrices of Cyclic Codes. Encoding of Cyclic Codes, Syndrome Computation and Error Detection, Decoding of Cyclic Codes, Cyclic Hamming Codes, Shortened Cyclic Codes	9
3	Convolutional codes: Encoding, state diagram, trellis diagram, Classification, realization, distance properties. Viterbi algorithm, BCJR algorithm. Performance bounds for convolutional codes	9
4	Turbo codes: Turbo decoding, Distance properties of turbo codes, Convergence of turbo codes. Automatic repeat request schemes. Applications of linear codes	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	Construct the encoder and decoder of linear block codes	**K3**
CO2	Understand the concept of error correction coding	**K2**
CO3	Understand the implementation of cyclic codes	**K2**
CO4	Apply Viterbi algorithm for decoding convolutional codes	**K3**
CO5	Experiment with turbo codes using iterative map and BCJR 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								2
CO3	3	3	3	2								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	Error Control Coding	Shu Lin and Daniel J. Costello, Jr.	PHI	2/e, 2004
2	Error Correction Coding	Todd K. Moon	Wiley-Interscience	1/e, 2006

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Theory of Error-Correcting Codes	F. J. MacWilliams, N. J. A. Sloane	North-Holland, Amsterdam	1/e, 1977
2	Algebraic Codes for Data Transmission	R. E. Blahut	Cambridge University Press	1/e, 2003
3	Fundamentals of Error-Correcting Codes	Cary W. Huffman, Vera Pless	Cambridge University Press	1/e, 2003

Video Links (NPTEL, SWAYAM…)

Mod. No.	Link ID
1	https://archive.nptel.ac.in/courses/108/104/108104092/
2	https://nptel.ac.in/courses/108102117
3	https://archive.nptel.ac.in/courses/108/104/108104092/
4	https://archive.nptel.ac.in/courses/108/104/108104092/

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,	**8**

	selection, cross over, mutation. Stopping condition for genetic algorithm.	
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 S4

COMPUTATIONAL GEOMETRY

(Common to CS/CM)

Course Code	PECST418	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, PCCST303	Course Type	Theory

Course Objectives:

1. To develop a solid understanding of the fundamental principles, techniques, and algorithms used in computational geometry, including geometric data structures, convex hulls, Voronoi diagrams, and Delaunay triangulations.
2. To equip students with the skills to apply computational geometry algorithms and techniques to address real-world problems in areas such as computer graphics, robotics, and geographic information systems (GIS).

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Computational Geometry:-** Basics of Computational Geometry - Introduction and applications of computational geometry, Geometric objects, and their representations, Basic geometric primitives: points, lines, segments, polygons (Text 1, Chapters 1, 2) Convex Hulls - Definition and properties of convex hulls, Graham's scan algorithm, Jarvis's march (gift wrapping) algorithm, Divide and conquer algorithm for convex hulls (Text 2, Section 33.3) Line Segment Intersection - Problem definition and applications, Plane	9

	sweep algorithm, Bentley-Ottmann algorithm (Text 3, Chapter 7)	
2	**Polygon Triangulation and Voronoi Diagrams:-** Polygon Triangulation - Definition and applications, Triangulation of monotone polygons, Ear clipping method, Chazelle's algorithm (Text 1, Chapter 3) Voronoi Diagrams - Definition and properties, Incremental construction algorithm, Fortune's sweep line algorithm (Text 1, Chapter 7) Delaunay Triangulations - Definition and properties, Relationship with Voronoi diagrams, Bowyer-Watson algorithm, Lawson's flip algorithm (Text 1, Chapter 9)	**9**
3	**Range Searching and Point Location :-** Range Searching - Problem definition and applications, 1-dimensional range searching, K-dimensional range trees, Fractional cascading (Text 1, Chapter 5) Point Location - Problem definition and applications, Trapezoidal map and randomized incremental algorithm, Kirkpatrick’s point location algorithm (Text 1, Chapter 6) Binary Space Partitioning - Definition and applications, BSP trees construction and properties, Use in computer graphics and collision detection (Text 1, Chapter 12)	**9**
4	**Advanced Topics and Applications :-** Arrangements of Lines and Duality - Arrangements of lines and complexity, Zone theorem, Duality transform and its applications (Text 1, Chapter 8) Motion Planning and Geometric Optimization - Problem definition and applications, Visibility graphs and shortest path problems, Art gallery problem, Linear programming in geometry (Text 1, Chapters 10, 11) Computational Geometry in Practice - Computational geometry libraries and software, Applications in robotics, computer graphics, GIS (Text 3, Chapters 9, 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 Fundamental Concepts and Applications of Computational Geometry	**K2**
CO2	Apply Algorithms for Convex Hulls and Line Segment Intersection Algorithms	**K3**
CO3	Perform Polygon Triangulation and Understand Voronoi Diagrams	**K3**
CO4	Build Delaunay Triangulations and Range Searching Techniques	**K3**
CO5	Apply Advanced Computational Geometry Techniques and Algorithms	**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	Computational Geometry: Algorithms and Applications	Mark de Berg, Otfried Cheong, Marc van Kreveld, and Mark Overmars	Springer India	3/e, 2011
2	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein	MIT Press	4/e, 2022
3	Computational Geometry in C	Joseph O'Rourke	Cambridge University Press	2/e, 1998

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Discrete and Computational Geometry Hardcover	Joseph O'Rourke , Satyan L. Devadoss	Princeton University Press	1/e,2011
2	Computational Geometry: An Introduction	Franco P. Preparata, Michael I. Shamos	Springer-Verlag New York Inc	5/e, 1993
3	Geometric Algorithms and Combinatorial Optimization	Martin Grötschel, Laszlo Lovasz, Alexander Schrijver	Springer-Verlag Berlin and Heidelberg GmbH & Co. K	2/e, 1993

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/102/106102011/
2	https://archive.nptel.ac.in/courses/106/102/106102011/
3	https://archive.nptel.ac.in/courses/106/102/106102011/
4	https://archive.nptel.ac.in/courses/106/102/106102011/

SEMESTER S4

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 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	**9**

	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

VLSI DESIGN

(Common to CS/CN/CI)

Course Code	PECST415	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)	GAEST305	Course Type	Elective

Course Objectives:

1. To impart the key concepts of MOS technology including characteristics of CMOS and its application in digital VLSI circuits to design basic CMOS logic gates.
2. To impart the key concepts of Integrated Circuit Design and introduce various design flows.
3. To equip the learner to implement both combinational and sequential logic circuits using both semi-custom and FPGA design flow.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**CMOS Fundamentals for Digital VLSI Design :** CPN junction, MOS transistor theory and operation, PMOS, NMOS, CMOS, CMOS Inverter, Voltage Transfer Curve, CMOS logic gates, Tristate Inverter, Tristate buffer. Combinational Circuits Timing - Rise Time, Fall time, Propagation Delay. Introduction to sequential logic circuits, flip-flops and latches, Timing analysis - Set-up time, Hold Time, Propagation Delay, Frequency of Operation, Static and Dynamic Timing Analysis, Pipelining	9
2	**Introduction to Integrated Circuits (ICs):** CMOS fabrication process overview- Photolithography, Structure of an Integrated Circuit, Types of Design flow - Custom design, Semi-custom design, array based design. A System Perspective, Hardware – Software Partitioning, example Video compression, Functional Specification to RTL, Behavioural Synthesis.	9

3	**Semi-custom Design flow** Abstraction in VLSI Design Flow- Gajski-Kuhn's Y-chart, Hardware design using hardware description Languages, Design Verification- Simulation using Testbench, Property Checking, Equivalence Checking, Static Timing Analysis, Logic Synthesis, Physical Design- Min-cut Partitioning, Floor plan- , Global and Detailed Placement, Global and Detailed Routing, Micro project*	**9**
4	**Finite State Machines (FSMs):** Mealy and Moore models. Verilog HDL Design and implementation of RISC stored programmed Machine. **Field Programmable Gate Arrays (FPGAs)** : FPGA Architecture- Programming Technology, Programmable logical blocks, Programmable Interconnects, Programmable I/O blocks, FPGA Design Flow, SoC Design on FPGA, Micro project*.	**9**

***** *Micro-project on FPGA / Semi-Custom Flow.*

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

- Ability to capture the specification and ability for RTL coding,
- Ability to analyze the circuit for resource utilization such as area consumption and power consumption. Analyze the circuit for timing violations. Optimize 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 =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	Utilize the MOS Circuits and design basic circuits using CMOS.	**K3**
CO2	Explain IC design flow and design a system using hardware software co-design strategy.	**K3**
CO3	Design, simulate and implement systems design in HDL using semi-custom flow.	**K4**
CO4	Design, simulate and implement digital systems using programmable devices.	**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							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	Introduction to VLSI Design Flow	Sneh Saurabh	Cambridge University Press	1/e, 2023
2	Digital Integrated Circuits: A Design Perspective.	Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolic	Pearson Education	2/e, 2003
2	Digital Systems Design Using Verilog	Charles H. Roth Jr., Lizy Kurian John, Beyeong Kil Lee,	CL Engineering	1/e, 2015
3	Advanced Digital Design with the Verilog HDL	Micahel D. Ciletti	Pearson	2/e, 2017

Reference 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	Digital Design: With an Introduction to the Verilog HDL	M. Morris Mano, Michael D. Ciletti	Pearson India	5/e, 2012
3	Verilog HDL – A guide to digital design & Synthesis	Samir Palnitkar	Pearson	2/e, 2003
4	FPGA Based System Design	Wayne Wolf	Pearson	1/e, 2004
5	Embedded Core Design with FPGAs	Zainalabedin Navabi	McGraw-Hill	1/e, 2006

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	Introduction to Digital VLSI Design Flow, Introduction to Digital VLSI Design Flow, IIT Guwahati https://nptel.ac.in/courses/106103116
2	Introduction to VLSI Design by Prof. S. Srinivasan , IIT Madras, https://nptel.ac.in/courses/117106092
3	VLSI Physical Design by Prof. Indranil Sengupta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc21_cs12/preview
4	Digital System Design using PLDs and FPGAs , Prof. Kuruvilla Varghese from IISc Bangalore https://archive.nptel.ac.in/courses/117/108/117108040/

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 type**	Theory

Course Objectives:

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

SYLLABUS

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

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

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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 - 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/ 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 $\sqrt{b^2 \quad 4ac}$. 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

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 Table using ip command (Book 3 Ch 14)***	18

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

DESIGN AND ANALYSIS OF ALGORITHMS

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

Course Code	**PCCST502**	**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:

- To gain a foundational understanding of algorithms and their analysis.
- To develop problem-solving skills using various algorithm design paradigms like divide and conquer, dynamic programming, etc.
- To understand the concepts of tractable and intractable problems, and different complexity classes (P, NP, NP-hard, NP-complete).

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Algorithms – Characteristics, Criteria for Analysing Algorithms; Time and Space Complexity - Best, Worst, and Average Case Complexities; Asymptotic Notations and their properties; Time and Space Complexity Calculation of simple algorithms; Analysis of Recursive Algorithms - Recurrence Equations, Solution of Recurrence Equations : Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (proof not expected); Balanced Search Trees - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected)	11

2	Disjoint Sets - Disjoint set operations, Union and find algorithms, Analysis of union by rank with path compression, Connected components of a Graph; Graphs – Representations, Traversals : BFS, DFS and their analysis, Strongly Connected Components; Topological Sorting. Divide and Conquer Strategy – Control Abstraction, Merge Sort, Strassen's Matrix Multiplication, Analysis.	**11**
3	Greedy Strategy - Control Abstraction, Fractional Knapsack; Minimum Cost Spanning Tree – Kruskal's and Prim's, Analysis; Shortest Path Problem – Dijkstra's Algorithm, Analysis; Dynamic Programming - Control Abstraction, Optimality Principle, Matrix Chain Multiplication, Analysis; All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm, Analysis; Backtracking - Control Abstraction, N – Queens Problem, Algorithm.	**11**
4	Branch and Bound - Control Abstraction, Travelling Salesman Problem, Algorithm; Complexity - Tractable and Intractable Problems; Complexity Classes : P, NP, NP- Hard and NP-Complete Classes; NP Completeness proof - Clique Problem and Vertex Cover Problem; Approximation algorithms - Bin Packing; Randomized Algorithms - Definitions of Monte Carlo and Las Vegas algorithms; Randomized version of Quick Sort algorithm with analysis.	**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	Analyze any given algorithm and express its time and space complexities in asymptotic notations.	**K4**
CO2	Solve the recurrence equations using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms.	**K3**
CO3	Illustrate the operations of advanced data structures like AVL trees and Disjoint sets.	**K3**
CO4	Illustrate the representation, traversal and different operations on Graphs.	**K3**
CO5	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques.	**K2**
CO6	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability.	**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								3
CO2	3	3	3									2
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3	2								2
CO6	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 Algorithms	T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein,	Prentice-Hall India	4/e, 2018
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	Design and Analysis of Algorithms	Michael T. Goodrich Roberto Tamassia	Wiley	1/e, 2021
2	Algorithm Design	Jon Kleinberg, Eva Tardos	Pearson Education	1/e, 2005
3	Algorithms	Robert Sedgewick, Kevin Wayne	Pearson Education	4/e, 2011
4	Fundamentals of Algorithmics	GIlles Brassard, Paul Brately	Pearson Education	1/e, 1996
5	The Algorithm Design Manual	Steven S. Skiena	Springer	2/e, 2008

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106131/
2	https://www.coursera.org/learn/dynamic-programming-greedy-algorithms
3	https://online.stanford.edu/courses/soe-ycsalgorithms1-algorithms-design-and-analysis-part-1
4	https://online.stanford.edu/courses/soe-ycs0001-algorithms-design-and-analysis-part-2

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

MICROCONTROLLERS

(Common to CS/CC)

Course Code	PBCST504	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 introduce the ARM architecture and ARM-based microcontroller architecture.
2. To impart knowledge on the hardware and software components to develop embedded systems using STM32 microcontrollers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to ARM Cortex-M Architecture:-** Overview of Embedded Systems, Applications of Embedded Systems, Introduction to Embedded C, Microcontrollers vs. Microprocessors, Classification of processors, Overview of ARM Cortex-M Series, Introduction to the Cortex-M23 and Cortex-M33 processors and the Armv8-mArchitecture, ARM Core Features: Registers, Memory, and Bus Architecture, Comparison with previous generations of Cortex-M processors.	9
2	**STM32 Microcontroller Overview and Peripheral Programming:-** Introduction to STM32 Family, STM32U575 Features and Specifications, Power Management and Low-Power Features Libraries, Introduction to Integrated Development Environment and HAL, Writing, and Debugging Your First Program(LED Interfacing), Interfacing Seven-Segment Display, LCD Display, and Matrix Keypad, Relay Interfacing, Analog to Digital Conversion: Potentiometer, temperature sensor, LDR, Microphone, Digital to Analog Conversion: Simple DAC Output Generation, Generating a Sine Wave, Audio	11

	Signal Generation, Interrupt Handling, Timer and Counter Applications: Basic Timer Configuration, Timers as Counters, Timer-Based Real-Time Clock (RTC)	
3	**Communication Protocols and USB:-** Serial port terminal Application, Serial communication (USART, I2C, SPI, CAN), Interfacing an I2C Temperature Sensor and Displaying Data on an LCD, writing to and Reading from an SPI-based EEPROM, Configuring and Implementing CAN Communication between Multiple STM32U575 Microcontrollers, Creating a USB HID Device for Keyboard / Mouse Emulation	**10**
4	**IoT, Wireless Communication, and RTOS:-** Introduction to IoT, IoT Architecture, Protocols (MQTT, CoAP), IoT Security Principles and Common Threats Wireless Communication: Interfacing GSM (Call, SMS, Internet), Bluetooth Communication Basics, LoRa Communication Basics and Applications, Designing an IoT-Based Home Automation System, Introduction to RTOS Concepts, FreeRTOS with STM32: Task Creation, Scheduling, and Management, RTOS Timers, Delays, and RTC Integration, Inter-task Communication: Queues and Semaphores **Trust Zone Technology:** Introduction to ARM Trust Zone, Trust Zone Architecture and Features, Secure and Non-Secure Worlds: Configuration and Management, Implementing Trust Zone in STM32U575, Advanced Debugging and Optimization: Code and Memory Optimization Techniques, Debugging Strategies and Tools	**14**

Suggestion on Project Topics

- Identify real world problems requiring hardware solutions and develop them using peripheral devices. Some of the examples would be - Home automation, Small home/office security system, ARM based voice response system etc.

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 architectural features and instructions of the ARM microcontrollers.	**K2**
CO2	Develop applications involving interfacing of external devices and I/O with ARM microcontroller.	**K3**
CO3	Use various communication protocols of interaction with peer devices and peripherals.	**K3**
CO4	Demonstrate the use of a real time operating system in embedded system applications.	**K3**
CO5	Apply hardware security features of ARM in real world applications.	**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	3							3
CO4	3	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	The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors	Joseph Yiu	Newnes - Elsevier	3/e, 2014
2	Mastering STM32	Carmine Noviello	Learnpub	2/e, 2022

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	ARM System Developer's Guide	Andrew N. Sloss, Dominic Symes, Chris Wright	Morgan Kaufman	1/e, 2008
2	Embedded System Design with Arm Cortex-M Microcontrollers	Cem Ünsalan, Hüseyin Deniz Gürhan Mehmet Erkin Yücel	Springer	1/e, 2022
3	Introduction to ARM ® Cortex-M Microcontrollers	Jonathan W. Valvano	Self-Published	5/e, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105193/
2	https://www.st.com/resource/en/datasheet/

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 Hr.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 S5

ARTIFICIAL INTELLIGENCE

Course Code	PECST522	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 lay a solid foundation of the important abstractions, techniques, and reasoning for intelligent systems.
2. To enable the learners to understand the basic principles of Reinforcement Learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Artificial Intelligence:-** Introduction, Foundation and history of AI Agents and Environments; The concept of rationality; The nature of environments, Structure of agents. Problem solving Agents Well-defined problems and solutions, Formulating problems; Example problems- vacuum world, 8-puzzle, 8-queens.	8
2	**Searching:-** Depth First Search, Breadth First Search, Iterative Deepening Search. Heuristic Search strategies - Heuristic functions, The effect of heuristic accuracy on performance; Generate and test, Greedy best first search, A* algorithm, Constraint satisfaction problems, Adversarial search - Games, Optimal Decision in games, The minimax algorithm, Alpha–beta pruning.	10
3	**Knowledge-Based Agents** :- The Wumpus World, Logic, Propositional Logic, Reasoning Patterns in Propositional Logic, First order logic, Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining.	8

4	**Reinforcement Learning :-** Learning from Rewards, Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, Apprenticeship and Inverse Reinforcement Learning, Applications of Reinforcement Learning	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 how intelligent agents can solve problems.	**K2**
CO2	Use the different types of search methods to solve various problems.	**K3**
CO3	Formulate knowledge representation and examine resolution in propositional logic and first order logic.	**K3**
CO4	Utilize reinforcement learning techniques to create intelligent agents.	**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	-	-	-	-	-	-	-	2
CO2	3	3	3	2	-	-	-	-	-	-	-	2
CO3	2	2	2	2	-	-	-	-	-	-	-	2
CO4	3	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	AI – A Modern Approach	Stuart Russel, Peter Norvig	Pearson Education	4/e, 2021
2	Artificial Intelligence	Kevin Knight, Elaine Rich, Shivashankar B. Nair	Tata McGraw-Hill	3/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 Artificial Intelligence and Expert Systems	Dan W. Patterson	Pearson Education	1/e, 2015
2	Artificial Intelligence: Structures and Strategies for Complex Problem Solving	George F. Luger	Pearson Education	6/e, 2009
3	Artificial Intelligence : Making a System Intelligent	Nilakshi Jain	Wiley	1/e, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=X_Qt0U66aH0
2	https://www.youtube.com/watch?v=te1K8on1Pk0
3	https://www.youtube.com/watch?v=SEJhMO1IXZs
4	https://youtu.be/YaPSPu7K9S0?si=DizMPlZ9uVSy50iG

SEMESTER S5

DATA ANALYTICS

Course Code	PECST523	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 learner to understand the basic concepts of data analytics.
2. To cover the mathematics for data analytics, predictive and descriptive analytics of data, classification, and clustering & text analytics.
3. To enable the learners to perform data analysis on a real world scenario using appropriate tools.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Data Analytics:-** Analytics Process Model, Analytical Model Requirements, Data Analytics Life Cycle overview; Association of two variables - Discrete variables, Ordinal and Continuous variable; Probability calculus - probability distributions; Hypothesis Testing - Basic definitions. **Proximity Measures** - Data Objects, Attribute types, Dissimilarity and Similarity measures.	9
2	**Association of Two Variables:-** Summarizing the Distribution of Two Discrete Variables, Contingency Tables for Discrete Data, Joint, Marginal, and Conditional Frequency Distributions, Graphical Representation of Two Nominal or Ordinal Variables, Measures of Association for Two Discrete Variables,	9

	Association Between Ordinal and Continuous Variables, Visualization of Variables from Different Scales.	
3	**Statistical Description of data** - Central tendency, Dispersion, Range, Quartiles, Variance, Standard Deviation, and Interquartile Range. **Data Preprocessing -** Cleaning, Integration, Reduction, Transformation, Discretization. **Mining Frequent Patterns** - Associations, Correlations, and Apriori Algorithms. **Classification** - General approach to classification, ID3, Attribute selection measures, Naive Bayesian Classification. **Clustering** - K-Means, Agglomerative versus Divisive Hierarchical Clustering, BIRCH, DBSCAN.	**9**
4	**Text Processing** :- Boolean retrieval, Example IR problem, inverted index, processing Boolean queries, tokenization, stemming, phrase queries, vector space model, finite automata and language model, query likelihood model, naïve bayes text classification.	**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 key concepts of data analytics	**K2**
CO2	Apply appropriate techniques to convert raw data into suitable format for practical data analytics tasks	**K3**
CO3	Extend the concept of association rule mining in real world scenario	**K3**
CO4	Select appropriate clustering and classification algorithms for various applications and extend data analytics methods to the new domains of data.	**K4**
CO5	Understand the basics of text analytics and text classification	**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
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 Statistics and Data Analysis	Christian Heumann and Michael Schomaker	Springer	1/e, 2016
2	Jiawei Han and Micheline Kamber	Data Mining Concepts and Techniques	Elsevier	3/e, 2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Information Retrieval	Christopher D. Manning, Raghavan, P., Schutze, H.	Cambridge University Press	1/e, 2008
2	Mining Text Data	Charu C. Aggarwal, Cheng Xiang Zhai	Springer	1/e, 2012
3	Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends	Bart Baesens	John Wiley	1/e, 2013
4	Introduction to Data Mining	Pang-Ning Tan, Michael Steinbach and Vipin Kumar	Pearson Education	1/e, 2007

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs15/
2	https://onlinecourses.swayam2.ac.in/cec19_cs01/preview

SEMESTER S5

DATA COMPRESSION

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

Course Code	**PECST524**	**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 students to basic applications, concepts, and techniques of Data Compression.
2. To develop skills for using recent data compression software to solve practical problems in a variety of disciplines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basic Compression Techniques :-** Data Compression Approaches - Variable-Length Codes, Run-Length Encoding, Space - Filling Curves, Dictionary-Based Methods, Transforms, Quantization. Huffman Encoding - Huffman Decoding, Adaptive Huffman Coding, Facsimile Compression. Run Length Encoding (RLE), RLE Text compression, Dictionary based Coding- LZ77, LZ78, LZW and Deflate: Zip and Gzip compression.	10
2	**Advanced Techniques :-** Arithmetic Coding - The Basic Idea, Implementation,Underflow; Image Compression- Introduction, Approaches to Image Compression, History of Gray Codes, Image Transforms, Orthogonal Transforms, The Discrete Cosine Transform, Intermezzo: Statistical Distributions, JPEG, Human Vision and Color, The Wavelet Transform, Filter Banks, WSQ, Fingerprint Compression	10

3	**Video Compression :-** Video Compression - Analog video, Digital Video, Motion Compensation. MPEG standards MPEG, H.261	**8**
4	**Audio Compression :-** Audio Compression - Companding, The Human Auditory System, Heinrich Georg Barkhausen, Linear Prediction, μ-Law and A-Law Companding, Shorten	**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	Describe the fundamental approaches in data compression techniques	**K2**
CO2	Illustrate various classical data compression techniques	**K3**
CO3	Illustrate various text and image compression standards	**K3**
CO4	Describe the video compression mechanisms to reduce the redundancy in video	**K3**
CO5	Understand the fundamental principles of audio data compression	**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	3									3
CO4	3	3	3									3
CO5	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	A Concise Introduction to Data Compression	David Salomon	Springer	1/e, 2008
2	Data compression: The Complete Reference	David Salomon	Springer	3/e, 2004
3	Introduction to Data Compression	Khalid Sayood	Morgan Kaufman	1/e, 2003

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fractal and wavelet Image Compression techniques	Stephen Welstead,	PHI	1/e, 1999
2	Multimedia System	Sleinreitz	Springer	1/e, 2006
3	The Data Compression Book	Mark Nelson, Jean-loup Gailly	BPB Publications	1/e, 1996

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	An Introduction to Information Theory by Prof. Adrish Banerjee zt IIT Kanpur https://onlinecourses.nptel.ac.in/noc22_ee49/preview

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?	
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	

	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	
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	

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 Type**	Theory

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 pre-processing 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

ADVANCED GRAPH ALGORITHMS

Course Code	PECST595	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)	GAMAT401 PCCST303 PCCST502	Course Type	Theory

Course Objectives:

1. To gain proficiency in designing and implementing sophisticated graph algorithms for analyzing large-scale networks, and apply these techniques to real-world problems such as social network analysis and transportation optimization.
2. To develop the ability to critically evaluate and enhance advanced graph algorithms for dynamic and evolving graphs, using real-world case studies to illustrate their application and performance in complex scenarios.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Maximum Flow Algorithms - Dinic's Algorithm, Push-Relabel Algorithm. Applications - network bandwidth allocation, data center resource management. Minimum Cost Flow - Cycle-Canceling Algorithm, Capacity Scaling Algorithm. Applications - transportation logistics, network routing with cost constraints. **Assignments:** 1. Network Bandwidth Allocation - Optimize bandwidth allocation in a communication network using Dinic's Algorithm. Implement Dinic's Algorithm to solve a network flow problem where you are given a communication network represented as a directed graph with capacities on edges. Your goal is to maximize	9

	the flow from a source node to a sink node. Use a real-world network dataset (e.g., a telecommunications network with nodes and link capacities). 2. Logistics Optimization - Optimize the transportation of goods in a supply chain network using the Capacity Scaling Algorithm. Use the Capacity Scaling Algorithm to address a logistics problem where you need to minimize transportation costs in a supply chain network. The network is represented as a graph where nodes represent locations (warehouses, distribution centers, etc.), and edges represent transportation routes with associated costs. Use a dataset representing a supply chain network with nodes, edges, and costs.	
2	Strongly Connected Components (SCC) - Tarjan's Algorithm, Kosaraju's Algorithm. Applications - analyzing web page link structures, understanding connected components in social networks. Dynamic Graph Connectivity - Dynamic connectivity algorithms, Eulerian and Hamiltonian paths. Applications - real-time network monitoring, dynamic route planning. **Assignments**: 1. Web Page Link Analysis - Objective: Analyze strongly connected components (SCC) in a web graph using Tarjan's Algorithm. Implement Tarjan's Algorithm to find SCCs in a web graph where nodes represent web pages and edges represent hyperlinks. SCCs help in understanding the structure of the web and identifying clusters of interconnected pages. Use a real-world web graph dataset with nodes and edges. 2. Dynamic Route Planning - Manage and analyze routes in a transportation network that evolves over time using dynamic connectivity algorithms. Implement dynamic connectivity algorithms to handle a transportation network where edges and nodes may be added or removed over time. The goal is to maintain and update the connectivity information efficiently. Use a dataset representing a transportation network with dynamic updates.	**9**
3	Graph Matching - Edmonds' Algorithm for finding maximum matchings. Applications - job assignment, network design. Graph Coloring - Colorings for special classes of graphs (e.g., planar graphs, interval graphs). Applications - frequency assignment in wireless networks,	**9**

	scheduling problems **Assignments:** 1. Job Assignment Optimization - Solve job assignment problems using Edmonds' Algorithm. Implement Edmonds' Blossom Algorithm to address job assignment problems where you need to match workers to jobs in a way that maximizes the overall efficiency or minimizes the cost. Use a dataset with job assignments and associated costs or efficiencies. 2. Frequency Assignment - Allocate frequencies in wireless communication systems using graph coloring techniques. Apply graph coloring techniques to allocate frequencies to transmitters in a wireless communication network to avoid interference. The goal is to minimize the number of frequencies used while ensuring that adjacent transmitters do not use the same frequency. Use a dataset representing a network of transmitters with potential interference.	
4	Graph Partitioning and Community Detection - Kernighan-Lin Algorithm, Spectral Partitioning. Applications - social network community detection, large-scale data clustering. Parameterized Algorithms for Graph Problems - Fixed-parameter tractability for vertex cover, feedback vertex set. Applications - network security, bioinformatics. **Assignments:** 1. Social Network Community Detection - Detect communities in a social network using the Kernighan-Lin Algorithm. Apply the Kernighan-Lin Algorithm to detect communities in a social network where nodes represent individuals and edges represent relationships. The goal is to find clusters of highly interconnected individuals. Use a social network dataset with nodes and edges representing social connections. 2. Network Security Analysis - Identify critical nodes in a network using parameterized algorithms to assess network security. Use parameterized algorithms to identify critical nodes and vulnerabilities in a network. These nodes are crucial for the network's connectivity, and their removal would impact the network's security and robustness. Use a dataset representing a network with nodes and edges, along with possible vulnerabilities.	**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

Assignment evaluation pattern:

- Correctness and Accuracy (30%) - Correct Solution and Implementation.
- Effectiveness and Efficiency (25%) - Algorithm Efficiency and Performance Metrics.
- Analytical Depth (25%) - Problem Understanding and Solution Analysis.
- Justification and Comparisons (20%) - Choice Justification and Comparative Analysis.

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	Develop and implement advanced algorithms for network flow, graph connectivity, and matching, and evaluate their performance on real-world datasets.	**K3**
CO2	Analyze and compare the efficiency and effectiveness of various graph algorithms, including those for network optimization and community detection.	**K4**
CO3	Apply advanced graph algorithms to solve practical problems such as network optimization, job assignment, and frequency allocation, demonstrating their utility in real-world scenarios.	**K3**
CO4	Formulate and solve complex graph-related problems using appropriate algorithms, including those for graph traversal, minimum spanning trees, and network security analysis.	**K5**
CO5	Critically assess the strengths and limitations of different graph algorithms, and effectively communicate findings and recommendations through detailed reports and presentations.	**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								2
CO2	3	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	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	The MIT Press Cambridge	4/e 2023
2	Algorithms	Robert Sedgewick and Kevin Wayne	Addison-Wesley	4/e, 2023
3	Graph Algorithms	Shimon Even	Cambridge University Press	2/e, 2011
4	Graph Theory	Reinhard Diestel	Springer	4/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Guide to Graph Algorithms	Mingyu Xiao and Ton Kloks	Springer Verlag, Singapore;	1st, 2022
2	Network Science	Albert-László Barabási and Márton Pósfai	Cambridge University Press	1st, 2016
3	Modern Graph Theory	Bela Bollobas	Springer-Verlag New York Inc	1st, 1998
4	Network Flows: Theory, Algorithms, and Applications	Ravindra Ahuja, Thomas Magnanti, and James Orlin	Pearson	1st, 1993
5	Introduction to Graph Theory	Douglas B. West	Pearson	2nd, 2020
6	Modern Graph Theory Algorithms with Python: Harness the power of graph algorithms and real-world network applications using Python	Colleen M Farrelly and Franck Kalala Mutombo	Packt Publishing	2024

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

SEMESTER S5

NETWORKS LAB

(Common to CS/CD/CM/CB/CU/CI)

Course Code	**PCCSL507**	**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

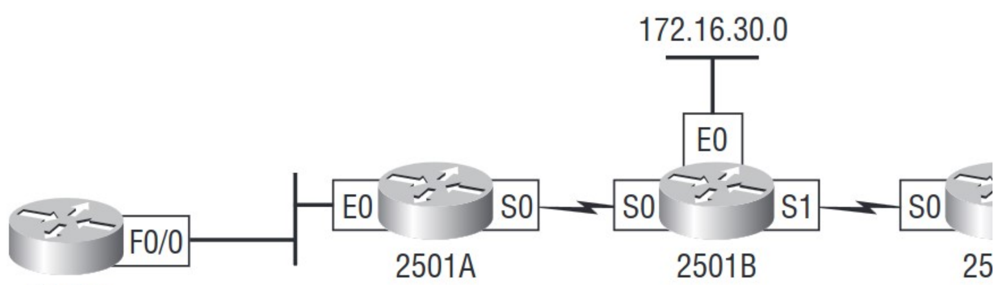
Course Objectives:

1. To provide hands-on experience in network programming using Linux System calls and network monitoring tools.
2. To comprehend the implementation of network protocols and algorithms, and configuration of network layer services using network simulators.

Expt. No.	**Experiments**
	Warm up
1	Familiarize Linux networking commands - ifconfig, ifplugstatus, iftop, ping, ip, traceroute, mtr, netstat, whois, nmap, nmcli, speedtest-cli, bmon, nslookup, tcpdump
	Wireshark based
2	Start your web browser and clear the browser's cache memory. Open Wireshark and start capturing. Then visit any webpage of your choice. Type **http** in the filter field of the Wireshark and click Apply so that only HTTP messages are displayed. After enough packets have been captured, select the **Capture** from the pull-down menu and select **Stop** to stop capturing. Using the captured information, determine the following: (a) the source IP address and destination IP address of the first GET message (b) the medium format, the language, the encoding, and the character set that the client can accept. (Use the first GET message) (c) the URL of the website and the user agent (Use the first GET message) (d) the source IP address and destination IP address of the first response message (e) the status codes for the first response message. (f) when the HTML file that you are retrieving was last modified at the server

	(g) value of the content-length field of the first response message (h) how long it took from the time the GET message was sent until the response message was received. (Use the timestamps of a GET message and that of the corresponding response message. By default, the time column's value is the amount of time in seconds since Wireshark tracing began.) (i) the HTTP version of your browser.
3	Compose an e-mail and address it to yourself, but do not send it yet. Open the Wireshark and start capturing. Go to your e-mail user agent and send the e-mail. In the Wireshark window, type **smtp** in the filter field and click **Apply**. Stop capturing and save the captured file. Using the captured information, answer the following: (a) All SMTP packets have the same two IP addresses. Which one is the IP address of your computer? Which host does the other IP address represent? (b) All SMTP packets have the same two port numbers. Which one is the port number of the SMTP client process? In which range is the client port number? (c) What is the port number of the SMTP server process? (d) Examine the SMTP commands or SMTP response codes in each SMTP packet and write down their meanings. (e) There is an IMF packet that is encapsulated inside an SMTP packet. What is the content of this packet?
4	First, clear the DNS record from the cache memory of your computer. For this, use **ipconfig/flushdns** on Windows or **systemd-resolve --flush-caches** on Linux. Next, clear your browser's cache memory. Open the Wireshark and start capturing. In your browser visit your college website. Wireshark starts to capture packets. Type **dns** in the filter field and press **Apply** so that only DNS messages are displayed. Stop capturing and save the captured file. Using the captured information, answer the following questions: (a) Locate the first DNS query message resolving your college website. What is the packet number (This “packet number” is assigned by Wireshark for listing purposes only; it is NOT a packet number contained in any real packet header.) in the trace for the DNS query message? (b) Is this query message sent over UDP or TCP? (c) Now locate the corresponding DNS response to the initial DNS query. What is the packet number in the trace for the DNS response message? Is this response message received via UDP or TCP? (d) What are the source and destination port numbers for the DNS query message?

	(e) What are the source and destination port numbers for the DNS response message? (f) To what IP address is the DNS query message sent? (g) What is the query message ID number? What is the response message ID number? What is the purpose of this field? (h) What is the length of the flag field in a DNS message? (i) Which bit in the flag field determines whether the message is a query or a response? (j) Which bits are used only in the response message? What is the function of these bits in the response message? (k) How many question records, answer records, authority records, and additional records are present in the query message? (l) How many question records, answer records, authority records, and additional records are present in the response message?
Socket programming based	
5	Client-Server communication using TCP:- The client inputs an integer *N* and creates a square matrix of order *N* by populating the matrix with random numbers in the range [1,50]. It then sends the matrix to the server which identifies the matrix type (upper triangular, lower triangular, diagonal). The server then informs the type (as a string) to the client which it prints.
6	Client-Server communication using UDP:- You are very good at communicating in the "new generation" English language with all sorts of abbreviations like **tbh**, **ig,** etc. Now design a client-server application as follows: The client inputs a new-generation English sentence from the user and sends it to the server. The server then translates the received sentence to formal English and sends the translated sentence back to the client which it prints. *<u>Sample string sent to the server</u>* Really idc about this stupid server as it is of no use irl but atm, I will design one, tbf to the professor. *<u>Translated string sent back to the client</u>* Really I don't care about this stupid server as it is of no use in real life but at the moment, I will design one, to be fair to the professor. You may consider only the following abbreviations: tbh, ig, tbf, atm, irl, lol, asap, omg, ttyl, idk, nvm
7	Implement a multi-user chat server using TCP as the transport layer protocol.
8	Implement a concurrent Time Server application using UDP to execute the program at a remote server. The client sends a time request to the server which sends its system time

	back. The client then displays the received time value.
9	Develop a concurrent file server that will provide the file requested by the client if it exists. If not, the server sends an appropriate message to the client. The server should also send its process ID (PID) to clients for displaying along with the file contents or with the message.
10	Develop a packet-capturing application using raw sockets.
Cisco's Packet tracer based	
11	Familiarizing router commands (a) Knowing the current mode (user or privileged), switching to privileged mode (b) Switching to configuration mode (c) Obtaining router information such as type, OS, memory stats, interface details etc. (d) Viewing the status of any routing protocols currently configured (e) Showing the routing table (f) Saving the running configuration (g) Viewing the command history (h) Viewing the router clock (i) Viewing the list of hosts (j) Displaying the statistics for all the interfaces (Both detailed and brief views) (k) Knowing the controller type (DTE or DCE) (l) Configuring serial and ethernet interfaces - enabling the interface, setting IP address, mask, and clock rate
	

router	Interface	I
2621	F0/0	1
2501A	E0	1
2501A	S0	1
2501B	E0	1
2501B	S0	1
2501B	S1	1

Figure 1: A sample network along with the interface addresses (all interfaces use a /24 mask)

12	Set up static routing for the network shown in Figure 1. Once the routes are set up, display the routing table and verify the connectivity using **ping**.
13	Implement RIPv2 routing for the network shown in Figure 1. Once the routes are set up, display the routing table and verify the connectivity using **ping**.
14	Implement OSPF routing for the network shown in Figure 1. Once the routes are set up, display the routing table and verify the connectivity using **ping**.
15	You are the network administrator of your college. A small portion of your campus network is shown in Figure 2. You want to allow only Host_B to communicate with the network 172.16.10.0. Verify your settings by the following checks: (a) Pinging Host_A from Host_B (b) Pinging Host_A from Lab_B and Lab_C

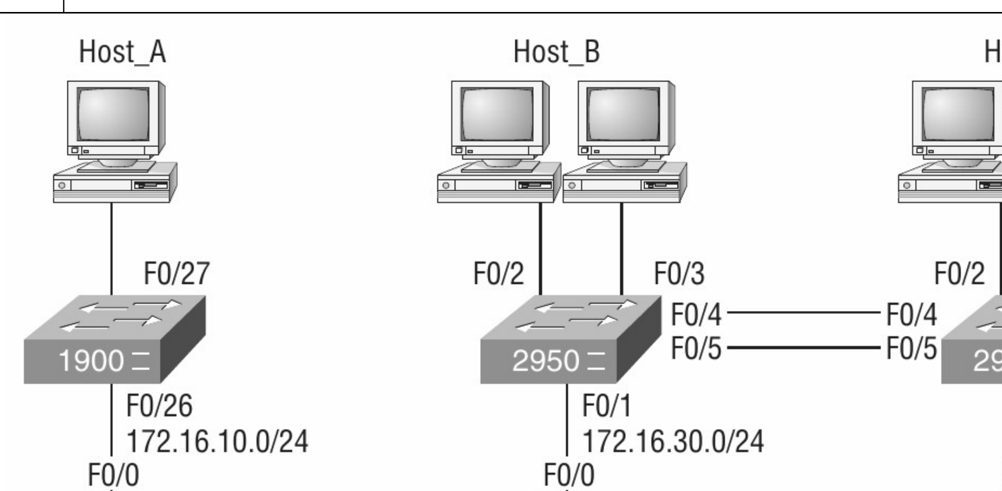


Figure 2: A portion of your college campus network

16	You are the network administrator of your college. The college is assigned a network address 140.80.0.0. There are 20 subnets in your college network. The Central Computing Facility (CCF) resides in the 4th subnet. The department of CSE is organizing an inter-department hackathon for which the registration closed yesterday. The registration was through the hackathon website hosted on a server which is assigned the 7th address in the 16th subnet. As the network administrator, your job now is to block students from accessing the hackathon website from CCF. [The server provides other services than the website hosting as well. Make sure you block only the website access. Other services should not be denied.]
17	Figure 3 shows an IPv6-based network. Interconnect the different subnets using RIPng.

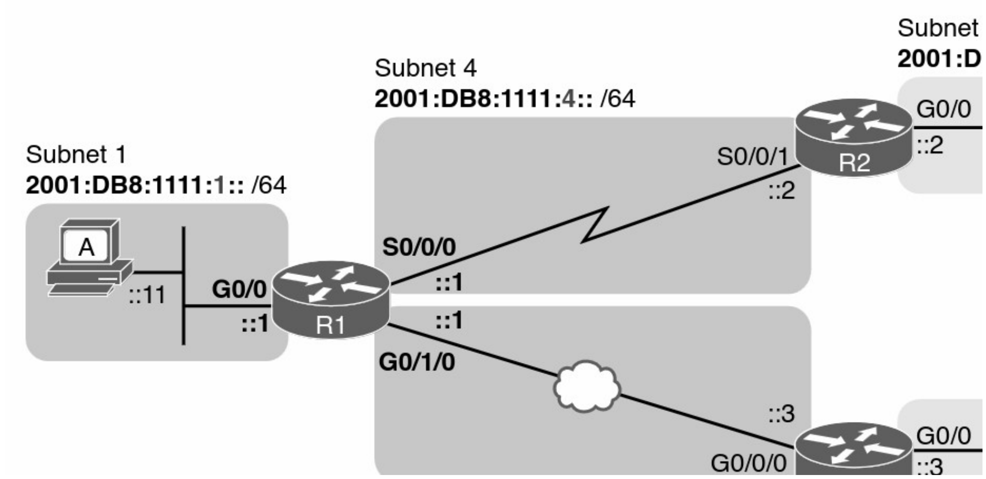


Figure 3: An IPv6 network

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 the working of application layer protocols by analyzing the pertinent headers in actual data packets captured using network monitoring tools.	**K3**
CO2	Exploit the client server paradigm to develop real time networking applications using transport layer protocols.	**K3**
CO3	Employ IPv4 and IPv6 addressing, subnetting to efficiently design networks.	**K3**
CO4	Simulate core networking concepts using a network simulator.	**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		2						3
CO3	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	Unix Network Programming, Volume 1: The Sockets Networking API	W. Richard Stevens, Andrew M. Rudoff, Bill Fenner	Pearson Education	3/e, 2004
2	CCNA Cisco certified network associate study guide Exam 640-802 6	Todd Lammle	Wiley	6/e, 2007
3	Beej's Guide to Network Programming: using Internet Sockets	Brian "beej Jorgensen" Hall	Amazon Digital Services	2019

Reference 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	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/106106091

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

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

SEMESTER S6

COMPILER DESIGN

(Common to CS/CD/CU/CC/CN/CB)

Course Code	**PCCST601**	**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)	PCCST302	**Course Type**	Theory

Course Objectives:

1. To provide a comprehensive understanding of the compiler construction process through its various phases viz. lexical analysis, parsing, semantic analysis, code generation, and optimization.
2. To introduce compiler construction tools like Lex and YACC and use them in lexical analysis and parsing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Compiler Structure, Overview of Translation: The Front End; The Optimizer; The Back End. Scanners - Recognizing Words, Regular Expressions, From Regular Expression to Scanner: FSA (Brush-up only), Implementing Scanners ***Hands-on:*** *Recognizing Words with Lex, Regular Expressions in Lex*	**6**
2	Parsing - Introduction, Expressing Syntax Top-Down Parsing - Transforming A Grammar: Eliminating Left Recursion; Backtrack-free Parsing; Left-Factoring To Eliminate Backtracking, Recursive Descent Parsers, Table-Driven LL(1) Parsers	**10**

3	Bottom-Up Parsing - Shift Reduce Parser, The LR(1) Parsing Algorithm, Building LR(1) Tables, Errors in the Table Construction, Reducing the Size of LR (1) Tables. ***Hands-on:*** *Building a calculator with YACC* Intermediate Representations: An IR Taxonomy, Graphical IRs - Syntax-Related Trees, Graphs; Linear IRs - Stack-Machine Code - Three-Address Code - Representing Linear Codes Syntax-Driven Translation: Introduction, Translating Expressions, Translating Control-Flow Statements	**16**
4	Code generation: Code Shape - Arithmetic Operators, Boolean and Relational Operators, Control-Flow Constructs (Conditional Execution, Loops and Iteration, Case Statements only), Procedure Calls Code Optimization - Introduction, Opportunities for Optimization, Scope Of Optimization Local Optimization: Local Value Numbering, Tree-Height Balancing Regional Optimization: Superlocal Value Numbering, Loop Unrolling Global Optimization: Finding Uninitialized Variables with Live Sets, Global Code Placement	**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	Use lexical analysis techniques to build a scanner for a given language specification. (Cognitive Knowledge Level: Apply)	**K3**
CO2	Construct parse trees for input programs using parsing algorithms and detect syntactic errors. (Cognitive Knowledge Level: Apply)	**K3**
CO3	Develop semantic analysis techniques to check program correctness. (Cognitive Knowledge Level: Apply)	**K3**
CO4	Build intermediate code representations by applying intermediate code generation techniques. (Cognitive Knowledge Level: Apply)	**K3**
CO5	Optimize generated code using code optimization strategies to improve performance. (Cognitive Knowledge Level: Apply)	**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
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	Engineering a Compiler	Keith D. Cooper, Linda Torczon	Elsevier Science	3/e, 2023
2	Lex and YACC	John R. Levine, Tony Mason, Doug Brown	O' Reily	2/e, 1992

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Compilers – Principles Techniques and Tools	Aho A.V., Ravi Sethi and D. Ullman.	Addison Wesley,	2/e, 2010.
2	Compiler Construction - Principles and Practice	Kenneth C Louden	Thomson Learning	1/e, 2007
3	Compiler Design in C	Allen Holub	Prentice-Hall software series	1/e, 1990
4	Modern Compiler Implementation in C	Andrew W. Appel	Cambridge University Press	2/e, 2004

Video Links (NPTEL, SWAYAM…)

Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/106/105/106105190/

SEMESTER S6

ADVANCED COMPUTING SYSTEMS

Course Code	PCCST602	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)	GAEST203 PBCST404 PCCST403	Course Type	Theory

Course Objectives:

1. To introduce the computational models prevalent in modern distributed systems.
2. To provide the concepts of computer clusters, virtualization, cloud computing, microservices and containers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Distributed System Models and Enabling Technologies:-** **The age of internet computing:-** – High performance and high throughput computing, Centralized, Parallel, Distributed and Cloud Computing. Design objectives of HPC and HTC. IoT and Cyber Physical systems. **Technologies for Network-Based systems:-** Multicore CPUs and Multithreading Technologies. GPU Computing. Virtual Machines. **System models for distributed and cloud computing:-** Clusters, Grids, P2P Systems, Clouds.	7
2	**Computer Clusters :-** **Clustering for massive parallelism:-** Design objectives, Design Issues – Ensuring high availability, Cluster families. Cluster Architecture. GPU Clusters – Components. **Computer Clusters** – Design principles – Single System Image features. High availability through redundancy. Fault tolerant cluster configurations, checkpoint and recovery techniques. **Cluster Job and Resource Management:-** – Job Scheduling methods, Job management system – administration, job types, migration schemes.	11

3	**Virtualization:-** Introduction, Virtualization at different levels and their comparison. VMM design requirements, OS level virtualization. Virtualization structures and mechanisms. CPU, Memory and I/O Virtualization. Virtual clusters and resource management. Live VM migration steps, migration of memory, files and network resources.	**9**
4	**Cloud Computing, Microservices and Containers:-** **Cloud Computing and Service models:-** Private, Public and Hybrid clouds. Cloud Design objectives and Cost Model. Infrastructure-as-a-Service, Platform-as-a-Service, Software-as-a-Service. **Microservices:-** – Introduction, advantages and disadvantages. Interprocess Communication – Types of interactions, Protocol, Standard and Message Format, Discovery Service, API Gateway, Service Registry **Containers** – Comparison of Virtual Machines and Containers. Introduction to Docker. Case Study - Docker Containers – Architecture, Components, Examples.	**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 the key enabling technologies for network-based systems, including multicore CPUs, multithreading, GPU computing, and virtualization, and how these technologies contribute to the performance and efficiency of distributed systems.	**K3**
CO2	Use computer cluster architectures, ensuring high availability, fault tolerance, and massive parallelism. They will also learn to implement effective job and resource management strategies within cluster environments.	**K4**
CO3	Explain various levels of virtualization, including CPU, memory, and I/O virtualization, and understand the design requirements and mechanisms of Virtual Machine Monitors (VMMs).	**K2**
CO4	Articulate the differences between private, public, and hybrid cloud models, and understand the design objectives and cost considerations associated with different cloud models.	**K4**
CO5	Explain microservices architecture, its advantages and disadvantages, and the principles of interprocess communication. They will also learn about the role of containers in modern computing, with a specific focus on Docker, including its architecture, components, and practical applications through case studies.	**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							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	Distributed and Cloud Computing: From Parallel Processing to the Internet of Things	Kai Hwang,Geoffrey C. Fox, Jack Dongarra	Morgan Kaufmann	1/e, 2013
2	Microservices and Containers	Parminder Singh Kocher	Addison-Wesley	1/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Patterns of Distributed Systems	Unmesh Joshi	Pearson Education	1/e, 2024
2	Cluster Computing, Grid Computing, Cloud and Virtualization	Deepa Kalavikatte	DSK Publisher	1/e, 2020
3	Cloud and Distributed Computing: Algorithms and Systems	Rajiv Misra, Yashwant Singh Patel	Wiley	1/e, 2020

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc24_cs118/preview
2	https://onlinecourses.nptel.ac.in/noc24_cs131/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

DEEP LEARNING

Course Code	PECST632	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 the learner an understanding about the foundations of Deep Learning architecture and applications
2. To equip the learner with the necessary skills to set-up neural network architecture and use it for real time problem solution.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient descent, Curse of Dimensionality, Deep feedforward networks.	8
2	Machine Learning and Deep learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.	9
3	CNN-Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, Alexnet – Applications. Recurrent Neural Networks, Bidirectional RNNs, Encoder – decoder sequence to sequence architectures – BPTT for training RNN, Long Short Term Memory Networks.	10
4	Computer Vision - Speech Recognition - Natural language Processing, Case studies in classification, Regression and deep networks. Regularized Autoencoder, stochastic Encoders and Decoders, Contractive Encoders. GAN and its variants	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	Construct fundamental neural network architectures and algorithms, including Multilayer Perceptron and Back-propagation	**K3**
CO2	Apply advanced techniques such as Stochastic Gradient Descent and address the Curse of Dimensionality in the context of deep learning models.	**K3**
CO3	Build various deep learning architectures, including feed-forward networks, Convolutional Neural Networks (CNNs), and their applications in real-world problems.	**K3**
CO4	Develop and utilize Recurrent Neural Networks (RNNs) and Long Short-Term Memory Networks (LSTMs) for sequence modeling and natural language processing tasks.	**K3**
CO5	Apply unsupervised learning techniques such as Autoencoders and Generative Adversarial Networks (GANs) to solve complex problems in computer vision and speech recognition.	**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	2		3							3
CO3	3	3	2		3							3
CO4	3	3	2		3							3
CO5	3	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	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	1/e, 2016
2	Neural Networks and Deep Learning	Michael A. Nielsen	Determination Press,	2/e, 2015
3	Learning Deep Architectures for AI	Yoshua Bengio	Now Publishers Inc	1/e, 2009
4	Deep Learning: A Practitioner's Approach	Josh Patterson, Adam Gibson	O'Reilly	1/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks	Umberto Michelucci	Apress	1/e, 2018
2	Deep Learning with Keras	Antonio Gulli, Sujit Pal	Packt	1/e, 2017
3	Deep Learning with Python	Francois Chollet	Manning	1/e. 2017
4	Deep Learning	M Gopal	Pearson	1/e, 2022
5	The Science of Deep Learning	Iddo Drori	Cambridge Univeristy Press	1/e, 2021

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105215 (Week 4)
2	https://nptel.ac.in/courses/106105215 (Week 5)
3	https://nptel.ac.in/courses/106105215 (Week 8)
4	https://nptel.ac.in/courses/106105215 (Week 10,11 and 12)

SEMESTER S6

WIRELESS & MOBILE COMPUTING

(Common to CS/CM/AM)

Course Code	**PECST633**	**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 learners to acquire advanced concepts on wireless communication systems and mobile ad-hoc networks.
2. To impart the basics of mobile computing, architecture of wireless transmission systems and next generation networks
3. To Learn the communication protocols, various architectures and security features used in mobile computing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Wireless LAN - Advantages, Design goals, Applications, Infrastructure Vs Ad-hoc mode, IEEE 802.11 System Architecture, Protocol Architecture, Physical layer, Medium Access Control layer, HIPERLAN-1, Bluetooth	9
2	Introduction to mobile computing – Functions, Middleware and Gateways, Application and services. Mobile computing architecture – Internet: The Ubiquitous network, Three-tier architecture for Mobile Computing, Design considerations for mobile computing.	8
3	Spread spectrum – Direct sequence, Frequency hopping. Medium Access Control – Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA). Satellite Systems – Basics, Applications, Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Routing, Localization, Handover. Telecommunication Systems - Global System for Mobile Communication (GSM)	9

4	Mobile network layer – Mobile Internet Protocol (IP), Dynamic Host Configuration Protocol (DHCP), Mobile ad-hoc networks – Routing, Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV), Ad-hoc routing protocols; Mobile transport layer – Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP; Security issues in mobile computing - Information security, Security techniques and algorithms, Security models.	**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 various mobile computing applications, services, design considerations and architectures	**K2**
CO2	Describe the various technology trends for next generation cellular wireless networks and use the spreading concept on data transmission	**K2**
CO3	Summarize the architecture of various wireless LAN technologies	**K2**
CO4	Identify the functionalities of mobile network layer & transport layer and various security issues in mobile computing	**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	Mobile Computing Technology - Application and Service Creation	Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal	McGraw Hill	2/e, 2010
2	Mobile Communications	Jochen Schiller	Pearson	2/e, 2000
3	Fundamentals of 5G Mobile Networks	Jonathan Rodriguez	Wiley	1/e, 2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mobile Computing	Raj Kamal	Oxford University Press	2/e, 2011
2	Computer Networks,	Andrew S. Tanenbaum	PHI	3/e, 2003
3	Wireless Communications Principles and Practice	Theodore S. Rappaport	PHI	2/e, 2004
4	Fundamentals of Networking and Communication	Curt M. White	Cengage learning	7/e, 2013

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106147/

SEMESTER S6

ADVANCED DATABASE SYSTEMS

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

Course Code	**PECST634**	**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 fundamentals of data modeling, query processing, and design in advanced databases and study the working principles of distributed databases.
2. To learn emerging databases such as XML and NoSQL.
3. To enable the student to use tools, methodologies, and skills for working successfully with databases in today's global, data driven business model.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Query Processing and Optimization - Measures of query cost, Algorithms for Selection with cost analysis, Algorithms for Join with cost analysis, Evaluation of expressions; Heuristics in Query Optimization - Optimization of Relational Algebra expressions; Physical Database Design and Tuning - Introduction to Physical Database Design, Overview of Database Tuning, Tuning the Conceptual Schema, Tuning Queries and Views; Impact of Concurrency.	9
2	Distributed Databases - Distributed Systems, Introduction, Architecture, Distributed Database Concepts, Distributed Data Storage, Distributed Transactions, Commit Protocols, Concurrency Control; Query Processing and Decomposition - Query Processing Objectives, Characterization of Query Processors, Layers of Query Processing, Query Decomposition, Localization of Distributed Data.	9
3	XML and Non Relational Databases - Introduction to Semi Structured Data and XML Databases, XML Data Model – XSD, XML: DTD and XML	9

	Schema, XML Presentation, XPath Queries, XQuery; NoSQL Databases - CAP Theorem, Document based; MongoDB Operation - Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment; Cassandra - Data Model, Key Space, Table Operations, CRUD Operations.	
4	Graph database - Introduction, Data Modelling with Graphs, Building a Graph Database application, Data Modeling, Predictive Analysis with Graph Theory; Depth and Breadth First Search; Path-Finding with Dijkstra's Algorithm; Graph Theory and Predictive Modeling	**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	Apply various measures for query processing and optimization, and apply techniques to tune database performance.	**K3**
CO2	Explain the architecture and fundamental concepts of distributed databases.	**K2**
CO3	Utilize semi-structured data, XML, and XML queries for effective data management	**K3**
CO4	Utilize NoSQL database systems to manage and manipulate data in real-time applications	**K3**
CO5	Develop advanced skills in graph database concepts, covering data modeling, application building, and the application of graph theory for predictive analysis and modeling.	**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	2	2									3
CO3	3	2	2		2							3
CO4	3	2	2		2							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	Ramez Elmasri, Shamkant B. Navathe	Pearson	7/e, 2017
2	Database System Concepts	A. Silberschatz, H. Korth, S. Sudarshan	McGraw-Hill	7/e, 2021
3	Database Management Systems	R. Ramakrishnan, J. Gehrke	McGraw Hill	3/e, 2018
4	Graph Databases	Ian Robinson, Jim Webber & Emil Eifrem	O'Reilly	2/e, 2015
5	Database Systems	T. M. Connolly, C. Begg	Pearson	6/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of Database Management: Practical Guide to Storing, Managing and Analyzing Big and Small Data	W. Lemahieu, S. vanden Broucke and B. Baesens	Cambridge University Press	1/e, 2018
2	Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems	M. Kleppmann	O'Reilly	1,e2017
3	Database Systems: The Complete Book	Hector Garcia-Molina Jeffrey D. Ullman Jennifer Widom	Prentice Hall	2/e, 2009
4	Next generation databases: NoSQL, newSQL, and big data. Apres.	Guy Harrison	Apress	1/e, 2015
5	Foundations of Multidimensional and Metric Data Structures	Hanan Samet	Morgan Kaufmann	1/e, 2006

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	CAP Theorem https://nptel.ac.in/courses/106104189
2	Advanced database Queries https://archive.nptel.ac.in/courses/106/104/106104021
3	Database design https://archive.nptel.ac.in/courses/106106093/
4	Introduction to modern application development https://archive.nptel.ac.in/courses/106/106/106106156

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 the second derivative,Scale in Image Processing, Canny Edge Detection,	**8**

	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

FUNDAMENTALS OF CRYPTOGRAPHY

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

Course Code	**PECST637**	**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 foundational understanding of mathematical concepts in cryptography,
2. To gain comprehensive knowledge of cryptographic methods.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Number Theory - Divisibility and The Division Algorithm, The Euclidean Algorithm, Modular Arithmetic : The Modulus, Properties of Congruences, Modular Arithmetic Operations, The Extended Euclidean Algorithm, Primitive Roots, Existence of Primitive Roots for Primes, Fermat's Theorem, Euler's Totient Function, Euler's Theorem, Testing for Primality : Miller–Rabin Algorithm, A Deterministic Primality Algorithm, Discrete Logarithms, Chinese Remainder Theorem.	**10**
2	Security Attacks; Security Services; Security Mechanisms; Fundamental Security Design Principles; Cryptography - Symmetric Cipher Model, Substitution Techniques, Transposition techniques; Traditional Block Cipher Structure.	**8**
3	The Data Encryption Standard - DES Encryption & Decryption, Avalanche Effect, Strength of DES; Advanced Encryption Standard - AES Structure; Stream Ciphers; RC4; Principles of Public-Key Cryptosystems - Public-Key Cryptosystems, Applications for Public-Key Cryptosystems,	**10**

	Requirements for Public-Key Cryptography, The RSA Algorithm, Description of the Algorithm; Diffie–Hellman Key Exchange..	
4	Cryptographic Hash Functions - Applications of Cryptographic Hash Functions, Secure Hash Algorithm (SHA), SHA-3; MAC; MD5; Digital Signatures.; Key Management and Distribution - Symmetric Key Distribution; X.509 certificates; PKI.	**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 number theory concepts in data security	**K3**
CO2	Explain the cryptographic concepts and apply the classical encryption methods for data confidentiality	**K3**
CO3	Describe the symmetric and asymmetric ciphers used for information security	**K2**
CO4	Explain the algorithms used for authentication and integrity	**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								2
CO2	3	3	3	2								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	Cryptography & Network Security: Principles and practice	William Stallings	Pearson	7/e, 2017

Reference 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	A Classical Introduction to Cryptography: Applications for Communications Security	S. Vaudenay	Springer	1/e, 2009
4	Introduction to Cryptography: Principles and Applications	H. Delfs, H. Knebl	Springer-Verlag	1/E, 2002

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

QUANTUM COMPUTING

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

Course Code	**PECST638**	**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 an understanding of quantum computing against classical computing.
2. To understand fundamental principles of quantum computing, quantum algorithms and quantum information.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of Basics Concepts Review of linear algebra, Principles of quantum mechanics, Review of Information theory, Review of Theory of Computation. [Text 1 - Ch 1, 2; Text 2, Ch 11.1, 11.2]	**9**
2	Introduction to Quantum Information Qubit – Bloch sphere representation, Multiple qubit states, Quantum logic gates – single qubit and multi-qubit, Quantum circuits, Density matrix, Quantum entanglement. [Text 1 - Ch 3, 4; Text 2 - Ch 4]	**9**
3	Quantum Algorithms: - Simple Quantum Algorithms, Quantum Integral Transforms, Grover's Search Algorithm and Shor's Factorization Algorithm. [Text 1 - Ch 5,6,7,8]	**9**
4	Quantum Communication: - Von Neumann entropy, Holevo Bound, Data compression, Classical information over noisy quantum channels, Quantum information over noisy	**9**

	quantum channels, Quantum Key Distribution, Quantum Communication protocols [Text 2 - Ch 11.3, Ch 12.1 - 12.5]	

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 concept of quantum computing against classical computing.	**K2**
CO2	Illustrate various quantum computing algorithms.	**K2**
CO3	Explain the latest quantum communication & protocols.	**K2**
CO4	Experiment with new algorithms and protocols for quantum computing.	**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									2
CO2	3	2	3									2
CO3	3	2	3									2
CO4	3	2	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	Quantum Computing : From Linear Algebra to Physical Realizations	Mikio Nakahara Tetsuo Ohmi	CRC Press	1/e, 2008
2	Quantum Computation and Quantum Information	Michael A. Nielsen & Isaac L. Chuang	Cambridge University Press	1/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Quantum Computing for Programmers	Robert Hundt	Cambridge University Press	1/e, 2022
2	Quantum Computing for Everyone	Chris Bernhardt	MIT Press	1/e, 2020
3	An Introduction to Practical Quantum Key Distribution [paper]	Omar Amer Vaibhav Garg Walter O. Krawec	IEEE Aerospace and Electronic Systems Magazine	March 2021
4	Quantum communication [paper]	Nicolas Gisin & Rob Thew	Nature Photonics	March 2007

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106232/
2	https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-cy31/

SEMESTER S6

RANDOMIZED ALGORITHMS

Course Code	**PECST639**	**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)	GAMAT301 PCCST302 PCCST303 PCCST502	**Course Type**	Theory

Course Objectives:

1. To equip with the knowledge and skills to design and analyze algorithms that leverage randomness to improve performance, solve complex problems, and achieve better average-case or worst-case guarantees.
2. To provide a deep understanding of advanced randomization techniques and their applications in various domains, including hashing, graph algorithms, probabilistic method, and complexity theory.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Randomization - Introduction to randomized algorithms, Probabilistic analysis and expectations, Benefits and applications of randomization. (Text 1 - Chapter 1) Probability Review - Basic probability theory, Random variables and distributions, Linearity of expectation. (Text 2 - Chapters 1, 2) Basic Randomized Algorithms - Randomized quicksort, Randomized selection, Randomized data structures. (Text 3 - Sections 5.3, 9.2)	9
2	Randomized Graph Algorithms - Randomized algorithms for graph problems, Minimum cut problems, Randomized algorithms for network flows. (Text 1 - Chapters 5, 6) Hashing and Randomized Data Structures - Universal and perfect hashing, Skip lists, Bloom filters. (Text 3 - Chapter 11)	9

	Markov Chains and Random Walks - Introduction to Markov chains, Random walks on graphs, Applications in randomized algorithms. (Text 2 - Chapters 6, 7)	
3	The Probabilistic Method - Basics of the probabilistic method, Linearity of expectation, First and second-moment methods. (Text 4 - Chapters 1, 2) Chernoff Bounds and Concentration Inequalities - Markov's inequality, Chebyshev's inequality, Chernoff bounds, Applications of concentration inequalities. (Text 1 - Chapter 4)	**9**
4	Randomized Rounding and Martingales - Randomized rounding techniques, Applications in approximation algorithms, Introduction to martingales, Azuma's inequality. (Text 5 - Chapter 14) Randomized Complexity Classes - RP, ZPP, and BPP, Relationships between complexity classes, Amplification and derandomization techniques (Text 6 - Chapter 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	Demonstrate a strong understanding of the basics of randomized algorithms, including probabilistic analysis, expectations, and the benefits of randomization	**K3**
CO2	Illustrate basic randomized algorithms, such as randomized quicksort, selection, and data structures, and evaluate their performance against deterministic alternatives.	**K3**
CO3	Apply advanced randomized techniques, including randomized graph algorithms, hashing, and Markov chains, to address complex graph and data structure problems.	**K3**
CO4	Show expertise in probabilistic methods, including Chernoff bounds, concentration inequalities, and randomized rounding, and use these methods to solve approximation and analysis problems in algorithms.	**K3**
CO5	Understand and apply concepts related to randomized complexity classes, such as RP, ZPP, and BPP, and explore amplification and derandomization 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									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	Randomized Algorithms	Rajeev Motwani and Prabhakar Raghavan	Cambridge University Press	1/e, 2004
2	Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis	Michael Mitzenmacher and Eli Upfal	Cambridge University Press	3/e, 2017
3	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	The MIT Press	4/e, 2023
4	The Probabilistic Method	Noga Alon and Joel H. Spencer	Wiley-Blackwell	4/e 2016
5	Approximation Algorithms	Vijay V. Vazirani	Springer Nature (SIE)	2/e, 2013
6	Computational Complexity: A Modern Approach	Sanjeev Arora and Boaz Barak	Cambridge University Press	1/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Concentration of Measure for the analysis of randomized algorithms	Devdatt Dubhashi and Alessandro Panconesi	Cambridge University Press	1/e, 2012
2	The design of approximation algorithms	David Williamson and David Shmoys	Cambridge University Press	1/e, 2011
3	Algorithms	Robert Sedgewick and Kevin Wayne	Addison-Wesley	4/e, 2023

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/103/106103187/

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

FUNDAMENTALS OF CYBER SECURITY

Course Code	PBCST604	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 security terminologies along with familiarization of web-based attacks and the vulnerability assessment tools for real time practices
2. To help learners to perform network analysis and learns the measures to handle security bleaches at the system level

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Information Security** Introduction, Threats to Information Systems, Cyber Security and Security risk analysis, Information Gathering- Reconnaissance, Reco-ng, Software Vulnerabilities- Buffer Overflow, Stack Overflow, Format String, Vulnerability Assessment and Penetration Testing- Burpsuite, Metasploit.	**10**
2	**Web Security** Web Attacks- SQL Injection Attacks, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), Domain Name System- Security Issues with DNS, DNS attacks, DNSSEC, OWASP ZAP, WebGoat, Damn Vulnerable Web Application (DVWA), Website Mirroring, HTTRACK, Email Security- Email risks, Protocols, Operating safely when using email.	**12**
3	**Network Security:** Network Security Terminologies, DoS, DDoS, ARP Spoofing and Session	**12**

	Hijacking, Capturing the Network Traffic- Promiscuous Mode, Flooding, DHCP Redirection, Redirection and Interception with ICMP. Port Scanning- TCP and UDP, Port Scanning Tools- Nmap, SuperScan, Wireshark- Analysing and Filtering Traffic	
4	**System Security:** Windows Security: Attacks against windows system, Installing applications, Authentication and access control, Upgrades and Patches, Operating Windows safely, Windows Defender Firewall. Linux Security- Attacks in Linux system, Physical security, Controlling the configuration, Authentication and access control, Upgrades and Patches, Operating Linux safely, SELinux.	**10**

Suggestion on Project Topics

Network Traffic Monitoring and Analysis using Wireshark:

- Development: Capture network traffic in a controlled environment using Wireshark.
- Security Analysis & Fixing: Analyze captured traffic to identify potential vulnerabilities (e.g., plaintext passwords) and recommend security enhancements.

OWASP ZAP (Zed Attack Proxy) Security Testing Framework:

- Development: Create a web application with some common vulnerabilities.
- Security Analysis & Fixing: Use OWASP ZAP to perform security testing on the application, identify vulnerabilities, and then fix these issues by implementing secure coding practices.

Web Application Vulnerability Identification Using Burp Suite:

- Development: Develop a simple web application with common security flaws, such as SQL injection, XSS, and broken authentication mechanisms.
- Security Analysis & Fixing: Use Burp Suite to scan the application, identify vulnerabilities, and analyze the attack surface. Afterward, secure the application by fixing these vulnerabilities and re-running the scan to verify the fixes.

Penetration Testing Framework Using Metasploit:

- Development: Set up a vulnerable virtual environment using tools like Metasploitable or create your own vulnerable system or network services.
- Security Analysis & Fixing: Use Metasploit to exploit the system, demonstrate various attacks like privilege escalation, and then apply patches, configuration changes, and security best practices to mitigate the discovered vulnerabilities.

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	Use assessment tools for vulnerability testing	**K3**
CO2	Use various security tools to study web based attacks	**K3**
CO3	Identify the network based attacks using network monitoring tools	**K3**
CO4	Illustrate the system security measures used for windows and Linux operating systems	**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	3		3							3
CO2	2	2	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	Build Your Own Security Lab	Michael Gregg	Wiley	1/e, 2008
2	Network security and Cryptography	B. Menezes	Cengage	1/e, 2010
3	Shellcoder's Handbook: Discovering and Exploiting Security Holes	Chris Anley, John Heasman, Felix Lindner, Gerardo Richarte	Wiley	2/e,2007
4	Network Security Bible	Eric Cole, Ronald Krutz, James W Conley	Wiley	1/e, 2010

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	Tata McGraw-Hill.	3/e,2015
2	The Complete Reference: Information Security	Mark Rhodes-Ousley	McGraw-Hill	2/e,2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_cs127/preview
2	https://onlinecourses.nptel.ac.in/noc24_cs85/preview
3	https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
4	

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

SYSTEMS LAB

Course Code	**PCCSL607**	**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 introduce the fundamental concepts of compiler design, including lexical analysis, syntax analysis, and code generation.
2. To equip students with practical skills to design and implement the components of a compiler using tools like LEX and YACC.
3. To teach students the basic and advanced techniques of virtual machine instantiation and management using open-source hypervisors / public cloud platforms.

Expt. No.	Experiments
1	Design and implement a lexical analyzer using C language to recognize all valid tokens in the input program. The lexical analyzer should ignore redundant spaces, tabs and newlines. It should also ignore comments.
2	Write a lex program to display the number of lines, words and characters in an input text.
3	Generate a YACC specification to recognize a valid arithmetic expression that uses operators +, – , *,/ and parenthesis.
4	Implementation of Calculator using LEX and YACC
5	Convert the BNF rules into YACC form and write code to generate abstract syntax tree.
6	Write a program to find First and Follow of any given grammar.
7	Design and implement a recursive descent parser for a given grammar.
8	Construct a Shift Reduce Parser for a given language.
9	Write a program to perform constant propagation.

10	Implement Intermediate code generation for simple expressions.
11	Implement the back end of the compiler which takes the three address code and produces assembly language instructions that can be assembled and run using a corresponding assembler. The target assembly instructions can be simple move, add, sub, jump etc.
12	Instantiation of VMs with image file using open-source hypervisors / public cloud platforms.
13	Virtual machine Cluster set up using open-source hypervisors / public cloud platforms.
14	Setting host name for virtual machine nodes in cluster and ssh set up for remote login.
15	Copy a file from one virtual machine to another virtual machine.

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	Implement lexical and syntax analyzer using the tools LEX and YACC	**K3**
CO2	Develop Top-Down and Bottom-Up parsers.	**K3**
CO3	Implement intermediate code for expressions.	**K3**
CO4	Experiment with a cluster of virtual machines in a virtualized environment.	**K3**
CO5	Demonstrate the data sharing and communication between virtual machines.	**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	2	2	3	3	3					2		3
CO2	2	2	3	3	3				2	2		3
CO3	2	2	3	3	3				2	2		3
CO4			3	3	3				2	2		3
CO5					3				2	2		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	Engineering a Compiler	Keith D. Cooper Linda Torczon	Katey Birtcher	3/e, 2023
2	Lex and Yacc	John R Levine, Tony Mason& Doug Brown	O'Reilly Media, Inc	2/e, 2013
3	Distributed and Cloud Computing: From Parallel Processing to the Internet of Things	Kai Hwang, Jack Dongarra, Geoffrey C. Fox	Morgan Kaufman	1/e, 2018
4	Virtual Machines	Manan Shah, Charusmita Shah	Lambert Academic Publishing	1/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Compilers Principles Techniques and Tools	Aho A Ravi Sethi and J D Ullman	Addison Wesley	2/e, 2013
2	Compiler Construction Principles and Practice	Kenneth C Louden	Cenage Learning Indian Edition	1/e, 2007
3	System programming and operating system	D M Dhamdhare	Tata McGraw Hill & Company	1/e, 2013
4	The Theory and Practice of Compiler Writing	Tremblay and Sorenson	Tata McGraw Hill & Company	1/e, 1985

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105190/
2	https://www.virtualbox.org/

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

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 **Asynchronous JavaScript and XML -** AJAX : Making Asynchronous	9

	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 -	9

	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.	

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

EMBEDDED SYSTEMS

(Common to CS/CM/AM)

Course Code	**PECST746**	**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 strong foundation in embedded systems, including the architecture, components, and design principles.
2. To equip learners with the skills needed to design, develop, and integrate embedded systems using microcontrollers, especially 8051.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Embedded Systems:-** Definition of Embedded System, Embedded Systems Vs General Computing Systems, History, Classification, and, Major application areas of Embedded Systems, Purpose of Embedded Systems; Typical system - Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System components; Characteristics and Quality attributes of Embedded Systems.	**9**
2	**Designing with 8051 : -** Factors to be Considered in Selecting a Controller, Why 8051 Microcontroller, Designing with 8051, The 8052 Microcontroller, 8051/52 Variants; Different Addressing Modes Supported by 8051; The 8051 Instruction Set; Fundamental Issues in Hardware Software Co-Design; Computational Models in Embedded Design; Introduction to Unified Modelling Language (UML); Hardware Software Trade-offs.	**9**
3	**Design and Development :-** Hardware Design and Development - VLSI and Integrated Circuit Design, Recap of Electronic Design Automation (EDA) Tools, The PCB Layout Design, Printed Circuit Board (PCB) Fabrication; Firmware Design and	**9**

	Development - Embedded Firmware Design, Embedded Firmware Development Languages, Programming in Embedded C.	
4	**Integration and Testing of Embedded Hardware and Firmware :-** Integration of Hardware and Firmware, Boards Bring up, The Embedded System Development Environment - The Integrated Development Environment (IDE), Types of files generated on CrossCompilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.	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 core components, characteristics, and applications of embedded systems, and their difference from general computing systems	**K2**
CO2	Apply knowledge of the 8051 microcontroller, its architecture, instruction set, and addressing modes, to design and develop embedded systems.	**K3**
CO3	Develop embedded firmware using appropriate languages, and understand the key concepts in hardware-software co-design.	**K3**
CO4	Use the integration of embedded hardware and firmware, and utilize tools for system testing and validation	**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	Introduction to Embedded Systems	Shibu K V	McGraw Hill	2/e, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Embedded Systems Architecture, Programming and Design	Raj Kamal	McGraw Hill	3/e, 2017
2	Embedded Systems Design- A Unified Hardware/Software Introduction	Frank Vahid, Tony Givargis	Wiley	1/e, 2006
3	Embedded Systems	Lyla B Das	Pearson	

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://nptel.ac.in/courses/108102045

SEMESTER S7

BLOCKCHAIN AND CRYPTOCURRENCIES

Course Code	**PECST747**	**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)	PBCST604	**Course Type**	Theory

Course Objectives:

1. To provide a comprehensive understanding of blockchain architecture, elements, types (public, private, consortium), and industry applications.
2. To help the learners to assess strengths and weaknesses of various blockchain consensus mechanisms (e.g., Proof of Work, Proof of Stake, Practical Byzantine Fault Tolerance).
3. To enable learners to use blockchain real-world applications in government, healthcare, finance, and supply chain management, identifying implementation opportunities and challenges.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Blockchain Fundamentals** Introduction, Blockchain Definition, Deciphering the Blockchain, Features and challenges of Blockchain, Applications in Blockchain, Decentralisation, Distributed Ledger Technology, Blockchain variants.	**7**
2	**Cryptography in Blockchain and Consensus Mechanisms** Concept of Hashing, Creating a Transaction Hash, Merkle Trees - Importance of Merkle tree, Chaining of Blocks, Building the Network, Accessing the network, Types of Wallets. Need for Consensus, Two Generals' Problem, Byzantine Generals' Problem, Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT)- working, Paxos and Raft Algorithms.	**9**
3	**Cryptocurrencies - Bitcoin and Ethereum** Bitcoin: Components, Nodes in Bitcoin network, Transactions and memory	**10**

	pools, Proof of Work-Mining Cryptocurrencies, Hard and Soft Forks, Tracking Bitcoins-Unspent Transaction Outputs. Ethereum: Transition from Bitcoin to Ethereum, Concept of Ethereum World Computer, Ethereum Virtual Machine, Ethereum Network, Transition from PoW to PoS- Working of PoS, Smart Contracts in Ethereum, Decentralised Applications in Ethereum, Tools used in Ethereum.	
4	**Blockchain Ethereum Platform using Solidity and Use Cases in Blockchain :-** Solidity Language - Remix IDE, Structure of a Smart Contract Program, Modifiers, Events, Functions, Inheritance, External Libraries, Error Handling. Permissioned Blockchains, Introduction to Hyperledger Foundation, Hyperledger Distributed Ledger frameworks, Hyperledger Fabric. Use Cases in Blockchain - Finance, Education, Government, Healthcare and Supply Chain Management.	**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 fundamental concepts of Blockchain technology.	**K2**
CO2	Illustrate the cryptographic building blocks of Blockchain technology and understand the consensus mechanisms.	**K2**
CO3	Explain the concepts of cryptocurrency bitcoin, mining processes, and wallet management.	**K2**
CO4	Use the concepts of Ethereum platform and understand the use cases of blockchain technology	**K3**
CO5	Develop skills in designing and deploying simple applications using Solidity language.	**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		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	Blockchain Technology: Algorithms and Applications	Asharaf S, Sivadas Neelima, Adarsh S, Franklin John	Wiley	1/e, 2023
2	BlockchainTechnology	Chandramauoli Subrahmaniyan, Asha A George	Universities Press.	1/e ,2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Blockchain Technology - Concepts and Applications.	Kumar Saurabh, Ashutosh Saxena	Wiley	1/e, 2020
2	Mastering Blockchain	Imran Bashir	Packt Publishing	1/e, 2020
3	Solidity programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain	Ritesh Modi	Packt Publishing	1/e, 2018.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtube.com/playlist?list=PLrKK422S1aMma8lDA2JJjEUpC2ycuApuC&si=1OXTYDEZ4A5M8M4Q
2	https://youtube.com/playlist?list=PLHRLZtgrF2jl8yqucJsMFqh5XpRLTgCI4
3	https://youtube.com/playlist?list=PL6gx4Cwl9DGBrtymuJUiv9Lq5CAYpN8Gl
4	https://youtube.com/playlist?list=PLWUCKsxdKl0oksYr6IG_wRsaSUySQC0ck

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 databases, Special topics in Real-Time systems.	**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 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

APPROXIMATION ALGORITHMS

Course Code	**PECST749**	**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 a deep understanding of approximation algorithms, including their design, analysis, and application to various optimization problems.
2. To equip the skills to evaluate and analyze the efficiency and effectiveness of approximation techniques. This includes understanding performance metrics, approximation ratios, and the theoretical limits of approximation algorithms, as well as applying these techniques to complex problems in network design, combinatorial optimization, and other areas.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Approximation Algorithms - Introduction to approximation algorithms, Performance guarantees: approximation ratio and factor, Examples of approximation problems. (Chapter 1) Greedy Algorithms - Introduction to greedy algorithms, Set cover problem, Vertex cover problem. (Chapter 2) Local Search Algorithms - Local search techniques, k-Median and k-Center problems, Analysis of local search algorithms. (Chapter 3)	9
2	Linear Programming Relaxation - Introduction to linear programming (LP), LP relaxation of combinatorial problems, Primal-dual method. (Chapter 4) Rounding Techniques - Randomized rounding, Deterministic rounding, Applications to various problems. (Chapter 5) Integer Programming and Cutting Planes - Integer programming formulation, Cutting plane methods, Applications in network design. (Chapter 6)	9
3	Semi-Definite Programming - Introduction to semi-definite programming (SDP), Goemans-Williamson algorithm for MAX-CUT, Other applications of SDP. (Chapter 8) Approximation Schemes - Polynomial-time approximation schemes (PTAS),	9

	Fully polynomial-time approximation schemes (FPTAS), Examples: knapsack problem, Euclidean TSP. (Chapter 9)	
4	Inapproximability Results - Introduction to inapproximability, Reductions and hardness of approximation, PCP theorem and its implications. (Chapter 10) Network Design Problems - Steiner tree problem, Traveling Salesman Problem (TSP), Multicommodity flow problem. (Chapter 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 =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 a foundational understanding of approximation algorithms, including performance guarantees, approximation ratios, and common examples of approximation problems.	**K3**
CO2	Illustrate the principles of greedy algorithms and apply them to solve classic problems such as the set cover and vertex cover problems, understanding their efficiency and limitations.	**K3**
CO3	Show proficiency in local search algorithms and linear programming relaxation methods, including the primal-dual method, and apply these techniques to solve combinatorial optimization problems.	**K3**
CO4	Understand and implement rounding techniques, both randomized and deterministic, and learn the basics of semi-definite programming (SDP), including algorithms like Goemans-Williamson for the MAX-CUT problem.	**K3**
CO5	Demonstrate polynomial-time approximation schemes (PTAS) and fully polynomial-time approximation schemes (FPTAS), and explore inapproximability results, including reductions, hardness of approximation, and the PCP theorem.	**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
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	Approximation Algorithms	Vijay V. Vazirani	Springer Nature (SIE)	2/e, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The design of approximation algorithms	David Williamson and David Shmoys	Cambridge University Press	1/e, 2011
2	Randomized Algorithms	Rajeev Motwani and Prabhakar Raghavan	Cambridge University Press	1/e, 2004
3	Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis	Michael Mitzenmacher and Eli Upfal	Cambridge University Press	3/e, 2017
4	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	The MIT Press	4/e, 2023
5	The Probabilistic Method	Noga Alon and Joel H. Spencer	Wiley-Blackwell	4/e, 2016
6	Computational Complexity: A Modern Approach	Sanjeev Arora and Boaz Barak	Cambridge University Press	1/e, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105471
2	https://nptel.ac.in/courses/106105471
3	https://nptel.ac.in/courses/106105471
4	https://nptel.ac.in/courses/106105471

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 :-** 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	9
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
	COVID-Net Open Source Initiative - COVIDx CT-3 Dataset https://www.kaggle.com/datasets/hgunraj/covidxct

SEMESTER S7

TOPICS IN THEORETICAL COMPUTER SCIENCE

Course Code	PECST795	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 PCCST502	Course Type	Theory

Course Objectives:

1. To understand and apply spectral graph theory techniques to analyze and solve complex graph problems, such as community detection and network design, through detailed study and hands-on assignments.
2. To develop and evaluate LP- and SDP-based approximation algorithms for NP-hard problems, including real-world applications like scheduling and optimization, by implementing these algorithms and assessing their performance in practical scenarios

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Spectral Graph Theory - Introduction to Spectral Graph Theory, Graph Laplacians: Definition and Properties, Eigenvalues and Eigenvectors of Laplacian matrices, Cheeger's Inequality, Graph Partitioning. **Assignments:** 1. Implement Cheeger's inequality for a set of sample graphs. Compare the theoretical results with empirical data to analyze the effectiveness of different partitioning algorithms. Use a set of sample graphs such as Erdős-Rényi Random Graphs, Barabási-Albert Model: Known for scale-free properties, and Regular Graphs. Compare theoretical results with empirical data using different partitioning algorithms such as Spectral Clustering - Uses the eigenvectors of the Laplacian matrix, K-means Clustering - Applied to spectral embeddings of the graph, Normalized Cut - Minimizes the normalized cut criterion. Measure how close the empirical conductance is to the theoretical lower bound provided by Cheeger's inequality. Analyze which algorithms produce cuts with conductance values closer to the	9

	theoretical bounds. Real-world Application: Apply Cheeger's inequality to social network analysis to detect community structures. 2. Analyze the properties of the Laplacian matrix of a given graph (Erdős-Rényi Random Graphs). Compute its eigenvalues and eigenvectors and discuss the implications for graph partitioning. Examine the use of graph Laplacians in network community detection.	
2	Spectral Clustering - Introduction to Clustering and Spectral Clustering, Normalized Cut, Eigenvalue Techniques for Clustering, Spectral Clustering Algorithm, Applications of Spectral Clustering. **Assignment:** 1. Implement a spectral clustering algorithm and apply it to a real-world dataset (Iris dataset). After running the spectral clustering algorithm, evaluate the results using metrics such as Silhouette Score and Adjusted Rand Index (ARI). Plot the data points colored by their cluster assignments to visually inspect the clustering. Compare spectral clustering with other clustering techniques (e.g., k-means, hierarchical clustering) on the three types of datasets - Synthetic Data, Real-World Data (Iris Dataset), and High-Dimensional Data (Text Data (Use TF-IDF features)). Discuss the advantages and limitations of spectral clustering in different scenarios. Real-world Application: Use clustering results for anomaly detection in network security.	**9**
3	Expanders - Introduction to Expander Graphs, Properties and Construction of Expanders, edge-expanders, vertex-expanders, spectral-expanders, Expander Mixing Lemma, Random walks on expanders graphs, Applications of Expander Graphs: Error-Correcting Codes. **Assignments:** 1. Study the construction and properties of expander graphs such as Erdős-Rényi graphs, Ramanujan graphs and Cayley graphs. Implement algorithms for generating expander graphs and analyze their properties based on spectral gap and expansion property. 2. Apply expander graphs to error-correcting codes. Design and test codes based on expanders, and evaluate their performance in terms of error correction capabilities. Simulate a communication channel with	**9**

	added noise and measure the performance of the expander code in correcting errors. Evaluate the BER, code rate, and error correction capability by comparing the number of errors corrected versus the total number of errors introduced.	
4	LP- and SDP-based Approximation Algorithms for NP-Hard Problems - Linear Programming (LP) Relaxations and their Use in Approximation: Vertex Cover and Set Cover, Semidefinite Programming (SDP) and its Applications: Max-Cut Problem. **Assignments:** 1. Implement and evaluate LP relaxations for vertex cover and set cover problems (use Erdős-Rényi Graphs). Compare the results with exact solutions and analyze the quality of the approximations. 2. Develop and test approximation algorithms for Max-cut problem using SDP relaxations. Assess the performance and efficiency of your algorithms on various datasets. To assess the performance and efficiency of the SDP-based Max-Cut approximation, test the algorithm on various types of graphs, including: Erdős-Rényi Graphs, Barabási-Albert Graphs, and Real-world Graphs. Compare the cut values obtained from the SDP relaxation and rounding with known or exact solutions if available. For large graphs, use heuristics or bounds for comparison. Measure the time taken to solve the SDP relaxation and perform the rounding. This includes the time for solving the SDP problem and the time for eigen-decomposition.	**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

Assignment evaluation pattern:

- Theoretical Understanding (25%) - Evaluate the clarity and accuracy with which theoretical concepts such as spectral graph theory, clustering algorithms, expanders, and approximation methods are explained and applied.
- Application of Theory (25%) - Assess how well the theoretical methods are applied to address assignment problems. Check if solutions are relevant, accurate, and demonstrate a good grasp of the theoretical background.
- Depth of Analysis (25%) - Analyze the depth of the problem analysis, including how well the assignment tackles complex aspects and nuances of the problem.
- Interpretation of Results (25%) - Evaluate the meaningfulness and relevance of the conclusions drawn from the analysis. Check if the results provide significant insights into the problem.

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 and explain fundamental concepts of Spectral Graph Theory, including Laplacian matrices and their applications.	**K2**
CO2	Apply spectral clustering techniques to real-world data and evaluate clustering performance using appropriate metrics.	**K5**
CO3	Construct and analyze expander graphs, and assess their applications in network design and error-correcting codes.	**K4**
CO4	Develop and implement LP- and SDP-based approximation algorithms for solving NP-Hard problems, and compare their performance.	**K5**
CO5	Demonstrate the ability to solve complex theoretical problems using advanced algorithms and techniques covered in the course.	**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							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	Spectral Graph Theory (CBMS Regional Conference Series)	Fan R. K. Chung	American Mathematical Society	1/e, 1997
2	Algebraic Graph Theory	Norman Biggs	Cambridge India	2/e, 2016
3	Approximation Algorithms	Vijay V. Vazirani	Springer Nature	2/e, 2013
4	Convex Optimization	Stephen Boyd, Lieven Vandenberghe	Cambridge University Press	1/e, 2004

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Algebraic Graph Theory	C. Godsil, G.F. Royle	Springer Nature	1/e, 2009
2	The design of approximation algorithms	David Williamson, David Shmoys	Cambridge University Press	1/e, 2011
3	Randomized Algorithms	Rajeev Motwani, Prabhakar Raghavan	Cambridge University Press	1/e, 2004
4	Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis	Michael Mitzenmacher, Eli Upfal	Cambridge University Press	3/e, 2017
5	Graph Theory and Complex Networks: An Introduction	Maarten Van Steen	Maarten Van Steen	1/e, 2010

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/128/106/128106001/

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*

	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

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

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 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	**9**
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	**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 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, 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	**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	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/
3	
4	

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

PARALLEL ALGORITHMS

(Common to CS/CM/CD/AM)

Course Code	**PECST759**	**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)	PCCST303 PCCST502	**Course Type**	Theory

Course Objectives:

1. To develop a comprehensive understanding of parallel computing principles and architectures by studying various types of parallelism, such as data and task parallelism, and analyzing different computing architectures.
2. To implement and evaluate parallel algorithms for fundamental operations, such as matrix addition and multiplication, using performance metrics like speedup and scalability, while gaining hands-on experience with parallel programming models and tools.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Parallel Computing - Overview of parallel computing and its importance, Types of parallelism: data parallelism, task parallelism, Parallel computing architectures: SIMD, MIMD, shared memory, distributed memory. Parallel Programming Models - Parallel programming models: Parallel Random Access Machine (PRAM), bulk synchronous parallel (BSP), LogP, Shared memory vs. distributed memory models; Performance Metrics - Performance metrics for parallel algorithms: speedup, efficiency, scalability, Amdahl's Law and Gustafson's Law.	9
2	Parallel Algorithms for Basic Operations - Parallel algorithms for matrix addition, matrix multiplication, and reduction, Parallel prefix sum (Parallel scan) algorithms. Case Studies of Parallel Addition, Multiplication, Reduction, and Prefix Sum in Modern Computing Systems; Parallel Sorting Algorithms - Parallel sorting algorithms: parallel merge sort, parallel quicksort, bitonic merge sort, Comparison of parallel sorting techniques.	9
3	Parallel Graph Algorithms - Parallel algorithms for graph traversal: BFS, DFS, Parallel algorithms for minimum spanning tree (MST) and shortest path.	9

	Parallel Search Algorithms - Parallel search algorithms: parallel binary search, parallel search trees, Applications and analysis.	
4	Parallel Programming with OpenMP - Introduction to OpenMP, Parallel programming constructs in OpenMP, Performance tuning and optimization Parallel Programming with MPI - Introduction to MPI, Message passing model and MPI basics, Advanced MPI features and applications Parallel Numerical Algorithms - Solving linear systems: parallel Gaussian elimination, parallel LU decomposition, Parallel algorithms for eigenvalue problems, Applications and analysis.	**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 and articulate the fundamental principles and architectures of parallel computing.	**K2**
CO2	Implement and evaluate parallel algorithms for basic operations such as sorting and searching.	**K3**
CO3	Develop and analyze parallel algorithms for complex problems, including graph and numerical algorithms.	**K3**
CO4	Apply parallel programming techniques to real-world problems and assess the efficiency and performance of parallel solutions.	**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	3								3
CO4	3	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	Introduction to Parallel Computing	Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar	Addison-Wesley	2/e, 2003
2	Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers	Barry Wilkinson and Michael Allen	Pearson India	2/e, 2006
3	An Introduction to Parallel Algorithms	Joseph Jaja	Addison-Wesley Professional	1/e, 1992
4	Parallel Algorithms	Henri Casanova, Arnaud Legrand, Yves Robert	Chapman and Hall/CRC	1/e, 2020
5	Parallel Scientific Computing in C++ and MPI	George Em Karniadakis and Robert M. Kirby II	Cambridge University Press	1/e, 2003

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Parallel Programming for Multicore and Cluster Systems	Thomas Rauber, Gudula Rünger	Springer	3/e, 2023
2	Using OpenMP: Portable Shared Memory Parallel Programming	Barbara Chapman, Gabriele Jost, Ruud van der Pas	MIT Press	1/e,2007
3	Using MPI: Portable Parallel Programming with the Message-Passing Interface	William Gropp, Ewing Lusk, Anthony Skjellum	MIT Press	3/e, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106112/
2	https://archive.nptel.ac.in/courses/106/106/106106112/ https://nptel.ac.in/courses/106104120
3	https://archive.nptel.ac.in/courses/106/106/106106112/ https://nptel.ac.in/courses/106104120
4	https://archive.nptel.ac.in/courses/106/106/106106112/ https://nptel.ac.in/courses/106104120

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 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.	**8**
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.	**10**
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 -	**8**

	Reflecting the Cloud Journey, The Key Motivations for Cloud-Enabled Environments, IoT and Cloud-Inspired Smarter Environments, Hybrid, 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.	**10**

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

ALGORITHMS FOR DATA SCIENCE

(Common to CS/AM/CM)

Course Code	**PECST785**	**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 Mins.
Prerequisites (if any)	PCCST303 PCCST502	**Course Type**	Theory

Course Objectives:

1. To equip students with the ability to design, analyze, and implement advanced algorithms that are fundamental to data science, enabling them to process and analyze large-scale datasets efficiently and effectively.
2. To provide hands-on experience through real-world projects that require students to apply algorithmic techniques to solve data science problems, strengthen the development of practical skills in data manipulation, analysis, and interpretation.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Foundations of Data Science Algorithms** Introduction to Data Science and Algorithms - Overview of data science and its significance, Role of algorithms in data science; Data Preprocessing Techniques - Data cleaning, transformation, and normalization, Handling missing data, outliers, and data imputation techniques; Dimensionality reduction techniques - Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE); Algorithmic Approaches to Data Sampling - Random sampling, stratified sampling, and bootstrapping, Importance of representative sampling in data analysis. **Project 1**: Data Cleaning and Preprocessing - Develop a pipeline for cleaning and preprocessing a large, messy dataset like UCI Machine Learning Repository - Adult Data Set **Tasks:** Handle missing values, outliers, and noisy data. Apply	9

	dimensionality reduction techniques to simplify the dataset. Implement data transformation and normalization processes.	
2	**Algorithms for Data Summarization and Visualization :-** Data Summarization Techniques - Central tendency measures: mean, median, mode; Dispersion measures - variance, standard deviation, Interquartile range (IQR), Quantiles, percentiles, and outlier detection; Visualization Algorithms - Basics of data visualization, histograms, bar charts, scatter plots; Advanced visualization techniques - heatmaps, correlation matrices, and pair plots; Visualization tools and libraries - Matplotlib, Seaborn, Plotly; Algorithmic Approaches to Data Grouping - Clustering: k-means, hierarchical clustering, DBSCAN; Association rule learning - Apriori, FP-Growth. **Project 2**: Exploratory Data Analysis and Visualization Perform exploratory data analysis (EDA) and create visualizations to uncover patterns and insights in the dataset like Kaggle - Titanic Dataset ***Tasks:*** Summarize the dataset using statistical measures. Create various visualizations to explore relationships and patterns in the data. Implement clustering algorithms to identify natural groupings within the data.	**9**
3	**Algorithms for Data Modeling :-** Regression Algorithms - Linear regression and polynomial regression; Regularization techniques - Ridge, Lasso, Elastic Net; Evaluation metrics - RMSE, MAE, R^2; Classification Algorithms - Logistic regression, decision trees, and k-Nearest Neighbors (k-NN); Performance metrics - accuracy, precision, recall, F1-score, ROC-AUC; Algorithmic Optimization Techniques - Gradient descent and its variants: stochastic, mini-batch; Hyperparameter tuning - grid search, random search, Bayesian optimization. **Project 3**: Predictive Modeling and Evaluation - Build and evaluate predictive models using regression and classification algorithms using datasets like Kaggle - House Prices: Advanced Regression Techniques ***Tasks:*** Implement linear and polynomial regression models to predict house prices. Apply classification algorithms to classify houses into different categories. Evaluate the models using appropriate performance metrics and fine-tune them for better accuracy.	**9**
4	**Algorithms for Big Data and Scalability :-** Introduction to Big Data Algorithms - Overview of big data challenges and	**9**

	processing techniques; Distributed computing frameworks - Hadoop, Spark; MapReduce paradigm - concepts and applications; Scalable Data Processing Algorithms - Algorithms for large-scale data processing : sorting, searching, filtering; Data partitioning and shuffling techniques in distributed systems; Handling data with memory constraints - external memory algorithms. **Project 4**: Scalable Data Processing with Spark - Implement scalable algorithms using Apache Spark to process large datasets efficiently using datasets like Kaggle - Google Analytics Customer Revenue Prediction ***Tasks:*** Set up a Spark environment for large-scale data processing. Implement scalable algorithms for sorting, searching, and filtering the dataset. Analyze the performance of your algorithms on different dataset sizes and optimize for scalability.	

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

Assignment evaluation pattern:

- Correctness and Accuracy (30%) - Correct Solution and Implementation.
- Effectiveness and Efficiency (25%) - Algorithm Efficiency and Performance Metrics.
- Analytical Depth (25%) - Problem Understanding and Solution Analysis.
- Justification and Comparisons (20%) - Choice Justification and Comparative Analysis.

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 data preprocessing and cleaning techniques to prepare raw data for analysis, ensuring the quality and reliability of the datasets.	**K3**
CO2	Perform exploratory data analysis (EDA) and create insightful visualizations that help in understanding the underlying patterns and trends in the data.	**K4**
CO3	Develop predictive models using various regression and classification algorithms, and optimize them for better performance, applying appropriate evaluation metrics.	**K5**
CO4	Implement scalable algorithms using distributed computing frameworks like Apache Spark to process large datasets efficiently.	**K6**

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

CO-PO Mapping Table (Mapping od 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
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	Algorithms for Data Science Hardcover	Brian Steele, John Chandler, Swarna Reddy	Springer International	1/e, 2016
2	Mining of Massive Datasets	Jure Leskovec, Anand Rajaraman, Jeff Ullman	Cambridge University Press	2/e, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Foundations of Data Science	Avrim Blum, John Hopcroft and Ravi Kannan	Cambridge University Press	1/e, 2020
2	The Elements Of Statistical Learning: Data Mining, Inference, And Prediction	Trevor Hastie, Robert Tibshirani and Jerome Friedman	Springer	9/e, 2017
3	Data Mining: Concepts and Techniques	Jiawei Han, Micheline Kamber and Jian Pei Professor	Morgan Kaufmann	3/e, 2011
4	Data Mining and Predictive Analytics	Daniel T. Larose	Wiley	2/e, 2015
5	Hadoop for Dummies	Dirk Deroos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss	Wiley	1/e, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/104/106104189/ https://onlinecourses.nptel.ac.in/noc20_cs92/preview
2	https://archive.nptel.ac.in/courses/106/104/106104189/ https://onlinecourses.nptel.ac.in/noc20_cs92/preview
3	https://archive.nptel.ac.in/courses/106/104/106104189/ https://onlinecourses.nptel.ac.in/noc20_cs92/preview
4	https://archive.nptel.ac.in/courses/106/104/106104189/ https://nptel.ac.in/courses/106105186 https://archive.nptel.ac.in/courses/106/106/106106142/

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/ https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044 https://www.coursera.org/learn/data-security-privacy#modules https://nptel.ac.in/courses/106105217 https://archive.nptel.ac.in/courses/106/106/106106156/
2	
3	
4	

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	0	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST204 OR 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: StatelessWidget 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, SharedPreferences, 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

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

TOPICS IN SECURITY

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

Course Code	**PECST863**	**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 explore various web security and privacy concerns
2. To impart security policies and models for data integrity.
3. To enable the learners to protect databases and introduce IDS

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of Security and Threat Management**: Computer Security, Threats, Harm, Vulnerabilities, Authentication, Access Control **Web Security-** Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data **Privacy-** Privacy Concepts, Principles and Policies, Privacy on the Web, Privacy Principles and Policies, Email Security.	9
2	**Cryptography in Network Security-** Network Encryption, Browser Encryption, Onion Routing, IPSEC, VPN **Intrusion Detection and Prevention Systems-**Types of IDSs, Other Intrusion Detection Technology, Intrusion Prevention Systems, Intrusion Response, Goals for Intrusion Detection Systems, IDS Strengths and Limitations	9
3	**Database Security**: -Machine Learning for Malware detection, Supervised Learning for Misuse/Signature Detection, Anomaly Detection using ML, Spam detection based on Machine Learning approach, Adversarial Machine Learning Security Requirements of Databases, Reliability and Integrity of Databases, Database Disclosure	10

4	**Security policies and models**: Confidentiality Policies, Bell- LaPadula model, Integrity policies, Biba model, Clark-Wilson models, Chinese wall model, waterfall model. **Management and Incidents-** Security Planning, Business Continuity Planning, Handling Incidents, Risk Analysis, Dealing with Disaster	**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	Explain the fundamentals of threat management, web security and privacy	**K2**
CO2	Identify the significance of network security and IDS	**K2**
CO3	Apply machine learning algorithms for database security	**K3**
CO4	Explain the policies and models for data integrity along with managements and incidents associated with data	**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	Security in Computing	Charles P. Pfleeger, Shari Lawrence Pfleeger Jonathan Margulies	Pearson	5/e, 2015
2	Data mining and machine learning in cybersecurity	Dua, Sumeet, Xian Du	Auerbach Publications	1/e, 2011
3	Machine learning and security: Protecting systems with data and algorithms.	Chio, Clarence, David Freeman	O'Reilly	1/e, 2018
4	Network Security and Cryptography	Bernard Menezes	Cengage Learning	1/e, 2010
5	Computer Security: Art and Science	M Bishop	Addison - Wesley	2/e, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of information security	E Whiteman, J Mattord	Cengage Learning	4/e, 2011
2	Network Security Essentials: Applications and Standards	William Stallings	McGraw Hill	6/e, 2018
3	Network security: the complete reference.	Bragg, Roberta	McGraw-Hill	1/e, 2004
4	Database Security	Basta A., Zgola M,	Cengage Learning	3/e, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc24_cs121 https://nptel.ac.in/courses/106106093 https://archive.nptel.ac.in/courses/106/106/106106129/

SEMESTER S8

COMPUTATIONAL COMPLEXITY

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

Course Code	**PECST864**	**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)	PCCST302, PCCST502	**Course Type**	Theory

Course Objectives:

1. To develop an understanding of various computational models, including deterministic and nondeterministic models, Turing machines, and other computational models, and analyze their capabilities and limitations, focusing on how these models influence the classification of problems into complexity classes.
2. To explore key complexity classes such as P, NP, and PSPACE, and apply polynomial-time reductions to prove the NP-completeness of various problems, and also investigate space complexity, polynomial hierarchy, and advanced topics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Complexity Theory - Basic concepts and motivations, Deterministic and nondeterministic models, Turing machines, and computational models. (Text 2 - Ch 7) Complexity Classes P and NP - Definitions and examples of P and NP, Polynomial-time algorithms, NP-completeness and the Cook-Levin theorem. (Text 2 - Ch 7, 8) Reductions and Completeness - Polynomial-time reductions, NP-complete problems, and their significance, Examples of NP-complete problems (Text 1 - Ch 2)	**9**
2	Space Complexity - Space complexity classes: L, NL, PSPACE, Savitch's theorem and NL-completeness, PSPACE-completeness. (Text 2 - Ch 8) Polynomial Hierarchy and Alternation - Definition of the polynomial hierarchy (PH), Complete problems for each level of PH, Relationship between PH and other classes. (Text 1 - Ch 5)	**9**
3	Interactive Proofs - Definition and examples of interactive proofs, IP =	**9**

	PSPACE theorem, Zero-knowledge proofs. (Text 1 - Ch 8) Probabilistically Checkable Proofs (PCPs) - Introduction to PCPs, PCP theorem and implications, Applications in hardness of approximation. (Text 1 - Ch 9)	
4	Circuit Complexity - Boolean circuits and circuit complexity, Circuit lower bounds, Complexity of specific functions. (Text 2 - Ch 9) Quantum Complexity - Basics of quantum computation, Quantum complexity classes: BQP, QMA, Quantum algorithms and their complexity. (Text 3 - Ch 10, 11)	**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 and interpret different computational models, including deterministic and nondeterministic Turing machines.	**K2**
CO2	Recall and categorize complexity classes such as P, NP, and PSPACE, and explain their fundamental properties.	**K2**
CO3	Use polynomial-time reductions to demonstrate problem completeness and analyze the computational difficulty of problems.	**K3**
CO4	Evaluate problems based on their space complexity and apply theories like Savitch's theorem to assess space-bounded algorithms.	**K4**
CO5	Examine advanced topics in complexity theory, including interactive proofs, PCPs, and quantum complexity, and their implications for computational theory.	**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	Computational Complexity: A Modern Approach	Sanjeev Arora, Boaz Barak	Cambridge University Press	1/e, 2019
2	Introduction to the Theory of Computation	Michael Sipser	Cengage	3/e, 2014
3	Quantum Computing: A Gentle Introduction	Eleanor Rieffel, Wolfgang Polak	MIT Press	1/e, 2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Randomized Algorithms	Rajeev Motwani and Prabhakar Raghavan	Cambridge University Press	1/e, 2004
2	Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis	Michael Mitzenmacher and Eli Upfal	Cambridge University Press	3/e, 2017
3	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	The MIT Press Cambridge	4/e, 2023
4	The Probabilistic Method	Noga Alon and Joel H. Spencer	Wiley-Blackwell	4/e, 2016
5	Approximation Algorithms	Vijay V. Vazirani	Springer	4/e, 2013
6	Theory of Computation : Classical And Contemporary Approaches	Dexter C Kozen	Springer	6/e, 2006
7	Computational Complexity: A Conceptual Perspective,	Oded Goldreich	Cambridge University Press	1/e, 2008

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview
3	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview
4	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview https://archive.nptel.ac.in/courses/106/104/106104241/

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

STORAGE SYSTEMS

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

Course Code	**PECST867**	**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 storage technologies and architectures.
2. To empower students to design and implement effective storage solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Storage technologies:-** Computer storage technologies-Magnetic bubble memories, Charged Coupled Devices - CCDs, Micro-Electro-Mechanical Systems - MEMS, Flash memories, Processing In Memory - PIM, Optical storage - Data deduplication in storage systems. Storage Arrays- Architectural Principles, Replication, Local Snapshot Redundant Arrays of Independent Disks (RAID) - RAID0,RAID2,RAID3, RAID4, RAID5, RAID6, Hybrid RAID.	9
2	**Data Storage Networking:-** Fibre Channel SAN- FC SAN Components,SAN Topologies, iSCSI SAN- iSCSI names, Sessions, iSNS, Network Attached Storage - NAS Protocols, NAS Arrays, NAS Performance Object Storage - Objects and Object IDs, metadata, API Access	9
3	**Business Continuity, Backup and Recovery:-** Replication- Synchronous Replication, Asynchronous Replication Application, Layer Replication, Logical Volume Manager–Based Replication, Backup Methods- Hot Backups, Offline Backups, LAN-Based Backups, LAN-Free Backups (SAN Based), Serverless Backups, NDMP, Backup Types- Full Backups, Incremental Backups, Differential Backups ,	9

	Synthetic Full Backups, Application-Aware Backups	
4	**Storage Management:-** Capacity Management- Capacity Reporting, Thin Provisioning Considerations, Deduplication and Compression, Quotas and Archiving, Showback and Chargeback, Performance Management- Latency/Response Time, IOPS,MBps and Transfer Rate, Factors Affecting Storage Performance Management Protocols and Interfaces.	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 emerging storage technologies.	**K2**
CO2	Compare and contrast different storage networking technologies.	**K2**
CO3	Understand the importance of business continuity.	**K2**
CO4	Develop a comprehensive backup and recovery strategy	**K3**
CO5	Utilize management tools and best practices to monitor, optimize, and secure storage resources, ensuring optimal performance and data integrity.	**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
CO2	3	3	2									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	Data Storage Networking	Nigel Poulton	WILEY	2/e, 2015
2	Computer Storage Fundamentals	Susanta Dutta	BPB Publication	1/e, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Storage Systems : Organization, Performance, Coding, Reliability, and Their Data Processing	Alexander Thomasian	Morgan Kaufmann	1/e, 2021
2	Information Storage and Management	Somasundaram Gnanasundaram Alok Shrivastava	Wiley	2/e, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/108/106108058/

SEMESTER S8

PROMPT ENGINEERING

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

Course Code	**PECST868**	**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 students' practical skills in applying prompt engineering techniques to real-world applications, while fostering an awareness of the ethical considerations and challenges in the field
2. To give an understanding of contextual cues to mitigating biases with techniques for seamless interaction with AI systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Prompt Engineering and Language Models :-** Fundamentals of Natural Language Processing (NLP) - Overview of Language Models: From Rule-Based Systems to Transformer Architectures (e.g., GPT, BERT) - Understanding Prompts: Definition, Importance, and Applications - Introduction to Prompt Engineering: Techniques and Use Cases - Ethical Considerations in Prompt Engineering ***Handson*** : Explore various language models using platforms like OpenAI, Hugging Face, or Google Colab; Experimenting with basic prompts to understand the impact of phrasing and context on model outputs.	**9**
2	**Techniques and Strategies in Prompt Engineering :-** Designing Effective Prompts - Best Practices and Common Pitfalls; Prompt Tuning and Fine-Tuning Language Model; Using Zero-Shot, Few-Shot, and Multi-Shot Learning in Prompts; Exploring the Role of Context, Repetition, and Specificity in Prompt Responses; Advanced Prompt Engineering Techniques: Prompt Chaining, Iterative Prompting. ***Handson :*** Crafting and optimizing prompts for specific tasks (e.g., text generation, summarization, Q&A); Using prompt engineering to fine-tune pre-	**9**

	trained models on specific datasets or tasks.	
3	**Applications of Prompt Engineering :-** Prompt Engineering in Chatbots and Conversational AI; Content Generation: Creative Writing, Code Generation, and Data Augmentation; Prompt Engineering for Sentiment Analysis, Classification, and Translation; Integration of Prompt Engineering with Other AI Technologies (e.g., Computer Vision, Data Science); Real-World Case Studies and Industry Applications ***Handson :*** Developing a simple chatbot using prompt engineering techniques, Case study analysis and reproduction of real-world prompt engineering applications	**9**
4	**Challenges, Future Trends, and Research in Prompt Engineering :-** Challenges in Prompt Engineering: Ambiguity, Bias, and Misinterpretation; Evaluating and Improving Prompt Performance: Metrics and Benchmarks; Future Trends: Emerging Techniques and the Evolution of Language Models; ***Handson :*** Working on a capstone project to solve a real-world problem using prompt engineering	**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 core principles of NLP, language models, and the role of prompts in influencing AI behavior.	**K2**
CO2	Demonstrate the ability to design and fine-tune prompts for specific tasks, optimizing language models for desired outputs	**K3**
CO3	Apply prompt engineering techniques to develop functional AI applications, such as chatbots, content generation tools, and automated systems.	**K3**
CO4	Compare the ethical implications of prompt engineering, addressing challenges such as bias, ambiguity, and misuse, and propose solutions to mitigate these issues.	**K3**
CO5	Apply prompt engineering techniques to a variety of assigned tasks	**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	Speech and Language Processing	Daniel Jurafsky and James H. Martin	Pearson	2/e, 2013
2	Unlocking the Secrets of Prompt Engineering	Gilbert Mizrahi	Packt	1/e, 2023
3	Prompt Engineering	Ian Khan	Wiley	1/e, 2024

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Natural Language Processing with Python	Steven Bird, Ewan Klein, and Edward Loper	Oreilly	1/e, 2009
2	Transformers for Natural Language Processing	Denis Rothman	Packt	1/e, 2021

SEMESTER S8

COMPUTATIONAL NUMBER THEORY

(Common to CS/CM)

Course Code	PECST869	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)	PCCST205 PCCST303 PCCST502	Course Type	Theory

Course Objectives:

1. To develop proficiency in key algorithms for number-theoretic operations, including primality testing, integer factorization, and modular exponentiation and to analyze and implement these algorithms efficiently to solve problems in number theory and cryptography.
2. To apply advanced computational techniques, such as elliptic curve cryptography and lattice-based methods, to address complex problems in cryptographic systems and gain practical skills to implement and evaluate these techniques within real-world security applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Number Theory - Basic concepts and definitions, Greatest common divisor (GCD) and Euclidean algorithm; Modular Arithmetic - Congruences and modular arithmetic, Applications of modular arithmetic; Integer Factorization - Prime numbers and factorization, Algorithms for integer factorization; Basic Algorithms - Algorithms for modular arithmetic, Fast exponentiation techniques	9
2	Advanced Factorization Algorithms - Pollard's rho algorithm, Elliptic curve factorization; Public-Key Cryptography - RSA algorithm, Security analysis of RSA; Elliptic Curve Cryptography - Introduction to elliptic curves, Algorithms for elliptic curve cryptosystems	9
3	Public Key Cryptography - RSA algorithm and its implementation, Security aspects and cryptanalysis; Elliptic Curve Cryptography - Basics of elliptic curves, Elliptic curve cryptosystems; Cryptographic Protocols - Key	9

	exchange protocols, Digital signatures and authentication	
4	Algebraic Number Theory - Algebraic integers and number fields, Factorization in number fields; Computational Methods - Algorithms for solving Diophantine equations, Applications in computational algebra; Recent Developments and Applications - Applications in modern cryptography and coding theory	**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 basic number theory concepts and algorithms.	**K2**
CO2	Apply factorization algorithms to solve computational problems.	**K3**
CO3	Analyze and evaluate cryptographic systems based on number theory.	**K4**
CO4	Synthesize algebraic number theory concepts into computational methods.	**K4**
CO5	Create and present a project on recent advances and applications in computational number theory.	**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
CO2	3	3	3									2
CO3	3	3	3	3	3							2
CO4	3	3	3	3	3					2	2	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	A Computational Introduction to Number Theory and Algebra	Victor Shoup	Cambridge University 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	Computational Number Theory and Modern Cryptography	Song Y. Yan	John Wiley & Sons	1/e, 2013
2	A course in computational algebraic number theory	Henri Cohen	Springer-Verlag	4/e, 2000
3	Computational Number Theory	Abhijit Das	CRC	1/e, 2013
4	Modern Computer Algebra	Joachim von zur Gathen and Jürgen Gerhard	Cambridge University Press	4/e, 2013
5	An Introduction to the Theory of Numbers	G. H. Hardy, Edward M. Wright, Roger Heath- Brown and Joseph Silverman	Oxford University Press	6/e, 2008

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/
2	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/
3	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/
4	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/

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**
	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

SEMESTER 3

ELECTRICAL & ELECTRONICS ENGINEERING

SEMESTER S3

MATHEMATICS FOR ELECTRICAL SCIENCE AND PHYSICAL SCIENCE – 3

(Common to B & C Groups)

Course Code	**GYMAT301**	**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 knowledge in complex numbers.	**Course Type**	Theory

Course Objectives:

1. To introduce the concept and applications of Fourier transforms in various engineering fields.
2. To introduce the basic theory of functions of a complex variable, including residue integration and conformal transformation, and their applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fourier Integral, From Fourier series to Fourier Integral, Fourier Cosine and Sine integrals, Fourier Cosine and Sine Transform, Linearity, Transforms of Derivatives, Fourier Transform and its inverse, Linearity, Transforms of Derivative. **(Text 1: Relevant topics from sections 11.7, 11.8, 11.9)**	**9**
2	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of $w= z^2$, $w=e^z$,$w=\frac{1}{z}$, $w=sinz$. **(Text 1: Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4)**	**9**
3	Complex Integration: Line integrals in the complex plane (Definition & Basic properties), First evaluation method, Second evaluation method, Cauchy's integral theorem (without proof) on simply connected domain, Independence of path, Cauchy integral theorem on multiply connected	**9**

	domain (without proof), Cauchy Integral formula (without proof). **(Text 1: Relevant topics from sections 14.1, 14.2, 14.3)**	
4	Taylor series and Maclaurin series, Laurent series (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Residue Integration- Integral of Rational Functions of $cos\theta$ and $sin\theta$. **(Text 1: Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4)**	**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	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering.	**K3**
CO2	Understand the analyticity of complex functions and apply it in conformal mapping.	**K3**
CO3	Compute complex integrals using Cauchy's integral theorem and Cauchy's integral formula.	**K3**
CO4	Understand the series expansion of complex function about a singularity and apply residue theorem to compute real integrals.	**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	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10^{th} edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Complex Analysis	Dennis G. Zill, Patrick D. Shanahan	Jones & Bartlett	3rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1st edition, 2011

SEMESTER S3

CIRCUITS & NETWORKS

Course Code	**PCEET302**	**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)	Introduction to Electrical Engineering	**Course Type**	Theory

Course Objectives:

1. This course analyses electrical circuits in steady-state and dynamic conditions with DC and sinusoidal excitations
2. It also describes the two-port networks in terms of various parameters.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Mesh analysis and nodal analysis (Review only)- super mesh and super node - Superposition principle - source transformation – analysis with DC and AC (sinusoidal) excitation Thevenin's theorem - Norton's theorem - Maximum power transfer theorem - analysis with DC and AC (sinusoidal) excitation with independent and dependent sources. Reciprocity Theorem - application to the analysis of DC Circuits.	**12**
2	Resonance - series resonance– resonant frequency – variations of impedance and current with frequency – bandwidth – quality factor– parallel resonance (series RL in parallel with C –calculation of resonant frequency). Power in 3-phase circuits – complex power - active, reactive and apparent power in balanced load – steadystate analysis of 3-wire unbalanced delta connected circuit - steady state analysis of 3-phase 4-wire and 3-wire (using Millman's theorem only) unbalanced star connected circuit –neutral shift	**12**
3	Laplace transforms(Review only) Transient response of simple series and parallel RL and RC circuits with	**12**

	DC excitation and initial conditions – natural response and forced response – time constant - solution using Laplace transforms – transformed circuits in s-domain – solution using mesh analysis and nodal analysis Transient response of series RLC circuit with DC excitation and initial conditions – damping –overdamped, underdamped, critically damped and undamped - solution using Laplace transforms Transient response of simple series and parallel RL and RC circuits with sinusoidal excitation and zero initial conditions – solution using Laplace transforms	
4	Two port networks – Z, Y, h, T parameters – conditions for symmetry and reciprocity – relationship between parameters – interconnection of two port networks – series, parallel and cascade Coupled circuit – dot convention – fixing of dots – coefficient of coupling - conductively coupled equivalent circuit - sinusoidal steady state analysis of coupled circuits.	**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	Apply circuit theorems to solve complex DC and AC electric networks	**K3**
CO2	Apply transformation from time domain to s-domain, solve dynamic electric circuits.	**K3**
CO3	Solve series and parallel resonant circuits	**K3**
CO4	Analyse three-phase networks in star and delta configurations under balanced and unbalanced conditions.	**K3**
CO5	Describe two-port networks in terms of various parameters.	**K3**
CO6	Explain the steady-state behaviour of coupled circuits with sinusoidal excitation	**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
CO5	3	3										3
CO6	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 Analysis	Van Valkenburg	Pearson	3rd 2019
2	Network Analysis and Synthesis	Ravish R Singh	McGraw Hill Education	2nd 2019
3	Electric Circuits & Networks	Suresh Kumar	Pearson	Ist 2008
4	Circuits and Networks, Analysis and Synthesis	A Sudhakar, Shyammohan S Palli	McGraw Hill Education	5th 2017

SEMESTER S3

DC MACHINES & TRANSFORMERS

Course Code	**PCEET303**	**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. Describe the constructional details, working and analyse the performance of DC machines and transformers under various load conditions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Constructional details of dc machines - armature winding - lap and wave – simplex, progressive only – winding diagrams of simplex, lap wound, double layer, 12-slot, 4-pole, dc armature with 12 commutator segments – winding diagram of simplex wave wound, double layer, 16-slot, 6-pole, dc armature with 12 commutator segments (winding diagram not for evaluation) DC generator - principle of operation of DC generator – emf equation – numerical problems Classification DC generators – steady-state equations – numerical problems DC shunt generator - no-load characteristics – critical field resistance, critical speed, voltage build-up - load characteristics – numerical problems Armature reaction - cross magnetising & demagnetising effect (computation of ampere-turns not required) – compensating winding – interpoles – commutation (concept only) – numerical problems Power flow diagram – losses and efficiency – maximum efficiency - numerical problems Parallel operation of DC shunt generators – load sharing – numerical problems	**12**

2	DC motor – back emf – torque equation – numerical problems Classification of DC motors – steady-state equations – numerical problems Characteristics of DC motors – numerical problems Starting of DC motors – 3-point starter Braking – regenerative braking, dynamic braking and plugging (concepts only) Speed control of DC shunt and series motors – field control and armature control – numerical problems Power flow diagram – losses and efficiency – numerical problems Testing - Swinburne's test – Hopkinson's test – retardation test - separation of rotational losses - numerical problems	**12**
3	Single phase transformers – constructional details - principle of operation - EMF equation - ideal and practical transformer – numerical problems Operation on no load and on load - phasor diagram at different load conditions - equivalent circuit - voltage regulation – numerical problems Losses and efficiency - condition for maximum efficiency – numerical problems Testing of transformers - polarity test - OC test, SC test - Sumpner's test – separation of losses – numerical problems	**11**
4	Autotransformer – saving of copper – numerical problems 3- phase transformer – construction - different connections of 3-phase transformers - Y-Y, Δ-Δ, Y-Δ, Δ-Y – numerical problems Difference between power transformer and distribution transformer – all-day efficiency – numerical problems Scott connection for 3-phase to 2-phase conversion Vector groupings – Yy0, Dd0, Yd1, Yd11, Dy1, Dy11 Parallel operation of 1-phase and 3-phase transformers - essential and desirable conditions On load and off-load tap-changers	**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	Describe the constructional details of DC machines	**K2**
CO2	Analyse the performance DC generator under various load conditions	**K3**
CO3	Analyse the performance DC motor under various load conditions	**K3**
CO4	Analyse the performance of 1-phase transformer and auto-transformer under various load conditions.	**K3**
CO5	Describe the constructional details and operation of 3-phase transformers.	**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	2										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	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	Electrical Machinery	P.S. Bimbhra	Khanna Publishers	7th edition 2021
2	Electric Machines	D P Kothari & I J Nagrath	Tata McGraw Hill	5th edition 2017
3	DC Machines & Transformers	K Murugesh Kumar	Vikas Publishing House	2nd edition 2004
4	Theory & Performance of Electrical Machines	J.B. Gupta	S K Kataria	15th edition 2022

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL https://archive.nptel.ac.in/courses/108/105/108105155/

SEMESTER S3

ANALOG ELECTRONICS

Course Code	**PBEET304**	**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. At the end of the course the student will be able to design of analog electronic systems using BJT, FET and OP-Amp

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Review of Bipolar Junction Transistor-** Introduction to DC Biasing – Base Bias – Voltage Divider Bias **Common Emitter Amplifier** – AC concepts —Role of coupling capacitors and emitter bypass capacitor- Common Emitter AC equivalent circuit- Amplifier Gain - Calculation of amplifier gains and impedances using h parameter equivalent circuit. **Emitter Follower Amplifier** **Power Amplifiers** -AC load line – RC Coupled amplifiers – Transformer coupled Class A amplifiers – Class B amplifiers(Derivation of efficiency) – Class AB amplifiers – Class C and Class D amplifiers	**9**
2	**Introduction to JFET** – JFET biasing circuits – Common Source Amplifier **Introduction to MOSFET** -MOSFET construction -D-MOSFET, E-MOSFET-Complementary MOSFET **Amplifier Frequency Response** – Basic concepts – BJT amplifier Frequency response – FET amplifier Frequency Response **Feedback and Oscillator circuits** – Feedback concepts – Feedback connection types – Practical Feedback circuits **Oscillators** – Phase Shift Oscillator (Expression of frequency oscillation)–	**9**

	Wien Bridge Oscillator – Tuned Oscillator circuits – Crystal Oscillator	
3	**Introduction to Operational Amplifiers (Op-Amps)** – Operation Overview – Differential amplifiers and Op-Amp Specifications -Gain, CMRR and slew rate **Op- Amp Circuits** – Inverting Amplifiers – Non inverting Amplifiers – Summing and Difference Amplifiers – Instrumentation Amplifiers Differentiator and Integrator circuits-practical circuits Comparators: Zero crossing and voltage level detectors, Schmitt trigger.	**9**
4	**Active Filters** – Butterworth, Chebyshev and Bessel Filters, Low pass filter – high pass filter -band pass and notch filters- Butterworth **Wave form generation using Op-Amps**: Square, triangular and ramp generatorcircuits using Op-Amp- Effect of slew rate on waveform generation. **Timer555 IC**: Internal diagram of 555 IC– Astable and Monostable multi-vibrators using 555 IC	**9**

Suggestion on Project Topics

In this curriculum Analog Electronics is the first Project Based Learning Course for the Electrical and Electronics Engineering students.

Project-Based Learning (PBL) is a student-centered teaching approach where the teacher serves as a facilitator and advisor.

Students are encouraged to think the need of the society and industry. Select a project topic relevant to the present society as well as covers topics in the syllabus.

In the first step they start defining problem statement with requirements and specifications.

In the second step, students work in groups to discover optimal and creative solutions by sharing their unique and inventive ideas for solutions.

They begin designing and developing components using contemporary tools and technology in the third level. Design the circuit and simulate it using available simulation tools. Also perform the hardware implementation to make it a product.

Project Topic Suggestions:

1. Regulated power supply
2. Electronic Thermometer with diode/transistor/instrumentation amplifier
3. Audio Amplifier
4. Multistage amplifiers
5. Biomedical signal processing devices
6. RF Transmitter

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 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	Design BJT and FET amplifier circuits	**K3**
CO2	Design Oscillator circuits	**K3**
CO3	Design and develop various OPAMP application circuits.	**K3**
CO4	Implementation of active filters	**K4**
CO5	Implement an electronic hardware circuit for the solution of a real time problem	**K4**

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	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	2	1	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	Introductory Electronic Devices and Circuits	Robert T Paynter	Pearson Education	
2	Electronic devices and Circuit Theory	Boylestad R. L. and L. Nashelsky	Pearson Education	
3	Electronic Circuits : Analysis and Design	Donald A Neaman	McGraw Hill Companies	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Analog Circuits	Floyd T.L.	Pearson Education	
2	Op-Amps and Linear Integrated Circuits	Gayakward R. A.	PHI Learning Pvt. Ltd.	
3	Electronic Devices and Circuits	David A Bell	Oxford Higher Education	
4	Linear Integrated Circuits	Choudhury R.	New Age International Publishers	

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/105/108105158/
2	https://archive.nptel.ac.in/courses/108/102/108102112/
3	https://nptel.ac.in/courses/108106084

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

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Course Code	**GNEST305**	**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. Demonstrate a solid understanding of advanced linear algebra concepts, machine learning algorithms and statistical analysis techniques relevant to engineering applications, principles and algorithms.
2. Apply theoretical concepts to solve practical engineering problems, analyze data to extract meaningful insights, and implement appropriate mathematical and computational techniques for AI and data science applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to AI and Machine Learning**: Basics of Machine Learning - types of Machine Learning systems-challenges in ML- Supervised learning model example- regression models- Classification model example- Logistic regression-unsupervised model example- K-means clustering. Artificial Neural Network- Perceptron- Universal Approximation Theorem (statement only)- Multi-Layer Perceptron- Deep Neural Network- demonstration of regression and classification problems using MLP.(Text-2)	11
2	**Mathematical Foundations of AI and Data science**: Role of linear algebra in Data representation and analysis – Matrix decomposition- Singular Value Decomposition (SVD)- Spectral decomposition- Dimensionality reduction technique-Principal Component Analysis (PCA). (Text-1)	11
3	**Applied Probability and Statistics for AI and Data Science**: Basics of probability-random variables and statistical measures - rules in probability-	11

	Bayes theorem and its applications- statistical estimation-Maximum Likelihood Estimator (MLE) - statistical summaries- Correlation analysis- linear correlation (direct problems only)- regression analysis- linear regression (using least square method) (Text book 4)	
4	**Basics of Data Science**: Benefits of data science-use of statistics and Machine Learning in Data Science- data science process - applications of Machine Learning in Data Science- modelling process- demonstration of ML applications in data science- Big Data and Data Science. (For visualization the software tools like Tableau, PowerBI, R or Python can be used. For Machine Learning implementation, Python, MATLAB or R can be used.) (Text book-5)	**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	Apply the concept of machine learning algorithms including neural networks and supervised/unsupervised learning techniques for engineering applications.	**K3**
CO2	Apply advanced mathematical concepts such as matrix operations, singular values, and principal component analysis to analyze and solve engineering problems**.**	**K3**
CO3	Analyze and interpret data using statistical methods including descriptive statistics, correlation, and regression analysis to derive meaningful insights and make informed decisions.	**K3**
CO4	Integrate statistical approaches and machine learning techniques to ensure practically feasible solutions in engineering contexts.	**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								

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press	6^{th} edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media, Inc.	2^{nd} edition,2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1^{st} edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9^{th} edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1^{st} edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data science: concepts and practice	Kotu, Vijay, and Bala Deshpande	Morgan Kaufmann	2^{nd} edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1^{st} edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1^{st} edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1^{st} edition, 2019
5	Probability and Statistics - The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1^{st} edition, 2009
6	An Introduction to the Science of Statistics: From Theory to Implementation	Joseph C. Watkins	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.math.arizo	Preliminary Edition.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106198/
2	https://archive.nptel.ac.in/courses/106/106/106106198/ https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-29-singular-value-decomposition/
3	https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-19-video/
4	https://archive.nptel.ac.in/courses/106/106/106106198/

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	**6**

	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: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**, employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations**, Ethical values and practices in**	**6**

	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 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	**6**

	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

CIRCUITS AND MEASUREMENTS LAB

Course Code	**PCEEL307**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:0:3	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	**Course Type**	Lab

Course Objectives:

1. To train the students to familiarize and practice various measuring instruments and different transducers for measurement of physical parameters.
2. Students will also be introduced to a team working environment where they develop the necessary skills for planning, preparing and implementing basic instrumentation systems

Expt. No.	Experiments
1	Verification of Superposition theorem. *
2	Verification of (a) Thevenin's theorem and Maximum Power Transfer theorem.* (b) Calculation of Norton's equivalent circuit (calculation only).
3	Determination of impedance, admittance and power factor in RLC series/ parallel circuit and to study the effect of reactive components on power factor.
4	Measurement of two port network parameters.
5	Step response of RLC circuit (suggested to use DSO).
6	3-phase power measurement using one-wattmeter and two-wattmeter methods, and determination of reactive/apparent power drawn.*
7	Resistance measurement using Wheatstone's bridge and extension of range of voltmeters.
8	Resistance measurement using Wheatstone's bridge and extension of range of voltmeters.
9	Extension of instrument range using instrument transformers (CT and PT).
10	Calibration of 1-phase Energy meter at various power factors and phantom loading (minimum 3 conditions) *.
11	Calibration of 3-phase Energy meter using standard wattmeter
12	Determination of B-H curve, μ-H curve and μ-B curve of a magnetic specimen.

13	Measurement of self inductance, Mutual inductance and Coupling coefficient of a 1-phase transformer.
14	Measurement of Capacitance/ Inductance/ frequency using AC bridges.
15	Determination of characteristics of Thermal sensors: Thermistor, Thermocouple and RTD*.
16	Determination of P-V characteristics of solar PV array and determination of fill factor (study of partial shading may be included).
17	Determination of insulation resistance and earth resistance.
18	Calibration of meters (Ammeter/Voltmeter) using Potentiometers.
19	Determination of characteristics of transducers: LVDT, Strain gauge, and Load-cell
20	Simulation of circuits using software platforms like PSpice/LT spice / MATLAB / Multisim etc.*
21	Implementation of IoT-based data acquisition system
22	Demo Experiments: (a) Measurement of energy using TOD meter / Digital meters/ Bidirectional meter (b) Measurement of electrical variables and frequency using CRO and DSO (c) Harmonic analysers (d) Instrumentation systems for Gas / Fire/ Smoke Detection Systems. (e) Virtual instrumentation experiments using LABVIEW

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	Analyse voltage current phasor relations of RLC circuits	**K3**
CO2	Verify DC network theorems by setting up various electric circuits	**K3**
CO3	Measure power in single and three phase circuits by various methods	**K3**
CO4	Determine the calibration characteristics of various meters used in electrical systems	**K3**
CO5	Determine magnetic characteristics of different electrical devices	**K3**
CO6	Analyse the characteristics of various types of transducer systems	**K3**
CO7	Determine electrical parameters using various bridges	**K3**
CO8	Develop simulation models of electric circuits using modern simulation tools.	**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			3
CO2	3	3	2	-	-	-	-	-	2	-	-	3
CO3	3	3	-	-	-	-	-	-	2	-	-	3
CO4	3	3	-	-	-	-	-	-	2	-	-	3
CO5	3	3	-	-	-	-	-	-	2	-	-	3
CO6	3	3	2	-	3	-	-	-	2	-	-	3
CO7	3	3	-	-	-	-	-	-	2	-	-	3
CO8	3	3	2	-	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	A course in Electrical and Electronic Measurements & Instrumentation,	A. K. Sawhney:	Dhanpat Rai Publishers	
2	A course in Electrical & Electronic Measurement & Instrumentation	J. B. Gupta:	S. K. Kataria & Sons Publishers	
3	Electronic Instrumentation	Kalsi H. S.:	Tata McGraw Hill, New Delhi.	3

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

ANALOG ELECTRONICS LAB

Course Code	**PCEEL308**	**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)	Nil	**Course Type**	Lab

Course Objectives:

1. Design of Transistor and Op amp Circuits
2. Simulation and hardware implementation of the circuits

Expt. No.	**Experiments**
Pre Lab Assignment	Measurement of current, voltage, frequency and phase shift of signal in a RC network using oscilloscope.
	Introduction to circuit simulation using any circuit simulation software.
1	Clipping and clamping circuits using diodes.
2	Basic RC circuits- High pass and Low pass filters
3	RC coupled amplifier using BJT in CE configuration-Measurement of gain, BW and plotting of frequency response.
4	Emitter Follower Amplifier
5	JFET amplifier-Measurement of gain, BW and plotting of frequency response.
6	MOSFET amplifier
7	Design and testing of voltage regulators – Zener and series
8	Design and set up of inverting and non-inverting amplifier.
9	Op-amps circuits – Scale changer, adder, integrator, and differentiator.
10	Precision rectifier using Op-amp.
11	Op- Amp Oscillators – RC Phase shift and Wien Bridge Oscillator
12	Op Amp Oscillator - LC Oscillators- Colpitts or Hartley Oscillator
13	Waveform generation– Square, triangular and saw tooth waveform generation using OPAMPs.

14	Basic comparator and Schmitt trigger circuits using Op-amp (Use comparator ICs such as LM311).
15	Active Filters (High Pass and Low pass-one each)
16	Instrumentation Amplifier
17	Astable and Monostable circuit using 555IC.
18	Introduction to PCB layout software.

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	Use the various electronic instruments and for conducting experiments.	**K1**
CO2	Design and develop various electronic circuits using diodes and Zener diodes.	**K3**
CO3	Design and implement amplifier and oscillator circuits using BJT and JFET.	**K3**
CO4	Design and implement basic circuits using IC (OPAMP and 555 timers).	**K3**
CO5	Simulate electronic circuits using any circuit simulation software.	**K3**
CO6	Use PCB layout software for circuit design	**K2**

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											
CO2	2	3	3	3	3				3	3		
CO3	2	3	3	3	3				3	3		
CO4	2	3	3	3	3				3	3		
CO5	2	3	3	3	3				3	3		
CO6	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	Introductory Electronic Devices and Circuits	Robert T Paynter	Pearson Education	
2	Electronic devices and Circuit Theory	Boylestad R. L. and L. Nashelsky	Pearson Education	
3	Electronic Circuits : Analysis and Design	Donald A Neaman	McGraw Hill Companies	

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

ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER S4

MATHEMATICS FOR ELECTRICAL SCIENCE– 4

(B Group)

Course Code	**GBMAT401**	**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 probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To expose the students to the basics of random processes essential for their subsequent study of analog and digital communication.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson 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	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and *t*-distribution), Hypotheses and Test Procedures, Type I and Type II error, *z* Tests for Hypotheses about a Population Mean (for large sample), *t* Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. **[Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]**	**9**
4	Random process concept, classification of process, Methods of Description of Random process, Special classes, Average Values of Random Process, Stationarity- SSS, WSS, Autocorrelation functions and its properties, Ergodicity, Mean-Ergodic Process, Mean-Ergodic Theorem, Correlation Ergodic Process, Distribution Ergodic Process. **[Text 2: Relevant topics from Chapter 6]**	**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	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using z-tests and the one-sample t-test.	**K3**
CO4	Analyze random processes by classifying them, describing their properties, utilizing autocorrelation functions, and understanding their applications in areas like signal processing and communication systems.	**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	-	-	-	-	-	-	-	2
CO2	3	3	2	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	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9th edition, 2016
2	Probability, Statistics and Random Processes	T Veerarajan	The McGraw-Hill	3rd edition, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. & Pillai, S.U.,	McGraw Hill.	4th edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6th edition, 2020
3	Probability and Random Processes	Palaniammal, S.	PHI Learning Private Limited	3rd edition, 2015
4	Introduction to Probability	David F. Anderson, Timo, Benedek	Cambridge	1st edition, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/117/105/117105085/
2	https://archive.nptel.ac.in/courses/117/105/117105085/
4	https://archive.nptel.ac.in/courses/117/105/117105085/

SEMESTER S4

SYNCHRONOUS & INDUCTION MACHINES

Course Code	PCEET402	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)	PCEET303	Course Type	Theory

Course Objectives:

1. Describe the constructional details, working and analyse the performance of synchronous machines and induction machines under various load conditions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Principle of Operation of 3-phase alternators – classification - constructional features - types of armature windings – winding diagram of a 3-phase, 12 slot, 2-pole, single layer full-pitched armature winding (winding diagram not for evaluation) – coil-span factor and distribution factor (sinusoidal flux distribution only) - EMF equation – numerical problems Cylindrical-rotor type synchronous generator on no-load – open circuit characteristics - Synchronous generator on load – armature reaction – effect of armature reaction - synchronous impedance - Equivalent circuit - phasor diagram – numerical problems Voltage regulation – OC and SC tests – emf and mmf methods – ZPF test - Potier method – numerical problems	12

2	Power flow equations in cylindrical-rotor type synchronous generator – numerical problems Parallel operation - synchronous generator on infinite bus-bar – conditions – methods of synchronisation – effect of change of mechanical input – effect of change of excitation - V-curves and inverted V curves – numerical problems Salient-pole synchronous generator - two reaction theory – phasor diagram – slip test for determination of X_d and X_q - numerical problems Synchronous motor – rotating magnetic field - principle of operation – starting methods Power developed (both cylindrical rotor type and salient-pole type) – excitation power & reluctance power – power angle characteristics - losses and efficiency – numerical problems V-curves and inverted V curves	**12**
3	3-phase Induction motor – principle of operation - classification - constructional features – torque equation - torque-slip characteristics – relation between starting torque, maximum torque and full-load torque - numerical problems Phasor diagram - equivalent circuit Power flow diagram - losses and efficiency – numerical problems No-load and blocked-rotor tests – circle diagram – numerical problems Starting of induction motors – types of starters – DOL starter, autotransformer starter, star-delta starter – numerical problems - rotor resistance starter (no design)	**11**
4	Braking of Induction motors – plugging, dynamic braking, regenerative braking (concepts only) Speed control – stator voltage control, V/f control, rotor resistance control Induction generator – line excited and self-excited induction generators (principle of operation only) – torque-slip characteristics for braking, motoring and regeneration Single-phase induction motors – double revolving field theory – equivalent circuit – torque slip characteristics Types of 1-phase inductions motors – split-phase, capacitor-start induction-run, permanent capacitor types – 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 =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	Describe the constructional details and analyse the performance of synchronous generators under various load conditions.	**K3**
CO2	Analyse the performance of synchronous motors under various load conditions	**K3**
CO3	Describe the constructional details and analyse the steady-state performance of induction motors under various load conditions	**K3**
CO4	Analyse the various starting, braking and speed control methods of 3-phase induction motors.	**K3**
CO5	Explain the construction details and working of various types of single-phase induction motors.	**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	2										3
CO2	3	2										3
CO3	3	2										3
CO4	3	2										3
CO5	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	Electrical Machinery	P.S. Bhimbra	Khanna	7th edition 2021
2	Performance & Design of AC Machines	M.G. Say	CBS	3rd edition 2002
3	Electric Machines	Kothari & Nagrath	Tata McGraw-Hill	5th edition 2017
4	Induction & Synchronous Machines	K Murugesh Kumar	Vikas	11th edition 2000
5	Theory & Performance of Electrical Machines	J.B. Gupta	S.K. Kataria	15th edition 2022

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/105/108105131/

SEMESTER S4

POWER ELECTRONICS AND DRIVES

Course Code	**PCEET403**	**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)	PCEET303, PCEET304	**Course Type**	Theory

Course Objectives:

1. To give a strong foundation on power converters, power quality and electric drives
2. To enable the students to select suitable power devices and passive components for target applications
3. To motivate students to design and implement power electronic converters having high efficiency, small size, high reliability and low cost

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Role of Power Electronics, Motivation, Objectives and Challenges, Power Electronics Vs Linear Electronics, Ideal and real switches- Static and dynamic Performance – Power losses- Temperature rise- Thermal Analogy- Use of Heat sinks- Need for high efficiency, small size, high reliability and low cost- Overview of Applications Uncontrolled Switch: Power Diodes – Types- Characteristics (Static and Dynamic) –Effects of Reverse Recovery Transient- Ratings-Schottky Diodes – Features & Applications Semi-controlled switch: SCR (Thyristor) – Symbol, Structure, Characteristics (Static and dynamic) – Turn-on and Turn-off phenomena – Ratings- Gate control of SCR – Gate pulse magnitude and duration requirements- Typical gate drive circuits – Gate synchronisation – Isolated gate drives	**11**

	Fully-controlled switches: MOSFETS and IGBTs: Symbol, Structure, Characteristics (Static and Dynamic) -Device ratings -Gate drive requirements–Typical gate drive circuits Modern power devices: Introduction to Wide Bandgap Devices – SiC MOSFET and GaN HEMT – Features and advantages **Suggestions:** Reading and interpreting datasheets are to be encouraged [To be tested through assignments] –Possibility of simulation assignments/homework may be explored- Design of MOSFET/IGBT gate drives – need/requirement of isolation in certain circuits- Use of pulse transformers/opto-isolators – sample circuits [Design assignments may be given using popular driver ICs for MOSFETs/SCRs – not to be tested in ESE]	
2	Controlled Rectifiers (Single Phase) – Fully controlled and half-controlled rectifiers (semi-converter)with RL and RLE loads- Rectifier and inverter modes of operation- waveforms (continuous & discontinuous conduction)– Output voltage, Input line current, Real Power, Power factor and THD(Continuous conduction, ripple free current)- Effect of source inductance(Full converter in continuous conduction, ripple free current) Controlled Rectifiers (3-Phase) - Fully controlled & Half-controlled bridge converter with RLE load (continuous conduction, ripple free current)– Waveforms- Output voltage equation AC voltage controllers (ACVC) – 1-phase full-wave ACVC with R & RL loads – waveforms – RMS output voltage - applications DC-DC Switching Regulators- Buck, Boost & Buck-Boost– Operation with Continuous conduction Waveforms– Effect of non-idealities such as capacitor ESR and inductor resistance (qualitative treatment only)- Design of filter inductance and capacitance- Selection of power devices	**12**
3	Switch mode DC-AC Voltage Source Inverters (VSI)- Single phase Half-Bridge and Full-Bridge configurations- Sinusoidal Pulse Width Modulation (PWM) - Control of Fundamental output voltage- Harmonic spectrum- Bipolar and Unipolar PWM- Linear, Over Modulation and Square wave modes -Merits and demerits- Need for blanking time (dead-time) Three-Phase Pulse Width Modulated VSI - Fundamental Output voltage- Linear, Over Modulation and Square wave modes – Third harmonic Injection PWM Single phase current regulated VSI –Tolerance band current control- Fixed	**11**

	frequency operation - Single phase current source Inverters (IGBT based)-Comparison Need for improved utility interface- Generation of current harmonics- Power factor- Harmonics and IEEE 519 standard- Active shaping of the input line current- Single-phase front end boost converter(circuit diagram, operation, block diagram of the control scheme)	
4	Introduction to Electric Drives– Advantages of adjustable speed electric drives –Block diagram, Types of loads – Classification of load torque- Motor torque-load combination: characteristics and dynamic equation- Steady state stability DC Drives- Chopper control of Separately Excited DC drives (SEDC) –One quadrant, Two quadrant and four quadrant Chopper fed drives(Continuous conduction only)- Motoring and Regenerative braking – Speed-Torque characteristics – Speed control- Controlled rectifier fed separately excited DC motor drive- Single phase and three phase (Continuous conduction only)- Speed-Torque characteristics- Speed control –Dual converter drives (single phase) - Circulating current Type and Non-circulating current - Static four-quadrant operation with SEDC Three-phase VSI fed induction motor drives: Stator Voltage control - V/F speed control– Speed-Torque characteristics- Speed control – operation below and above base speed – Braking: dynamic and regenerative	**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	Understand the operation of modern power semiconductor devices, its characteristics and select suitable gate driver circuits & heatsinks	**K3**
CO2	Understand the features of phase-controlled rectifiers, AC voltage Controllers &Switching Regulators and analyse the operation	**K3**
CO3	Understand the features of different types of switch mode DC-AC Inverters and analyse the operation	**K3**
CO4	Understand the need for improved efficiency, improved reliability, improved load &source waveforms and improved utility interface	**K2**
CO5	Understand the features of adjustable speed drives and analyse the Basic drive schemes for DC motors and Induction Motors	**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	1	3									2
CO3	3	1	3									2
CO4	3	1	3									2
CO5	3	1	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	Power Electronics- Converters, Applications and Design, 3ed(Indian Adaptation) by Mohan, Undeland, Robbins, Wiley India, 2022	Ned Mohan, Undeland, Robbins	Wiley-India	2022
2	Power Electronics- Principles and Applications	Joseph Vithayathil	Tata McgrawHill	2010
3	Power Electronics	Cyril W Lander	McGrawHill	1993
4	Power Electronics – Circuits, Devices and Applications	Muhammad H. Rashid	Pearson Education	2014
5	Power Electronics	D.W. Hart	McGrawHill	2010
6	Power Electronics – Essentials & Applications	L. Umanand	Wiley-India	2009
7	Fundamentals of Electric Drives	G K Dubey	Narosa	2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Elements of Power Electronics	Philip T Krein	Oxford	2017
2	Power Electronics Handbook-5e	Muhammad H. Rashid	Butterworth	2024

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Lecture Series on Power Electronics **by Prof. G. Bhuvaneswari**, IIT Delhi https://www.youtube.com/watch?v=Z2CORFayCv0&list=PLp6ek2hDcoND7i5-DAD9mPmYF1Wg6ROdO&index=3
2	NPTEL Lecture Series on Power Electronics by **Prof. L. Umanand**, IISc Bangalore https://www.youtube.com/watch?v=eLIdqiPMjBs&list=PLgMDNELGJ1CaXa4sX6QSrkhu-yP_Wu2EN&index=26
3	NPTEL Lecture Series by**Prof.ShabariNath**, IIT Guwahati https://www.youtube.com/watch?v=S_UXW2UzAi8&list=PLwdnzlV3ogoWVgA9fHBV36L_bxWZlpa7X&index=7

SEMESTER S4

DIGITAL ELECTRONICS

Course Code	PBEET404	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. Explain the various number systems, Digital logic gates and Boolean expressions
2. Design and implement different types of combinational and sequential logic circuits
3. Design and implement digital circuits using Hardware Descriptive Language.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Number Systems and Codes** – binary, octal and hexadecimal – conversions – ASCII code, Excess – 3 code, Gray code, BCD code **Signed numbers** – 1's complement and 2's complement – addition and subtraction **Basic logic gates** – universal gates – TTL – CMOS – Internal diagram of TTL NAND gate and CMOS NOR gate – comparison of CMOS and TTL performance. **Boolean laws and theorems** – Sum of products and Product of sums forms – K map representation and simplification (up to four variables) – pairs, quads, octets – don't care conditions.	9
2	**Combinational circuits** – half adder and full adder, half subtractor and full subtractor – 4-bit parallel binary adder/subtractor. **Comparators** – parity generators and checkers – encoders – decoders – BCD to seven segment decoder. **Multiplexers** – implementation of boolean expressions using multiplexers – demultiplexers.	9

3	**Flip-Flops** – SR, JK, D and T flip-flops – characteristic table and excitation table – JK Master Slave Flip-flop – Conversion of flip- flops – SR to JK and JK to SR only. **Up/Down counters** – asynchronous counters – mod-6 and mod-10 counters. Synchronous counters – design of synchronous counters – Ring counter – Johnson Counter. **Shift registers -** SISO, SIPO, PISO, PIPO.	**10**
4	**State Machines** – state transition diagram – Moore and Mealy machines. **Digital to Analog converter** –weighted resistor type, R-2R Ladder type. **Analog to Digital Converter** – flash type, successive approximation type. **Introduction to Verilog** – Implementation of AND, OR, half adder and full adder.	**8**

Suggestion on Project Topics

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 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	Identify various number systems, binary codes and formulate digital functions using Boolean algebra.	**K2**
CO2	Design combinational logic circuits.	**K3**
CO3	Design sequential logic circuits.	**K3**
CO4	Describe the operation of various analog to digital and digital to analog conversion circuits.	**K2**
CO5	Explain the basic concepts of programming using Verilog HDL	**K2**
CO6	Design and realize medium complexity practical digital hardware circuits.	**K6**

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
CO2	3	2		2	2			2	2			3
CO3	3	2		2	2			2	2			3
CO4	3	2										3
CO5	3	2		2	2			2	2			3
CO6	3	3	3	3	3	2	2	3	3		2	3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Fundamentals	Floyd T.L	Pearson Education	11/e, 2017
2	Digital Principles and Applications	Albert Paul Malvino & Donald P. Leach	Mc-GRAW Hill International Editions	4/e, 2018
3	Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog	M. Morris Mano, Michael D. Ciletti	Pearson Education	6/e, 2018
4	Digital Integrated Electronics	Herbert Taub and Donald Schilling	McGraw Hill Education	2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Digital Logic with Verilog Design	Stephen Brown	McGraw Hill Education	2nd Edition
2	Fundamental of Digital Circuits	A Anand Kumar	Prentice Hall	4/e, 2023
3	Digital Circuits and Design	S. Salivahanan	Oxford University Press	2018
4	Digital Design Verilog HDL and Fundamentals	Joseph Cavanagh	CRC Press	1st Edition, 2008

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/105/108105132/ https://archive.nptel.ac.in/courses/18/106/108106177/
2	https://archive.nptel.ac.in/courses/108/105/108105132/ https://archive.nptel.ac.in/courses/108/106/108106177/
3	https://archive.nptel.ac.in/courses/108/105/108105132/ https://archive.nptel.ac.in/courses/108/106/108106177/
4	https://archive.nptel.ac.in/courses/108/105/108105132/ https://archive.nptel.ac.in/courses/108/106/108106177/

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

ELECTRONIC INSTRUMENTATION

Course Code	**PEEET411**	**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)	PCEET205	**Course Type**	Theory

Course Objectives:

1. The objective of this course is to impart comprehensive understanding in the field of electronic instrumentation, industrial instrumentation and communication systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Functional elements of electronic instrumentation system – Calibration methods: Static, Dynamic, Field, Traceable, Master. Transducers- Classification-Criteria for selection- Static and dynamic characteristics- Zeroth and first order instruments and time responses. Resistive transducers for liquid level and humidity Inductive transducers- types and basic principles- LVDT- synchro Capacitive transducers- types and basic principles- Thickness measurement Piezoelectric transducers- Hall effect transducers-Basic principle and applications Electronic IC for sensor applications, Micro Electromechanical system (MEMS) Advantages and Applications, MEMS micro sensors and actuators, MEMS accelerometers	**10**

2	Signal conditioning for instrumentation systems: Voltage to Current Converter, Transducer bridges: null type and deflection bridges, AC bridges using push pull transducers Amplifiers: Instrumentation amplifiers- charge amplifiers- isolation amplifier Role of filters: Low pass, high pass, band pass and band rejection filters, Introduction to digital filters Data Transmission- Types of Telemetry System- Modulation methods: Pulse modulation, Pulse amplitude modulation, Pulse code modulation General telemetry systems- Cable transmission of analog and digital data- Fibre optic data transmission Principles of time division and frequency division multiplexing- Radio-wireless communication, WLAN architecture. Protocols: Field Bus, Profibus , HART	**10**
3	Display methods and devices: Different types of display –display system building blocks. Data Presentation Element: Recorders-Strip Chart Recorder, Potentiometric Recorder, X-Y Recorder. Magnetic recorder, Digital recorders- Data logger Experiments and statistical analysis: Performance of experiment-characteristics of experimental data- description of dispensed data- type of probability distribution-probability error	**9**

4	Introduction to Process Control - Block diagram of the process control loop. Analog and Digital DAS: Programmable logic controllers (PLC), Organization- Hardware details- I/O- Power supply- CPU- Standards Programming aspects- Ladder programming- realization of AND, OR, NAND, NOR and XOR logic, the concept of latching, Introduction to Timer/Counters, Numerical Exercises based on Timers and Counters. SCADA and DCS systems: SCADA: Introduction, SCADA Architecture, Common System Components, Supervision and Control, HMI, RTU and Supervisory Stations, Protocols-IEC 60870-5-101 and DNP3. Distributed Control System: Introduction, DCS Architecture, Control modes.	**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	Identify the sensors/transducers suitable for industrial applications.	**K3**
CO2	Design the signal conditioning circuits for industrial instrumentation and automation.	**K3**
CO3	Understand the concepts of data transmission methods applicable to electronic instrumentation systems.	**K2**
CO4	Develop the logic for the process control applications using PLC programming	**K3**
CO5	Analyze the performance of measurement systems using statistical methods	**K4**
CO6	Describe the fundamental concepts of DCS and SCADA 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	2	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	2	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	2	-	-	-	-	-	-	2
CO5	3	2	-	-	2	-	-	-	-	-	-	2
CO6	3	2	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	A course in Electrical and Electronic Measurements & Instrumentation	A. K. Sawhney	Dhanpat Rai & Co.	2011
2	A course in Electrical & Electronic Measurement & Instrumentation	J. B. Gupta	S K Kataria & Sons	14th Ed., 2014
3	Electrical Measurements & Measuring Instruments	Golding E.W and Widdis	Wheeler Pub.	
4	Electronic Instrumentation	H. S. Kalsi	McGraw Hill, New Delhi	4th Ed., 2019
5	Principles of Electrical Measurement	S Tumanski	Taylor & Francis.	
6	Electronic Instrumentation and Measurements	David A Bel	Oxford	
7	Programmable Logic Controllers	William Bolton	Elsevier India Pvt. Ltd	5th edition,
8	SCADA: Supervisory Control and Data Acquisition	Stuart A. Boyer,	International Society of Automation,	4th edition, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Electronics Instrumentation	Cooper W.D	Prentice Hall of India	
2	Basic Electrical Measurements	Stout M.B	Prentice Hall	
3	Electronic Measurements & Instrumentation	Oliver & Cage	McGraw Hill	
4	Doebelin's Measurements Systems	E.O Doebelin and D.N Manik	McGraw Hill Education (India) Pvt. Ltd.	6th Ed.
5	Electrical and Electronics Measurements and Instrumentation	P.Purkait, B.Biswas, S.Das and C. Koley	McGraw Hill Education (India) Pvt. Ltd.,	2013

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/105/108105153/ https://archive.nptel.ac.in/courses/108/108/108108147/
2	https://archive.nptel.ac.in/courses/108/105/108105153/
3	https://archive.nptel.ac.in/courses/108/105/108105153/
4	https://archive.nptel.ac.in/courses/108/108/108108147/ https://archive.nptel.ac.in/courses/106/105/106105166/

SEMESTER S4

RENEWABLE ENERGY SOURCES

Course Code	PEEET412	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 understand energy scenario, energy sources and their utilization
2. To explore society's present needs and future energy demands
3. To study the principles of renewable energy conversion systems
4. To be exposed to energy conservation methods

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** Principles of renewable energy; energy and sustainable development, fundamentals and social implications. Worldwide renewable energy availability, renewable energy availability in India, types of renewable energy. **Wind Energy:** Properties of wind, availability of wind energy in India, wind velocity and power from wind (numerical problems); major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and multi-blade system. Vertical axis - Savonius and Darrieus types.	9

2	**Solar Energy:** Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements - Pyrheliometers, Pyranometer, Sunshine Recorder. Solar Thermal systems: concentrating and non-concentrating collectors - Flat plate collectors; Solar tower electric power plant. Photovoltaic system for electric power generation – Classification of PV system - Principle of Solar cell, advantages, disadvantages and applications of solar photovoltaic system.	9
3	**Biomass Energy:** Introduction; Principle of biomass energy generation - Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome type biogas plant; Urban waste to energy conversion; Biomass gasification (Downdraft). **Tidal Power:** Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, classification of tidal power plants - harnessing tidal energy, advantages and limitations.	9
4	**Ocean Thermal Energy Conversion:** Principle of working, classification, OTEC power stations in the world, environmental impacts associated with OTEC. Introduction to geothermal energy **Green Energy:** Introduction, Fuel cells: Classification of fuel cells – Hydrogen energy; Operating principles, Zero-energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.	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	Describe the environmental aspects of renewable energy resources in comparison with various conventional energy systems, their prospects and limitations.	**K1**
CO2	Understand the concepts of wind energy.	**K1**
CO3	Describe the use of solar energy and the various components used in the energy production with respect to applications like-heating, cooling, desalination, power generation.	**K2**
CO4	Understand the concept of biomass energy resources and conversion principles of tidal energy.	**K2**
CO5	Acquire the basic knowledge of ocean thermal energy conversion. Understand the principle of green energy and hydrogen energy.	**K1**

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
CO2	3	3										2
CO3	3	3										2
CO4	3	3										2
CO5	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	Non-conventional energy sources	G. D. Rai	Khanna	4th edition 2023
2	Renewable energy systems	Thomas E. Kissell, David M. Buchla, Thomas L. Floyd,	Pearson	2017
3	Non-Conventional Energy Resources	Sawhney G. S.	PHI Learning	2012
4	Renewable energy systems	Thomas E. Kissell, David M. Buchla, Thomas L. Floyd,	Pearson	Pearson 2017

SEMESTER S4

MATHEMATICS FOR MACHINE LEARNING

Course Code	PEEET413	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. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built.
2. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand and debug existing ones, and learn about the inherent assumptions and limitations of the current methodologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.	9
2	ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky	9

	Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.	
3	VECTOR CALCULUS: Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation. Higher Order Derivatives- Linearization and Multivariate Taylor Series.	**9**
4	Probability and Distributions: Construction of a Probability Space - Discrete and Continuous Probabilities, Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform. Optimization: Optimization Using Gradient Descent - Gradient Descent With Momentum. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming.	**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	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems	**K3**
CO2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients	**K3**
CO3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems	**K3**
CO4	Train Machine Learning Models using unconstrained and constrained optimization 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	2	1									2
CO2	3	2										2
CO3	3	2	1									2
CO4	3	2										2
CO5												

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mathematics for Machine Learning	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press (freely available at https:// mml - book.github.io)	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Linear Algebra and Its Applications,	Gilbert Strang		4th Edition
2	Linear Algebra Done Right	Axler, Sheldon	Springer	2015
3	Introduction to Applied Linear Algebra	Stephen Boyd and Lieven Vandenberghe	Cambridge University Press	2018
4	Pattern Recognition and Machine Learning	Christopher M Bishop	Springer	2006
5	Convex Optimization	Stephen Boyd and Lieven Vandenberghe	Cambridge University Press	2004
6	Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond	Bernhard Scholkopf and Smola, Alexander J Smola	MIT Press	2002
7	Information Theory, Inference, and Learning Algorithms	David J. C MacKay	Cambridge University Press	2003
8	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	2012
9	The Nature of Statistical Learning Theory	Vladimir N Vapnik	Springer	2000

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	archive.nptel.ac.in/courses/111/107/111107137 onlinecourses.nptel.ac.in/noc24_cs38/
2	archive.nptel.ac.in/courses/111/107/111107137 onlinecourses.nptel.ac.in/noc24_cs38/
3	archive.nptel.ac.in/courses/111/107/111107137 onlinecourses.nptel.ac.in/noc24_cs38/
4	archive.nptel.ac.in/courses/111/107/111107137 onlinecourses.nptel.ac.in/noc24_cs38/

SEMESTER S4

THEORY OF COMPUTATION

Course Code	PEEET414	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 code)	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to formal language theory– Alphabets, Strings, Concatenation of strings, Languages. Regular Languages - Deterministic Finite State Automata (DFA) (Proof of correctness of construction not required), Nondeterministic Finite State Automata (NFA), Equivalence of DFA and NFA, Regular Grammar (RG), Equivalence of RGs and DFA.	9
2	Regular Languages -Regular Expression (RE), Equivalence of REs and DFA, Homomorphisms, Necessary conditions for regular languages, Closure Properties of Regular Languages, DFA state minimization (No proof required).Context Free Grammar (CFG)- CFG representation of Context Free Languages (proof of correctness is required), derivation trees and ambiguity, Normal forms for CFGs	9

3	Context-Free Languages -Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA), Equivalence of PDAs and CFGs (Proof not required), Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages	**9**
4	Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata. Turing Machines - Standard Turing Machine, Robustness of Turing Machine, Universal Turing Machine, Halting Problem, Recursive and Recursively Enumerable Languages. Chomsky classification of formal languages	**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	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable	**K2**
CO2	Design finite state automata, regular grammar, and regular representations for regular languages.	**K3**
CO3	Design push-down automata and context-free grammar representations for given context-free languages.	**K3**
CO4	Design Turing machines as language acceptors or transducers.	**K3**
CO5	Explain the notion of decidability.	**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	2	-	-	-	-	-	-	-	-	3
CO2	3	3	3	2	-	-	-	-	-	-	-	3
CO3	3	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	Automata and Computability,	Dexter C. Kozen	Springer	1999

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Automata Theory, Languages, and Computation	John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman,	Pearson Education	3/e, 2007
2	Introduction To Theory of Computation,	Michael Sipser	Cengage Publishers	2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=77nkSUsQqJk
2	https://www.youtube.com/watch?v=77nkSUsQqJk
3	https://www.youtube.com/watch?v=77nkSUsQqJk
4	https://www.youtube.com/watch?v=77nkSUsQqJk

SEMESTER S4

COMPUTER ORGANIZATION

Course Code	PEEET416	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 code)	Course Type	Theory

Course Objectives:

1. The course introduces the principles of computer organization and the basic architectural concepts.
2. To be understand memory systems in digital computer.
3. To better with IO devices communication with processor.
4. To understand control logic design.
5. To be clear with pipeline concepts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basic Structure of computers** –functional units - basic operational concepts - bus structures. Memory locations and addresses -memory operations, Instructions and instruction sequencing, addressing modes. **Basic processing unit** – fundamental concepts – instruction cycle – execution of a complete instruction -single bus and multiple bus organization.	9
2	**Register transfer logic:** Inter register transfer – arithmetic, logic and shift micro-operations. **Processor logic design:** - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit – Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator(Basic Concept Only).	9

3	**Control Logic Design:** Hardwired control-microprogrammed control-Microinstructions, Microprogram Sequencing. **Arithmetic algorithms:** Signed-Operand multiplication, Booth Algorithm, fast multiplication-bit pair recoding of multipliers. **Pipelining:** Basic principles, classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.	9
4	**Memory system:** Types of memory(**Concepts only),** Virtual memory, Content addressable memory, cache memories - mapping functions. **I/O organization:** Characteristics of I/O devices, Data transfer schemes - Programmed controlled I/O transfer, Interrupt controlled I/O transfer. Organization of interrupts - vectored interrupts – Servicing of multiple input/output devices – Polling and daisy chaining schemes. Direct memory accessing (DMA)	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	Identify the relevance of functional units, memory locations and addressing modes in a digital computer.	**K2**
CO2	Illustrate the register transfer logic,Processor logic design.	**K2**
CO3	Explain the implementation aspects of arithmetic algorithms and pipelining concept in a digital computer.	**K3**
CO4	Demonstrate the control signals required for the execution of a given instruction.	**K3**
CO5	Illustrate the organization of different types of memories and I/O organization.	**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	2	2	1						2		3
CO2	3	2	2	1						2		3
CO3	3	2	2	1						2		3
CO4	3	2	2	1						2		3
CO5	3	2	2	1						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	Computer Organization	Hamacher C., Z. Vranesic and S. Zaky,	McGraw Hill	5/e,2011
2	Digital Logic & Computer Design	Mano M. M	PHI	2004
3	Computer System Architecture	Mano M. M	PHI	2007

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	Patterson D.A. and J. L. Hennessy	Morgan Kaufmann Publishers	5/e,2013
2	Computer Organization and Architecture: Designing for Performance	William Stallings	Pearson,	9/e, 2013.
3	Computer Organization and Design	Chaudhuri P	Prentice Hall	2/e, 2008.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=msqxkEKFg8I&list=PLgHucKw979AvcnTpPNZMZyORdL5HvTr9m,, https://www.youtube.com/watch?v=k_QgyvsqtwA&list=PLgHucKw979AvcnTpPNZMZyORdL5HvTr9m&index=12
2	https://www.youtube.com/watch?v=0B-y1RPDXjs&list=PL59E5B57A04EAE09C&index=17
3	https://www.youtube.com/watch?v=AgoC0mlL6eQ&list=PLdS3u59E0DKjUKPcnCYxVxssEkX2zo-kV&index=8 https://www.youtube.com/watch?v=6CCwWCstDGc&list=PL1A5A6AE8AFC187B7&index=9https://www.youtube.com/watch?v=IQql2ojVzsU&list=PLEAYkSg4uSQ3dmkbCah82ek0KJnpz_DxL&index=5
4	https:/www.youtube.com/watch?v=Wfau1WC5m4c

SEMESTER S4

SOLID STATE DEVICES

Course Code	PEEET417	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)	GYEST104	Course Type	Theory

Course Objectives:

1. To design and analyze different electronic circuits for various applications.
2. To design various analog circuits using discrete electronic devices.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Wave shaping circuits**: First order RC low pass and high pass filters, Differentiator and Integrator, Diode clipping circuits, Diode clamping circuits, Voltage multipliers **Transistor biasing: Concept** of DC and AC load lines, Types -Fixed bias circuit, Self-bias, voltage divider bias, Bias stabilization. **Switching Circuits:** Astable, Bistable and Monostable multivibrators, Schmitt Trigger.	11
2	**BJT amplifiers:** RC coupled amplifier –Design, Voltage gain and frequency response. Small signal analysis of CE configuration - small signal hybrid-pi model for mid and low frequency (Gain, Input and output impedance). High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier. **Multistage amplifiers** - Cascade and Cascode amplifiers: Design, Effect on gain and bandwidth.	11
3	**MOSFETs** - MOSFET as an amplifier, Biasing of p-channel and n-channel MOSFET circuits, Small signal equivalent circuit, Small signal Voltage gain, current gain, input and output impedances of CS configuration, CS stage with diode connected load. **Feedback topologies:** Effect of positive and negative feedback on gain, frequency response and distortion, Feedback topologies and its effect on input and output impedance, Feedback amplifier circuits using BJT in	11

	each feedback topologies (Analysis of only Voltage series feedback circuit is required)	
4	**Oscillators:** Introduction, Barkhausen criterion, Classification of oscillators - RC phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators (working principle and design equations of the circuits only). Analysis of RC phase shift oscillator. **Power amplifiers:** Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary symmetry class B and class AB power amplifiers, Class C power amplifier efficiency and distortion (no analysis required). **Regulated power supplies:** Load and line regulation, Series voltage regulator, shunt voltage regulator, Short circuit protection and fold back protection.	**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	Design and analyze the RC circuits and BJT biasing circuits	**K4**
CO2	Perform small signal and high frequency analysis of BJT amplifier circuits using equivalent models	**K3**
CO3	Design and analyze MOSFET amplifier circuits	**K4**
CO4	Design and analyze feedback amplifiers and oscillators	**K4**
CO5	Design power amplifiers and voltage regulator circuits	**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	2									3
CO2	3	3										3
CO3	3	3	2									3
CO4	3	3	2									3
CO5	3	1	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	Electronic Devices and Circuit Theory	Robert Boylested and L. Nashelsky	Pearson	11/e,2017.
2	Microelectronic circuits	Sedra A S. and K. C. Smith	Oxford University Press	6/e,2013
3	Electronic Devices and Circuits	David A Bell	Oxford University Press	5/e,2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electronic circuits, Analysis and Design	Neamen D.	McGraw Hill	3/e,2007
2	Microelectronic Circuits – Analysis and Design	Rashid M. H	Cengage Learning	2/e,2011
3	Fundamentals of Microelectronics	Razavi B.	Wiley	2015
4	Integrated Electronics	Millman J. and C. Halkias	McGraw Hill	2/e, 2010

SEMESTER S4

ILLUMINATION TECHNOLOGY

Course Code	**PEEET418**	**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)	GBPHT121, GYEST104	**Course Type**	Theory

Course Objectives:

1. Understand the principles of light, including electromagnetic radiation, human eye perception, and the properties and types of lighting, both natural and artificial.
2. Develop the ability to measure and quantify light using various units and laws and apply these measurements to practical lighting scenarios.
3. Acquire the skills to design efficient and effective interior lighting systems, considering factors such as maintenance, uniformity, and the specific lighting needs of different environments.
4. Learn to design and implement outdoor lighting solutions, including street lighting, flood lighting, and special aesthetic lighting, with a focus on energy efficiency and safety.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Light: Electromagnetic radiation, Visible spectrum, Human eye and light perception, Visible light production by black body radiation and emission spectrum, Day lighting, Artificial lighting. Qualities of good lighting, Factor affecting the lighting – Glare (Discomfort and disability glare), Visual comfort probability (VCP) and Unified glare rating (UGR) to measure glare, Shadow, Colour rendering and Colour rendering index (CRI), Stroboscopic effect and method to reduce it. Methods of artificial lighting schemes – Direct, indirect, semi -direct, semi-indirect and diffused lighting, General lighting and task lighting, Areas of usage of such lighting schemes Definition of lamp and luminaire, Working of Incandescent and Halogen lamps, fluorescent lamps, Vapour lamps (LPSV, HPSV, Mercury), metal	**9**

	halide lamps, LED lamps.	
2	Measurements of Light : Definitions and units – Luminous flux & Lumen, luminous intensity & Candela, illuminance& Lux, Luminance &Candela/m^2, luminous efficacy, colour temperature, Candle power. M.H.C.P., M.S.C.P. and M.H.S.C.P. of lamp, Efficiency of a lamp, Concept of CIE 1931 colour space Laws of illumination – Inverse square law of illumination, Lambert's cosine law of illumination, Numerical problems based of laws of illumination, Practical application of the laws, Polar curve in illumination, Rousseau's construction Calculation of luminance and illumination in case of linear source, round source and flat source. Measuring apparatus- Goniophotometer, Integrating sphere, luxmeter	**10**
3	Design of Interior Lighting: Definitions of maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilisation and factors affecting it, Illumination required for various work planes, Types of fixtures and relative terms used for interior illumination such as DLOR and ULOR, Selection of lamp and luminance, Selection of utilisation factor, reflection factor and maintenance factor. Calculation of wattage of each lamp and no of lamps needed, Layout of lamp luminaire, Calculation of space to mounting height ratio, Indian standard recommendation and standard practices for illumination levels in various areas, Numerical problems from design of interior lighting. Installation aspects for lighting (mechanical and electrical) Special feature for entrance, staircase, corridor lighting, industrial building and hospital lighting, Emergency lighting, Lighting maintenance	**9**
4	Design of Outdoor Lighting: Street Lighting - Types of street and their level of illumination required, Terms related to street lighting, Types of fixtures used and their suitable application, Various arrangements in street lighting, Requirements of good street lighting , Selection of lamp and luminaire, Calculation of illumination level available on road. Flood Lighting: Terms related to flood lighting, Types of fixtures and their suitable applications, Selection of lamp and projector, recommended method for aiming of lamp, Calculation of their wattage and number and their arrangement. Tunnel lighting zones and schemes, Special Features of aesthetic lighting - decorative lighting of monuments, parks and streets, Safety considerations in public lighting, Sports lighting, lighting for hazardous area.	**9**

	Energy efficient lighting systems strategies and controls like dimmers, motion and occupancy sensors, photo sensors and timers. Introduction to software used for lighting design, DIALux and Relux(Self study)	

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 fundamental principles of light, including electromagnetic radiation, visible spectrum, and human eye perception and to analyse qualities of good lighting and factors affecting lighting such as glare, shadow, colour rendering, and stroboscopic effects.	**K4**
CO2	Apply methods of artificial lighting schemes and understand the working principles of various lamps and luminaires.	**K3**
CO3	Evaluate measurements of light using definitions, units, laws of illumination, and measurement apparatus.	**K5**
CO4	Design and implement efficient interior lighting systems that enhance visual comfort, optimize energy usage, and comply with standard practices and recommendations for various environments, including residential, commercial, and industrial spaces.	**K6**
CO5	Develop the ability to design and implement comprehensive outdoor lighting solutions, including street lighting, flood lighting, tunnel lighting, and aesthetic lighting for public spaces, ensuring energy efficiency, safety, and adherence to industry standards and practices.	**K6**

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	1	1	1	1	1	1
CO2	3	3	3	2	2	2	1	1	1	1	1	1
CO3	3	3	3	2	2	2	1	1	1	1	1	1
CO4	3	3	3	2	2	2	1	1	1	1	1	1
CO5	3	3	3	2	2	2	1	1	1	1	1	1

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	Applied Illumination Engineering	Jack L. Lindsey	PHI, 1991	1991
2	Lighting	D.C. Pritchard	Routledge	2016
3	The Lighting Handbook, Zumtobel Lighting GmbH, Austria July 2017			

Reference Books	
Sl. No	**Title of the Book**
1	National Lighting Code 2010 (SP72:2010), Bureau of Indian Standards
2	M.A. Cayless, Lamps and Lighting , Routledge, 1996
3	Lighting Engineering Applied calculations R. H. Simons and A. R. Bean, Routledge; 1st edition, 2020
4	Craig DiLouie, Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications, CRC Press, 2005.
5	Sask Power, SEP4, Roadway lighting Design guide
6	IS Codes : IS:1944-1970, IS:10322-1982, IS:3646-1992, IS:2440-1975, IS:6665-1972

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
Module – I to IV	https://archive.nptel.ac.in/courses/108/105/108105060/
Module – I to IV	http://www.nptelvideos.com/course.php?id=482
Module -III	https://www.youtube.com/watch?v=PZo4G12MbO4

SEMESTER S4

OBJECT ORIENTED PROGRAMMING

Course Code	PEEET419	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)	GBEST204 Programming in C	Course Type	Theory

Course Objectives:

1. To introduce the basic concepts of object-oriented design techniques.
2. To give a thorough understanding of basics of Java programming.
3. To provide basic exposure to the Exception handling and Multithreaded programming etc.
4. To impart the techniques of Swing in Java and database connectivity.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** **Approaches to Software Design -** Functional Oriented Design, Object Oriented Design, Case Study of Automated Fire Alarm System. **Object Modeling Using Unified Modeling Language (UML)** – Basic Object-Oriented concepts, UML diagrams, Use case Diagram, Class diagram. **Introduction to Java -** Java Buzzwords, Java program structure, Java compiler, Bytecode, Java Virtual Machine (JVM), Comments, Lexical Issues.	9

2	**Core Java Fundamentals:** **Primitive Data types -** Integers, Floating Point Types, Characters, Boolean. Type Conversion and Casting, Variables, Arrays, Strings. **Operators -** Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. **Control Statements -** Selection Statements, Iteration Statements and Jump Statements. **Object Oriented Programming in Java -** Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading. Inheritance - Super Class, Sub Class, Method Overriding-super Keyword. **Input/Output -** I/O Basics, Reading Console Input, Writing Console Output.	9
3	**More features of Java:** **Packages -** Defining Package, Importing Packages. **Access Control-**public, private, protected. **Exception Handling -** Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally. **Multithreaded programming-**Thread model, Creating threads, Creating multiple threads, thread synchronization.	9
4	**Graphical User Interface and Database support of Java:** **Swings fundamentals -** Swing Key Features, Model View Controller (MVC), Components and Containers, Swing Packages, Swing Layout Managers. **Event Handling in Swings:** Delegation event model, event handling using swing components-JFrame, JLabel, JButton, JTextField. **Java DataBase Connectivity (JDBC)-** JDBC architecture, Creating and Executing Queries – create table, delete, insert, select.	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	Write Java programs using the object-oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism.	**K2**
CO2	Utilise datatypes, operators, control statements, object-oriented class, concepts, I/O basics in Java to develop programs.	**K3**
CO3	Illustrate how robust programs can be written in Java using packages, exception handling mechanism and Multithreaded programming.	**K3**
CO4	Write Graphical User Interface based application programs by utilising Swing in Java and database connectivity.	**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	3	2	-	-	-	-	-	-	-		-
CO3	3	3	3	2	2	-	-	-	-	-	-	-
CO4	2	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	Java: The Complete Reference.	Herbert Schildt	Tata McGraw Hill	8th edition, 2011
2	Fundamentals of Software Engineering	Rajib Mall	PHI	4th edition, 2014
3	Java How to Program, Early Objects	Paul Deitel, Harvey Deitel	Pearson	11th Edition, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programming JAVA a Primer	BalagurusamyE	McGraw Hill	5/e, 2014.
2	Object Oriented Systems Development using the Unified Modeling Language	Ali Bahrami	McGraw-Hill Int.	2017
3	Introduction to Java Programming	Y. Daniel Liang	Pearson	7/e, 2013.
4	Core Java: An Integrated Approach	Nageswararao R.	Dreamtech Press	2008
5	Java in A Nutshell	Flanagan D	O'Reilly	5/e, 2005.
6	Object Oriented Design with UML and Java	Barclay K.J. Savage,	Elsevier	2004
7	Head First Java	Sierra K.	O'Reilly	2/e, 2005.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105191
2	https://onlinecourses.nptel.ac.in/noc20_cs08/preview

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 Mins.
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**, employment and everyday life, History of women in Science & Technology,	6

	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 Policies and Regulations:** Overview of key environmental policies and regulations (national and international), Role of engineers in policy	**6**

	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

DC MACHINES & TRANSFORMERS LAB

Course Code	PCEEL407	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)	PCEET303	Course Type	Lab

Course Objectives:

1. Provide practical experience in operation and testing of DC machines and transformers

Expt. No.	Experiments
	PART A – DC MACHINES
1	**Open circuit characteristics of DC shunt generator (CO1)** Objectives: a. Predetermine the OCC at different speeds b. Determine the critical field resistance c. Determine the maximum voltage built up with given shunt field resistance d. Determine the critical speed for a given shunt field resistance
2	**Load test on DC shunt generator (CO1)** Objectives: Determine the external and internal characteristics
3	**Brake test on DC shunt motor (CO2)** Objectives: Plot the following characteristics a. Performance characteristics b. Electrical characteristics c. Mechanical characteristics

4	**Brake test on DC series motor (CO2)** Objectives: Plot the following characteristics a. Performance characteristics b. Electrical characteristics c. Mechanical characteristics
5	**Load test on DC compound generator (CO1)** Objectives: a. Plot the load characteristics when cumulatively compounded b. Plot the load characteristics when differentially compounded
6	**Swinburne's test on a DC shunt machine (CO3)** Objectives: a. Predetermine the efficiency while DC machine is acting as generator and motor b. Plot the efficiency curves while DC machine is acting as generator and motor
7	**Hopkinson's test on a pair of DC machines (CO3)** Objectives: Determine the efficiency the DC machine while working as a motor and generator under various load conditions
8	**Retardation test on a DC machine (CO3)** Objectives: a. Separate the hysteresis, eddy current, friction and windage losses b. Find the moment of inertia of the rotating system
9	**Separation of losses in a DC shunt motor (CO3)** Objectives: Separate the hysteresis, eddy current, friction and windage losses by conducting no-load tests at different excitations.
PART B - TRANSFORMERS	
10	**OC and SC tests on single-phase transformer (CO4)** Objectives: 1. Predetermine the voltage regulation and efficiency at different loads and power factors. 2. Determine the equivalent circuit referred to LV side and HV side 3. Plot the voltage regulation vs power factor curves at full-load and half full-load. 4. Plot the efficiency curve at unity p.f. and 0.5 p.f. 5. Determine the power factor at which the voltage regulation is zero 6. Determine the load at which maximum efficiency occurs and the maximum

	efficiency.
11	**Load test on single-phase transformer (CO4)** Objectives: Determine the voltage regulation and efficiency at different loads and at unity power factor.
12	**Separation of losses in a single-phase transformer (CO4)** Objectives: a. Separate the hysteresis and eddy current losses using voltage and frequency control. b. Plot losses Vs frequency curves at normal voltage and different frequencies c. Plot losses Vs frequency curves at different frequencies keeping V/f constant
13	**Sumpner's test (CO4)** Objectives: a. Predetermine the voltage regulation and efficiency at different loads (full-load and half full-load) and power factors (unity, 0.8 lag and lead) b. Determine the equivalent circuit referred to LV side and HV side
14	**Parallel operation of two dissimilar single-phase transformers (CO4)** Objectives: a. Determine the load sharing while two dissimilar transformers are operating in parallel b. Verify the load sharing by using the impedances of the two transformers
15	**OC and SC tests on 3-phase transformer (CO5)** Objectives: a. Predetermine the voltage regulation and efficiency at different loads (full-load and half full-load) and power factors (unity, 0.8 lag and lead) b. Determine the per phase equivalent circuit
16	**Scott Connections (CO4)** Objectives: Convert 3-phase AC supply into 2-phase AC by means of Scott connection and to conduct the load test for finding the performance
NOTE: A minimum of TWELVE experiments are mandatory out of the sixteen listed	

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	Analyze the performance of DC generators by conducting load/no-load tests	**K3**
CO2	Sketch the performance characteristics of DC shunt and series motors	**K3**
CO3	Investigate the losses and efficiency in DC machines by conducting no-load tests	**K3**
CO4	Examine the performance of individual and parallel connected single-phase transformers by conducting load/no-load tests	**K3**
CO5	Determine the voltage regulation and efficiency of 3-phase transformer by conducting no-load tests.	**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					3	2		3
CO2	3	2		2					3	2		3
CO3	3	2		2					3	2		3
CO4	3	2		2					3	2		3
CO5	3	2		2					3	2		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	Electrical Machinery	P.S. Bimbhra	Khanna Publishers	7th edition 2021
2	Electric Machines	D P Kothari & I J Nagrath	Tata McGraw Hill	5th edition 2017

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

POWER ELECTRONICS AND DRIVES LAB

Course Code	**PCEEL408**	**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)	PCEET403	**Course Type**	Lab

Course Objectives:

1. To motivate students to design and implement power electronic converters having high efficiency, small size, high reliability and low cost
2. To enable the students to select suitable power devices and passive components
3. To compare simulation results and hardware results and do iterative design

Expt. No.	Experiments
	Suggestions: *Students are encouraged to do the simulations associated with the experiments before the corresponding lab session so that more emphasis can be given to the hardware part in the lab (Simulations can be done off-lab) and the simulation results need to be correlated with the hardware results. For experiments where the effects of device parasitics cannot be neglected and circuit-level simulations are needed, SPICE based simulation software such as LTSpice^{TM}, OrCAD^{TM}, PSpice^{TM}, Proteus^{TM} etc. may be used. In other cases, software like MATLAB Simulink^{TM}, SciLab^{TM}, SEQUEL^{TM}, PSIM^{TM}, PLECS^{TM} etc. may be used if required.*
	Preliminary work-1 ***(Mandatory)*** (a) Testing and Troubleshooting- Power diodes, SCR, Power Transistors, MOSFETS, IGBTS, OP-Amps, MOSFET drivers etc – Use of Multimeter, DSO, and Data sheets (b) Simulation of any Power Electronic circuit using a SPICE based software such as LTSpice, ORCAD, PSpice, and Proteus

	Preliminary work -2 ***(Mandatory)*** (a) PCB routing using any standard PCB layout software such as ORCAD, Proteus, KiCAD, Altium, Eagle etc. ensuring good PCB routing practices (b) Soldering and desoldering Practice – Through-Hole/SMD (It is recommended to select any one of the experiments for the PCB practice)
1	**Static VI characteristics of Power Devices** **Aim:** To simulate the static VI characteristics of (a) Power Diode (b) SCR (b) MOSFET (c) IGBT using any suitable simulation software and compare with datasheet values
2	**High frequency diode - Measurement of power loss and reverse recovery time Aim:** To measure the power losses & reverse recovery time of a high frequency diode, compare with theoretical estimate and to compare with a schottky diode of similar ratings (Hardware/Simulation).
3	**Single-Phase half-wave-controlled rectifier feeding R/RL load** **Aim:** To simulate and set up a half-wave-controlled rectifier with line synchronized R and RC firing circuits and plot relevant waveforms such as voltage waveform across the load and thyristor, gate voltage and gate current for different firing angles. The need for line synchronization to be emphasized. (Any suitable simulation software may be used for the simulation)
4	**Single-Phase half-controlled(semi-converter)/fully-controlled rectifier feeding R/RL loads** **Aim:** To simulate and set up any type of line synchronized Triggering circuit such as UJT firing, Ramp firing, Digital firing etc. for single-phase half-controlled/full controlled rectifier feeding R and RL loads and observe relevant waveforms. The need for line synchronization to be emphasized (Any suitable simulation software may be used for the simulation).
5	**Effect of source inductance in single-phase controlled rectifier feeding highly inductive loads** **Aim:** To set up a single-phase full controlled rectifier with source inductance, for highly inductive loads, observe relevant waveforms and calculate the source power factor, line current THD and the average voltage lost due to the effect of source inductance (Simulation may be used to get more insights).
6	**Single-Phase half-controlled/fully-controlled Rectifier fed PMDC/Separately excited DC motor drive** **Aim:** To simulate and set up a single-phase half-controlled/full controlled rectifier feeding a PMDC/SEDC motor (additional inductor may be included in the armature circuit to get continuous conduction) and observe relevant waveforms (Any suitable simulation

	software may be used for the simulation)
7	**AC Voltage controller feeding R/RL loads** **Aim:** To set up a single-phase AC voltage controller using TRIAC/SCR and to observe relevant waveforms such as voltage waveforms across the load (R/RL Load) & TRIAC/SCR, gate voltage, gate current etc. for different firing angles (Simulation may be used to get more insights).
8	**Isolated Gate Driver Circuit for Single-phase half-Bridge IGBT/MOSFET Inverter** **Aim:** (a) To identify the gate current and voltage requirement to drive the MOSFET/IGBT in a half-bridge configuration for a certain switching frequency with galvanic isolation, to select suitable industry-standard IGBT/MOSFET driver ICs and to test the driver circuit both for floating and ground-referenced configurations, and to observe relevant waveforms (b) To simulate and set up a circuit for dead-time generation for use with the half- bridge inverter
9	**Gate drive using Bootstrap technique** **Aim:** To identify the gate current and voltage requirement to drive the MOSFET/IGBT with boot-strap technique for a certain switching frequency, understand the merits & pertinent limitations of the bootstrapping circuit and to explore dead-time and shutdown/over current protection options
10	**Single-phase half-bridge/full-bridge IGBT/MOSFET inverter feeding RL load** **Aim:** To simulate and set up a single-phase half-bridge inverter with L/LC filter for square wave and sine-triangle PWM, observe relevant waveforms and obtain THD (Any suitable simulation software may be used for the simulation)
11	**Inductor design and Fabrication** **Aim:** To design and fabricate an inductor to be used in a high frequency switching application and measure the inductance value using time constant measurement/LCR meter **Note:** The inductor may be designed taking into account the requirement in expt #12
12	**Design and set-up a buck/ boost /buck-boost converter** ***(Mandatory Experiment)*** **Aim:** (a) Design, simulate and set up a buck/boost/buck-boost converter (continuous conduction mode) and observe relevant waveforms (b) Compare the measured quantities such as capacitor voltage ripple and inductor current ripple with the designed values (c) Calculate power loss in power devices and select heat sink (and snubbers) needed if any (d) Overall efficiency computation and measurement of temperature of the heatsink and passive components (e) Explore performance improvement opportunities

	(Any suitable simulation software may be used for the simulation)
13	**Speed control of Permanent Magnet/Separately-Excited DC motor using chopper drive** **Aim:** To simulate and set up a One-quadrant/Two-quadrant DC chopper to control the speed of a PMDC/SEDC motor for operation in continuous conduction and observe relevant waveforms (Any suitable simulation software may be used for the simulation)
14	**Three-phase IGBT/MOSFET inverter feeding RL Load** **Aim:** To simulate and set up (Demo is sufficient) a three-phase inverter for (a) sine-triangle PWM (b) third-harmonic (or triple-n harmonic) injection PWM and observe relevant waveforms & THD. Influence of various parameters such as switching frequency, amplitude & frequency modulation indices, dead-time etc. on the performance may be studied (Any suitable simulation software may be used for the simulation).
15	**Stator Voltage control of Three-Phase Induction Motor** **Aim:** To set up (Demo is sufficient) a three-phase induction motor drive using stator voltage control and observe relevant waveforms & THD (Simulation may be used to get more insights).
16	**Single phase unidirectional/bidirectional interface – boost PWM rectifier Aim:** To set up (Demo is sufficient) a single-phase PWM rectifier with near unity power, observe relevant waveforms and obtain the line current THD/PF (Simulation may be used to get more insights).
17	**V/F control of Three-Phase Induction Motor** **Aim:** To simulate and set up (Demo is sufficient) a three-phase induction motor drive using V/F control and observe relevant waveforms & THD for different speeds of operation (Any suitable simulation software may be used for the simulation).

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 the operation of modern power semiconductor devices, its characteristics and Design & Select suitable gate driver circuits & heatsinks	**K5**
CO2	Understand the features of phase-controlled rectifiers, AC voltage Controllers & Switching Regulators and Analyse the operation	**K4**
CO3	Understand the features of different types of switch mode DC-AC Inverters and Analyse the operation	**K3**
CO4	Understand the need for improved efficiency, improved reliability, improved load & source waveforms and improved utility interface	**K3**
CO5	Understand the features of adjustable speed drives and Analyse the basic drive schemes for DC motors and Induction Motors	**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									
CO2	3	1	3									
CO3	3	1	3									
CO4	3	1	3									
CO5	3	1	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	Power Electronics- Essentials and Applications	L. Umanand	John Wiley	2009
2	Power Electronic Systems- Theory and Design	Jai P Agrawal	Pearson	2006
3	Power Electronics- Converters, Applications and Design, 3e (Indian Adaptation)	Ned Mohan, Undeland, Robbins	Wiley India	2022
4	Power electronics: principles and applications	Joseph Vithayathil	Tata McGraw Hill	2010
5	Power Electronics	D.W. Hart	McGraw Hill	2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Elements of Power Electronics	Philip T Krein	Oxford	2017
2	Power Electronics- Devices, Circuits and Applications	Muhammad H. Rashid,	Pearson	2014
3	Power Electronics	Cyril W Lander	McGrawHill	1993
4	Power Electronics- A first course: Simulations and Laboratory Implementations	Ned Mohan, Siddharth Raju	Wiley	2023
5	Power Electronics Step by Step- Design, Modeling, Simulation and Control	Weidong Xiao	McGrawHill	2021

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Lecture Series on Power Electronics **by Prof. G. Bhuvaneswari**, IIT Delhi https://www.youtube.com/watch?v=Z2CORFayCv0&list=PLp6ek2hDcoND7i5-DAD9mPmYF1Wg6ROdO&index=3
2	NPTEL Lecture Series on Power Electronics by **Prof. L. Umanand**, IISc Bangalore https://www.youtube.com/watch?v=eLIdqiPMjBs&list=PLgMDNELGJ1CaXa4sX6QSrkhu-yP_Wu2EN&index=26
3	NPTEL Lecture Series by **Prof. Shabari Nath**, IIT Guwahati https://www.youtube.com/watch?v=S_UXW2UzAi8&list=PLwdnzlV3ogoWVgA9fHBV36L_bxWZlpa7X&index=7

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

ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER S5

POWER GENERATION, TRANSMISSION AND PROTECTION

Course Code	**PCEET501**	**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)	PCEET302	**Course Type**	Theory

Course Objectives:

1. To deliver fundamental concepts in power system components.
2. To deliver basic idea of power generation, transmission and protection.
3. To introduce new topics to students like energy storage systems and deregulated systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Generation from renewable and non-renewable sources – Hydro, thermal, nuclear- (block schematic details, environmental and ethical factors, advantages, disadvantages) Solar and wind - (block schematic details, environmental factors, regulations, advantages, disadvantages) Energy storage systems as alternative energy sources – BESS, CESS, thermal SS Load curve – Load duration curve, Load factor, diversity factor, demand factor, Plant capacity factor, plant use factor - Numerical Problems	**11**
2	Power Transmission System - (Electrical Model)- Line parameters – resistance - inductance and capacitance (Derivation of three phase double circuit) Transmission line modelling - classifications (concept only) – transmission line as two port network – derivation and calculation of ABCD parameters (derivation and numerical problems)	**11**

	Skin Effect & Ferranti Effect – Corona (qualitative study only) – Surge Impedance Loading Insulators – string efficiency – grading (numerical problems	
3	Introduction to EHVAC and HVDC: Principle, advantages/disadvantages Underground cables – ratings - classification - Capacitance of cables – grading – 2 types AC Distribution systems – connection schemes – radial and ring main systems – single phase only (numerical problems) Method of power factor improvement using capacitors (numerical problems) Tariff - different types Introduction to energy markets (regulated and deregulated systems)	**11**
4	Need for protection- Types of protection schemes – primary and back-up Protective relays – Basics of typical electromechanical relay – induction type only Static (block diagrams of o/c and instantaneous o/c relays) Microprocessor (block diagram and flow chart of o/c relay) Fundamentals of Numerical relay Principles of overcurrent, directional, distance and differential Circuit breakers – operating principle – arc phenomenon – arc extinction – principle & methods – Important terms in arc extinction Problems of circuit interruption – capacitive current chopping – ratings of CBs Circuit breaker classification based on medium of arc extinction – SF6 & VCB Introduction to GIS	**11**

Note: Visit to a nearby substation, identify the components and prepare a report.

Additional topics:

1) *Calculation of Sag and tension in transmission lines*
2) *Introduction to Machine Learning in Power System Protection – Insulation co-ordination*
3) *Overview of Communication: PLCC - Fibre Optic - Introduction to IEC61850*

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	Learn different types of power generating systems and schedule generation appropriate fora given area.	**K3**
CO2	Evaluate the electrical performance of any transmission line.	**K3**
CO3	Compute various physical characteristics of overhead and underground transmission systems.	**K3**
CO4	Demonstrate the working of relays and switch gear for protection schemes.	**K2**
CO5	Design a simple ac electrical distribution system as per the standards.	**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					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	Electrical Power Systems	Wadhwa C. L.	New Age International	8th edition 2023
2	Principles of Power System	V. K. Mehta and Rohit Mehta	S. Chand	4th edition reprint 2020
3	Power System Protection and Switchgear	Badri Ramand D.N.Viswakarma	Tata McGraw Hill	2nd edition, 2011
4	Non-conventional energy sources	B. H. Khan	Tata McGraw Hill	3rd edition, 2017

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering and Chemical Thermodynamics	Milo D. Koretsky	Wiley	2ndEdn, 2012
2	Chemical and Process Thermodynamics	Kyle B.G.	Pearson	3rdEdn, 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/103/103/103103144/
2	https://archive.nptel.ac.in/courses/103/103/103103144/
3	https://archive.nptel.ac.in/courses/103/103/103103144/
4	https://archive.nptel.ac.in/courses/103/103/103103144/

SEMESTER S5

ELECTROMAGNETIC THEORY

Course Code	PCEET502	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)	GBMAT201	Course Type	Theory

Course Objectives:

1. To familiarize the students with the fundamentals of electrostatics, magnetostatics, time-varying fields and electromagnetic waves.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Mathematical Preliminaries :** Rectangular, Cylindrical and Spherical Coordinate Systems - Representation of Point, Unit vector, Vector, Constant surfaces, Transformation of points, unit vectors and vectors among the three coordinate systems - Transformation matrices, Del operator - Representation in the three coordinate systems, Gradient of scalar field - Physical meaning of gradient, Divergence of a vector field - Physical significance of divergence - Divergence Theorem -, Curl of a vector field - Physical significance of curl - Stoke's Theorem **Electrostatic Fields :** Coulomb's Law, Electric Field Intensity, Force and Field due to system of charges, Gauss's Law - integral form, Electric Flux Density, Field due to line of charge, surface and volume charge distributions.	**11**
2	**Electrostatic Fields in material media :**Gauss's law - point form, Electric potential, Relation between E and V, Field due to electric dipole, Energy density in static electric fields, Conduction and Convection Current, Ohm's law in point form, Resistance,	**11**

	Capacitance of parallel plate capacitor, Coaxial and Spherical capacitors, Continuity equation, Boundary conditions, Poisson's and Laplace's Equations (solution not required) **Magnetostatics :** Biot Savart's Law, Ampere's Circuital Law in integral and point form, Magnetic field due to infinite line current, infinite sheet of current, Coaxial cable, Non conservativeness of magnetic field, Magnetic scalar potential, Magnetic vector potential.	
3	**Magnetostatics in Material Media :**Force on a charged particle due to a magnetic field, Force between two current carrying conductors, Magnetic Torque and Moment, Magnetization in materials, Magnetic boundary conditions, Inductance, Energy stored in magnetostatic fields. **Electromagnetic Induction and Maxwell- Heaviside Equations:** Faraday's law, Transformer emf and Motional emf, Displacement Current, Maxwell-Heaviside equations.	**10**
4	**Electromagnetic Waves :**Time varying potentials, Waves in general, Electromagnetic waves, Wave propagation in lossy dielectrics, Plane waves in free space, conductors, skin effect, Power, Poynting theorem, Reflection of plane wave at normal incidence. **Transmission Lines:** Transmission line equations, Characteristic impedance, Input impedance, Standing wave ratio.	**10**
Additional topics (not for ESE evaluation)	Numerical procedures for solving Laplace's and Poisson's equation, Method of images, Force on magnetic materials, Magnetic levitation, Wireless power transfer, Microstrip lines	

** - Detailed mathematical treatment of Gradient, Divergence and Curl has been taught in Second Semester Mathematics in Vector Calculus. Hence an overview with electromagnetic theory perspective is sufficient. However, a couple of remedial classes may be provided to lateral entry students to cover the basics of Differentiation, Integration and Vector Calculus*

Demonstrations for coordinate systems and gradient, divergence and curl may be done using mathematical sketching softwares like GeoGebra, Geometer's sketchpad etc.

Demonstration of fields, integrals and derivatives can be done using high end softwares like Scilab/ Matlab / Octave and low end softwares like maxima.

Assignments can be software based wherever possible.

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	Apply vector calculus in Electricity and Magnetism.	**K3**
CO2	Compute electric and magnetic fields in different media	**K3**
CO3	Deduce the Maxwell-Heaviside Equations from the basic laws of electricity and magnetism	**K3**
CO4	Predict the production of electromagnetic waves with electric and magnetic fields	**K4**
CO5	Demonstrate the propagation of electromagnetic excitations in transmission lines	**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			2	3						2
CO2	3	3			2	3						2
CO3	3	3			2	3						2
CO4	3	3			2	3						2
CO5	3	3			2	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	Elements of Electromagnetics	Mathew N O Sadiku	Oxford University Press	7th Edition, 2018
2	Engineering Electromagnetics	William H Hayt Jr, John A Buck	Tata McGraw Hill	9th Edition, 2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Electrodynamics	David J Griffiths	Cambridge University Press	4th Edition, 2017
2	Electromagnetics	John D Kraus, Keith R Carver	Tata McGraw Hill	2nd Edition, 1981

Books for Further Reading				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Div, Curl, Grad and All That	H M Schey	W W Norton and Company	Fourth Edition, 2005
2	Basic Laws of Electromagnetism	I E Irodov	Mir Publishers	1983
3	Lectures on Physics, Volume II	Righard P Feynman	Narosa	2005

SEMESTER S5

SIGNALS AND SYSTEMS

Course Code	**PCEET503**	**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)	Mathematics for Electrical Science	**Course Type**	Theory

Course Objectives:

1. To introduce time domain and frequency domain representation of continuous and discrete time signals and perform various mathematical operations
2. To introduce various types of signals and systems
3. To introduce time domain and frequency domain representation of continuous and discrete time systems.
4. To familiarize mathematical modelling of dynamic systems and analyze it's stability

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Signals and Systems:** Elementary Signals, Classification and representation of continuous time and discrete time signals, Signal operations. (3 hours) Concept of system: Continuous time and discrete time systems; Properties of systems: Time invariance, Linearity, Causality, Systems with and without memory, Stability. (3 hours) Convolution Integral and sum. (2 hours) Impulse and step response. (1 hour)	**9**

2	**Frequency domain characterization of Signals and Systems:** *Fourier transform:* Existence - Properties of Continuous time Fourier transform; Concept of Frequency response; Significance of Fourier transform and difference from Fourier series. (3 hours) Review of Laplace Transforms. *Characterization of LTI systems:* Differential equation representation of continuous time LTI systems. Transfer function representation of differential equation in Laplace domain. (2 hours) *Modeling of LTI systems:* Electrical, translational and rotational mechanical systems, DC servo-motor; Force voltage, Force current analogy. (4 hours)	**9**
3	**Sampled Data Systems and Z-Transform:** Sampling process - Impulse train sampling-sampling theorem- Aliasing effect. (2 hour) Zero-order and First-order hold circuits - Signal reconstruction. (2 hours) *Z-Transform:* Region of convergence- Properties of Z-Transform Inverse Z-Transform. Pulse transfer function. Difference equations representation using Z-transform and it's solution using inverse Z-Transform. (3 hours) Impulse and step response of discrete-time systems. (3 hours)	**10**
4	**Dynamic System Representation and Stability:** Open loop and closed loop systems. Effect of feedback in systems. Block diagram representation - block diagram reduction. Signal flow graph - Mason's gain formula. (5 hours) Type and Order of the systems - Pole-Zero representation of systems. Characteristic equation. Routh stability criterion. (3 hours)	**8**

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	To represent continuous and discrete time signals in time domain and perform various mathematical operations	**K2**
CO2	To represent continuous time signals and systems in frequency domain	**K3**
CO3	To represent discrete time signals and systems in Z-domain.	**K3**
CO4	To analyse the stability of continuous time dynamical systems	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	1	3	3	3			3	2
CO2	3	3	2	2	2	3	3	3			3	2
CO3	3	3	2	2	2	3	3	3			3	2
CO4	3	3	2	2	2	3	3	3			3	2
CO5												

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Simon Haykin, Barry Van Veen	Wiley	2nd Edition, 2007
2	Discrete Time Control Systems	Katsuhiko Ogata	Pearson	2nd Edition, 2006
3	Control Systems Engineering	Norman S. Nise	Wiley	5th Edition, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Signals and Systems	Oppenheim A.V., Willsky A.S. & Nawab S.H.	Prentice Hall	2nd Edition, 2015
2	Modern Control Systems	Dorf R. C., Bishop R. H	Pearson Education India	12th Edition, 2013
3	Digital Signal Processing Principles	John G. Proakis& Dimitris G.Manolakis	Prentice Hall	4th Edition, 2007

SEMESTER S5

MICROPROCESSORS AND EMBEDDED SYSTEMS

Course Code	**PBEET504**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:1	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PBEET304, PBEET404, GBEST204	**Course Type**	Theory

Course Objectives:

1. This course aims to design and implement Embedded Systems using latest microprocessors / Microcontroller based boards.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to microprocessors**- Features and Architecture of 8085- Registers of 8085 - Flags - 8085 Pin diagram- Pins, Signals and functions - Assembly language programming- Basic Instruction set to write Simple programs - Arithmetic, Logical, Branching instructions, Opcodes, hand coding, Programs involving 8 and 16bit Addition, Subtraction, Memory Reading and writing, Sorting – Addressing modes-Classification of instructions.	**12**
2	**Stack and Subroutines** – CALL and RETURN instructions –Timing and control – Machine cycles, instruction cycle and T states – fetch and execute cycles –Timing diagram for instructions- Delay subroutines – Interrupts- Interrupt service Routines- Interfacing ADC and DAC	**10**
3	**Introduction to Embedded Systems**-Application domain, features and characteristics, Microprocessors and Micro controllers– Choice and suitability for applications	**12**

	Introduction to Arduino UNO(8bit)- Hardware fundamentals of ATmega328Pmicrocontroller based Board. Arduino Architecture, Pin diagram and functions of Pins- Overview of main features such as I/O Ports, Timers, interrupts, PWM, ADC (Introduction only). Introduction to Arduino IDE- Arduino Libraries, Steps for creating an Arduino program- Arduino Sketch Structure and Flow- Setup and loop functions. Programming in Embedded C. Data types- operators, conditional statements- Loops, Arrays and functions- Built in functions in Arduino - Program to blink an LED and its control., Interfacing LCD, Seven Segment LED, switch Interface, Binary counter Working with LED Controlled by Switch/ Potentiometer, Interfacing with Relays, Buzzer, Working with Basic sensors and actuators using Arduino.	
4	**ARM (Advanced RISC Machines) based Embedded System Design**: Classification of Microprocessors based on the word length, architecture and Instruction Set- Reduced Instruction Set Computer (RISC) and Complex Instruction Set Computer (CISC). Features and characteristics **Introduction to Arduino due(32bit)**- micro controller board (based on the atmel sam3x-- arm cortex- m3 cpu)- Features, General Specifications Overview, General architecture- Features OF Microcontroller, INPUTS,OUTPUTS, Ratings, Functional Overview, Pinout- familiarization of the ports of the board. Programming Basics- Arduino IDE-Use of Timer, Interfacing of ADC and DAC -PWM implementation – Introduction to Arduino Cloud Editor	**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	Describe the architecture of 8085 microprocessor and 8085 Assembly language programming.	**K2**
CO2	Understand the need for interrupts, Subroutines, timing diagram of 8085 microprocessor and interfacing	**K2**
CO3	Understand and gain the basic idea about the embedded system and selection of processors.	**K2**
CO4	Able to gain working level knowledge about a Arduino Uno based system architecture and Arduino IDE	**K2**
CO5	Write Programs using Embedded C and implement an application using Arduino UNO board.	**K3**
CO6	Understand the RISC Architecture and Apply the knowledge for solving the real life problems using ARM - Arduino DUE board based embedded system.	**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	3	2	3	3	2	1						
CO3	3	2	2	2	2							
CO4	3	2										1
CO5	3	2	3	2	1	1						1
CO6	3	2	3	2	1	1						1

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 *Microprocessor* and *Micro controllers*	*Ram*, *B.DHANPAT*	Rai Publications (P) Ltd.-New Delhi	
2	Microprocessor, Architecture, Programming and Applications	Ramesh Gaonkar	Penram International Publishing;	Sixth edition, 2014.
3	Arduino Cookbook”	Michael Margolis,	O’Reilly Media, Inc.	1st Edition
4	Microprocessor Theory and Application	Rafiquzzaman	PHI Learning	First Edition

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Arduino-Based Embedded Systems	Rajesh Singh, Anita Gehlot,Bhupendra Singh, and Sushabhan Choudhury		
2	Arduino for beginners: Essential Skills Every Maker Needs”	John Baichtal	Person Education	
3	Arduino Made Simple	Ashwin Pajankar		
4	Embedded C, Pont	Michael J		
5	Programming Arduino Next Steps: Going Further with Sketches	Simon Monk		
6	Arduino: A Technical Reference by	J.M. Hughes	O'Reilly Media, Inc. ISBN: 9781491934494	
7	Arduino Workshop: A Hands-On Introduction with 65 Projects	John ***Boxall***		
8	Exploring Arduino: Tools and Techniques for Engineering Wizardry	Jeremy Blum WILEY		

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc20_ee42/preview
2	https://onlinecourses.nptel.ac.in/noc20_ee42/preview
3	https://onlinecourses.nptel.ac.in/noc20_ee42/preview https ://www.arduino.cc/en/Tutorial/HomePage
4	https://onlinecourses.nptel.ac.in/noc20_ee42/preview https://docs.arduino.cc/hardware/due/

SEMESTER S5

ENERGY STORAGE SYSTEMS

Course Code	PEEET521	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 introduce the importance and application of energy storage systems.
2. To familiarize with different energy storage technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Need and role of energy storage systems in power system, General considerations, Energy and power balance in a storage unit, Mathematical model of storage system: modelling of power transformation system (PTS)-Central store (CS) and charge–discharge control system (CDCS), Econometric model of storage system. Thermal energy: General considerations -Storage media- Containment-Thermal energy storage in a power plant, Potential energy: Pumped hydro-Compressed Air.	9
2	Kinetic energy: Mechanical- Flywheel, Power to Gas: Hydrogen-Synthetic methane. Electro chemical energy: Batteries-Battery parameters: C-rating– SoC – DoD -Specific Energy- Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Superconducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.	9

3	Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated power systems with renewable powersources, Storage role in an integrated power system with grid-connected renewablepowersources.	**9**
4	Smart grid, Smart micro grid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Management and control hierarchy of storage systems. Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Battery SCADA, Hybrid energy storage systems: configurations and 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 =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	Identify the role of energy storage in power systems.	**K3**
CO2	Classify thermal, kinetic and potential energy storage systems and their applications.	**K3**
CO3	Compare electrochemical, electrostatic and electromagnetic storage technologies.	**K3**
CO4	Illustrate energy storage technology in renewable energy integration.	**K2**
CO5	Summarise energy storage technology applications for smart grids.	**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	1					1					
CO2	3	1					1					
CO3	3	1					1					
CO4	3	1					1					
CO5	3	1					1					

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	Energy Storage for Power Systems	A.G.Ter-Gazarian	The Institution of Engineering and Technology (IET)Publication,UK,	Second Edition, 2011
2	Energy Storage in Power Systems	Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt	Wiley Publication	2016.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits	D. Rastler	Electric Power Research Institute (USA)	Technical Update, December 2010
2	The Role of Energy Storage with Renewable Electricity Generation	Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan	National Renewable Energy Laboratory (NREL)	January 2010
3	Electrical energy management of virtual power plants in distribution networks with renewable energy resources and energy storage systems	P. Nezamabadi and G. B. Gharehpetian	IEEE Power Distribution Conferenc	2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=o6Afp-MI_tQ&list=PLLy_2iUCG87AjWoOk0A3y4hpGQVTdtl6G&index=12 (NPTEL lecture IIT Roorkee)
2	https://www.youtube.com/watch?v=yar51GJVqgg (NPTEL lecture IIT Guwahati)
3	https://www.youtube.com/watch?v=frWxC5KL8kE (NPTEL lecture IIT Guwahati)
4	https://www.youtube.com/watch?v=AZIS_MCw8Qc (NPTEL lecture IIT Kanpur)

SEMESTER S5

ELECTRIC VEHICLES

Course Code	**PEEET522**	**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)	PCEET303, PCEET304 PCEET403	**Course Type**	Theory

Course Objectives:

1. Familiarise the various characteristics of conventional vehicles and compare them with electric vehicles
2. Analyse the various drive train topologies for electric vehicles
3. Discuss the propulsion unit for electric vehicles
4. Analyse the various energy storage systems and energy management strategies
5. Selection of drive systems and study of various communication protocols for EV

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Conventional Vehicles**: Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics (1hr). **Introduction to Electric Vehicles**: History of electric vehicles, Classification of electric vehicles. Overview of EV challenges. Overview of EV technologies-motor drive technology , energy source technology , battery charging technology , vehicle-to-grid technology(2hr) **Vehicle Dynamics & Load Forces:**Mathematical models to describe vehicle performance, vehicle load forces: aerodynamic drag,rolling resistance, grading resistance, vehicle acceleration, Calculation of motor power from traction torque, Numerical problems. (4 hrs)	**9**

	Electric Drive-trains: Basic concept of electric traction, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies, Fuel efficiency analysis.(2 hrs)	
2	**DC Drives:**Motoring using a PM DC Machine - DC motor electric drive using DC-DC converter - Generating/Braking using a PM DC Machine. (3hrs) **PMSM Drives**: Review of PMSM motor basics – Independent control of orthogonal flux and torque (concept only)- Field Oriented Control (FOC) – Sensored and sensorless control (block diagram only). (4hrs) **Sizing the drive system**: Matching the electric machine and the Internal Combustion Engine (ICE) ,Sizing the propulsion motor, Sizing the power electronics-Switch technology selection,Ripple capacitor design, Switching frequency and PWM. (2hrs)	**9**
3	**Battery based energy storage systems**: Types of battery-battery parameters-units of battery energy storage - capacity rate, - cell voltage - specific energy - cycle life - self-discharge- static battery equivalent circuit model - series-parallel battery pack equivalent circuits.(3hrs) **Other storage topologies**: Fuel Cell based energy storage systems-Supercapacitors- Flywheel- Hybridization of different energy storage devices. (2 hrs) **Sizing considerations of battery** -Time and charge/discharge cycles -Lifetime – Beginning of life (BOL) - End of life (EOL) - DOD - Efficiency of Battery Pack - Determination of pack Voltage, range for EV - Determination of Cell/Pack Voltage for a Given Output\Input Power. Battery management system, Numerical problems.(4hrs)	**9**
4	**Overview of Electric Vehicle Battery Chargers**–Types of chargers-On-board chargers, Off- board chargers, Wireless charger. Electric Vehicle Supply Equipment (EVSE) - Grid to EVSE to On-board chargers to battery pack power flow block schematic diagrams – V2G concept(3hrs)	**9**

	Types of charging stations - AC Level 1 & 2, DC - Level 3 -Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T - PIN diagrams and differences (2hrs) **Autonomous Vehicles**: Levels of automation, significance, functional architecture-sensors, actuators, path planning& effects of automation in vehicles (2hrs) **Vehicle Communication protocols** : Need & requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins, Communication Protocols - CAN, LIN, FLEXRAY (Basics only)- Power line communication (PLC) in EV (2 hrs)	

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	Familiarise the performance of conventional vehicles and electric vehicles	**K2**
CO2	Analyse the various drive train topologies for electric vehicles	**K3**
CO3	Discuss the propulsion unit for electric vehicles and selection of drive systems	**K3**
CO4	Analyse the various energy storage systems and energy management strategies	**K3**
CO5	Study of chargers, charging stations and various communication protocols for EV	**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									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	Electric Vehicles Machines and Drives- Design, Analysis and Application	K. T. Chau	John Wiley	2015
2	Propulsion Systems for Hybrid Vehicles	John M. Miller	The Institution of Engineering and Technology, London, United Kingdom	2010
3	Hybrid Electric Vehicles – Principles and applications with practical perspectives	Chris Mi, M A Masrur, D W Gao	Wiley	2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals, Theory and Design	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay	CRC Press	
2	Permanent Magnet Synchronous and Brushless DC Motors Drives	R. Krishnan	CRC Press	
3	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Hussein	CRC Press	2003

SEMESTER S5

DIGITAL SYSTEM DESIGN

Course Code	PEEET523	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	PE -Theory

Course Objectives:

1. To acquire knowledge about Asynchronous and clocked Synchronous sequential circuit design.
2. To detect the faults and hazards in digital circuit design
3. To design and implement digital circuits using VHDL.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Clocked Synchronous Networks, Analysis of Clocked Synchronous Sequential Networks (CSSN), Modelling of CSSN, State assignment and reduction, Design of CSSN.	10
2	ASM Chart and its realization. Asynchronous Sequential Circuits, Analysis of Asynchronous Sequential Circuits (ASC), Flow table reduction, Races in ASC, State assignment problem and the transition table.	10
3	Hazards – static and dynamic hazards in combinational networks, Essential Hazards, Design of Hazard free circuits, Data synchronizers, Mixed operating mode asynchronous circuits, Practical issues- clock skew and jitter, Synchronous and asynchronous inputs.	8

	Faults: Fault table method – path sensitization method – Boolean difference method.	
4	VLSI Design flow: Design entry: Schematic, Data types and objects, different modelling styles in VHDL - Dataflow, Behavioural and Structural Modelling. VHDL constructs and codes for combinational and sequential circuits.	**8**

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 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	Analyze asynchronous and clocked synchronous sequential circuits	**K3**
CO2	Design hazard-free digital circuits	**K3**
CO3	Identify faults in digital circuits	**K3**
CO4	Apply VHDL programming in digital system design	**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								3
CO2	3	2	2	2								3
CO3	3	3	2		2							3
CO4	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	Digital Principles & Design	Donald G Givone	Tata McGraw Hill	1/e 2002
2	Digital Design with an introduction to HDL, VHDL and Verilog	M.Morris Mano and Michel.D.Ciletti	Pearson education	6/e, 2018
3	Digital Design	John F Wakerly	Pearson Education	4/e 2008
4	Digital Logic Applications and Design	John M Yarbrough	Cengage India	1/e 2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Systems Testing and Testable Design	Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman	John Wiley & Sons Inc	
2	Logic Design Theory	N. N. Biswas	PHI	
3	Introduction to Digital Design Using Digilent FPGA Boards	Richard E. Haskell, Darrin M. Hanna	LBE Books- LLC	
4	Digital Circuits and Logic Design	Samuel C. Lee	PHI	
5	Digital System Design Using VHDL	R. Anand	Khanna Book Publishing Company	
6	Digital System Design using VHDL	Charles Roth	TMH	

SEMESTER S5

SOFTWARE ENGINEERING

Course Code	**PEEET524**	**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 code)	**Course Type**	Theory

Course Objectives:

1. Provides fundamental knowledge in the Software Development Process which covers Software Development, and Project Management concepts.
2. Enables 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:** Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.	8
2	**Requirement Analysis and Design:** Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering,	10

	Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps.	
3	**Implementation and Testing (12 hours)** Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.	**12**
4	**Software Project Management:** Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.	**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 =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	Interpret software process models and core activities, including handling changes with techniques like prototyping and incremental delivery.	**K2**
CO2	Describe agile methods, including the Agile Manifesto and agile project management practices.	**K2**
CO3	Prepare Software Requirement Specification and Software Design for a given problem	**K3**
CO4	Interpret object-oriented design principles, design patterns, software testing methods (including unit testing, integration testing, and test automation), and open-source licensing models (such as GPL, LGPL, and BSD).	**K2**
CO5	Describe software review techniques, DevOps practices and code management principles, and software evolution processes and maintenance strategies.	**K2**
CO6	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with proper application of SCRUM, Kanban and Lean frameworks.	**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
CO3	3	3	3							3		3
CO4	3	3	3									3
CO5	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	Software Engineering	Ian Sommerville	Pearson Education	Tenth edition, 2015
2	Software Engineering : A practitioner's approach	Roger S. Pressman	McGraw Hill publication	Eighth edition, 2014
3	Engineering Software Products: An Introduction to Modern Software Engineering	Ian Sommerville	Pearson Education	First Edition, 2020

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Kanban	David J. Anderson	Blue Hole Press	2010
2	Agile Management for Software Engineering	David J. Anderson	Pearson	2003
3	Software Project Management : A unified framework	Walker Royce	Pearson Education	1998
4	Implementing Lean Software Development: From Concept to Cash	Mary Poppendieck	Addison-Wesley Signature Series	2006

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105182
2	https://nptel.ac.in/courses/106105182
3	https://nptel.ac.in/courses/106105182
4	https://nptel.ac.in/courses/106105218

SEMESTER S5

DATA STRUCTURES

Course Code	PEEET526	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)	UCEST105, GBEST204	Course Type	Theory

Course Objectives:

1. To impart a thorough understanding of linear data structures such as arrays, stacks, queues and linked lists and their applications.
2. To impart a thorough understanding of non-linear data structures such as trees, graphs and their applications.
3. To impart familiarity with various sorting, searching and hashing techniques and their performance comparison.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Concepts of Data Structures: Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notations Arrays: Linear Search and Binary Search, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions	11
2	Linked List: Self-Referential Structures, Dynamic Memory Allocation, Singly Linked List- Operations on Linked List. Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List, Polynomial representation using Linked List	11

3	Trees and Graphs: Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs	**11**
4	Sorting and Hashing: Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort Hashing- Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis	**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	Compare performance of algorithms using asymptotic notations	**K2**
CO2	Solve real world problems efficiently using appropriate data structures like arrays, linked list, stacks and queues.	**K3**
CO3	Make use of nonlinear data structures like trees and graphs to design algorithms for various applications.	**K3**
CO4	Apply and compare various techniques for searching and sorting.	**K3**
CO5	Apply appropriate hash function to store and access a given dataset	**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	1	-	1	-	-	-	-	-	-
CO2	3	2	3	1	-	1	-	-	-	-	-	-
CO3	3	2	3	1	-	1	-	-	-	-	-	-
CO4	2	2	3	1	-	1	-	-	-	-	-	-
CO5	3	2	2	1	-	1	-	-	-	-	-	-

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,SartajSahni and Susan Anderson-Freed	Universities Press	
2	Classic Data Structures	Samanta D	Prentice Hall India	2/e, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Structures: A Pseudocode Approach with C	Richard F. Gilberg, Behrouz A. Forouzan	Cengage Learning	2/e, 2005
2	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Publication	1983
3	Introduction to Data Structures with Applications	Tremblay J. P. and P. G. Sorenson	Tata McGraw Hill	1995
4	Advanced Data Structures	Peter Brass	Cambridge University Press	2008
5	Theory and Problems of Data Structures	Lipschuts S.	Schaum’s Series	1986

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106102064 https://youtu.be/zWg7U0OEAoE https://youtu.be/g1USSZVWDsY https://youtu.be/PGWZUgzDMYI
2	https://nptel.ac.in/courses/106102064 https://youtu.be/PGWZUgzDMYI
3	https://nptel.ac.in/courses/106102064 https://youtu.be/tORLeHHtazM https://youtu.be/eWeqqVpgNPg https://youtu.be/9zpSs845wf8
4	https://youtu.be/KW0UvOW0XIo https://youtu.be/gtWw_8VvHjk

SEMESTER S5

INTRODUCTION TO MACHINE LEARNING

Course Code	**PEEET527**	**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)	GYEST305, UCEST105	**Course Type**	PE - Theory

Course Objectives:

1. To equip students with overall understanding of the underlying mathematical and algorithmic concepts of machine learning.
2. To understand and perform various data pre-processing and visualization in using various python libraries
3. To implement various machine learning algorithms using python.
4. To evaluate and optimize machine learning models for diverse applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Mathematics for Machine Learning. -** Association of two variables - Discrete variables, Ordinal and Continuous variable, Probability calculus - Summary Statistics, probability distributions, Inductive statistics - Point estimation, Interval estimation, Hypothesis Testing - Basic definitions, t-test, F-test, ANOVA	**9**
2	**Introduction to machine learning algorithms** - supervised vs. unsupervised learning, regression and classification, linear discriminant analysis, decision trees, random forests, and bagging. Unsupervised - Principal Component Analysis, clustering algorithms, SVMs, re-sampling methods: cross-validation and bootstrapping	**9**
3	**Introduction to python for ML -** essential python libraries and ML functions (NumPy, pandas, Matplotlib, SciKit-Learn), working with data sets	

	– data cleaning and pre-processing functions, Data visualization- bar, scatter, histogram, heatmaps.	
4	**ML algorithm implementation with python -** Linear Regression Simple and multiple linear regression, Model evaluation metrics: MSE, RMSE, R^2, Classification Algorithms - Logistic regression, k-Nearest Neighbours (k-NN), Decision Trees, Model evaluation metrics: accuracy, precision, recall, F1-score, Support Vector Machines (SVM), Ensemble methods (Random Forest, Gradient Boosting), Clustering Algorithms -K-means clustering, Hierarchical clustering.	**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 relationships between different types of variables (discrete, ordinal, and continuous) using summary statistics and probability distributions, and perform hypothesis testing including t-tests and F-tests.	**K2**
CO2	**Apply** different supervised and unsupervised machine learning algorithms (such as regression, classification, clustering, and dimensionality reduction) and their appropriate applications in solving real-world problems.	**K3**
CO3	**Apply** essential Python libraries (NumPy, Pandas, Matplotlib) to clean, pre-process, and visualize data sets, preparing data for machine learning applications.	**K3**
CO4	**Implement** machine learning algorithms (such as linear regression, logistic regression, k-Nearest Neighbours, Decision Trees, SVM, Random Forest, Gradient Boosting, and clustering) in Python and evaluate their performance using relevant metrics.	**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	2								2
CO3	3	3	2									2
CO4	3	3	2	3								2
CO5												

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mathematics for Machine Learning	Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong	Cambridge University Press	1st Edition, 2020
2	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer	1st Edition, 2006
3	Python Data Science Handbook: Essential Tools for Working with Data	Jake Vander Plas	O'Reilly Media	1st Edition, 2016
4	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media	2nd Edition, 2019
5	Introduction to Machine Learning with Python: A Guide for Data Scientists	Andreas C. Müller, Sarah Guido	O'Reilly Media	1st Edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Elements of Statistical Learning: Data Mining, Inference and Prediction	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer	2nd Edition, 2009
2	Data Mining: Concepts and Techniques	Jiawei Han, Micheline Kamber, Jian Pei	Morgan Kaufmann	3rd Edition, 2011
3	Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and Tensor Flow 2	Sebastian Raschka, Vahid Mirjalili	Packt Publishing	3rd Edition, 2019
4	Applied Predictive Modelling	Max Kuhn, Kjell Johnson	Springer	1st Edition, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
Module - I	https://onlinecourses.nptel.ac.in/noc23_cs18/preview
Module - II	https://onlinecourses.nptel.ac.in/noc23_cs18/preview
Module - III	https://nptel.ac.in/courses/106105152
Module - IV	https://nptel.ac.in/courses/106105152

SEMESTER S5

COMPUTER NETWORK SYSTEMS

Course Code	**PEEET528**	**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 familiarize various types of layers in OSI model.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction – Uses of computer networks, Network hardware, Network software - Protocol hierarchies – Design issues for the layers – Connection oriented versus connectionless service. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models. Physical Layer –Transmission media overview – Twisted pair and fiber optics. Performance indicators – Bandwidth, Throughput, Latency, Bandwidth–Delay product.	**8**
2	Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols. Medium Access Control (MAC) sublayer, Channel allocation problem, Multiple access protocols – CSMA, Collision free protocols. Ethernet – Switched Ethernet, fast Ethernet and gigabit Ethernet. Wireless LANs - 802.11 – Architecture and protocol stack, Use of Bridges, Repeaters, Hubs, Switches, Routers and Gateways.	**8**
3	Network layer design issues. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Routing for mobile hosts. Congestion control algorithms – Approaches to congestion control (Details not required). Quality of Service (QoS) - Requirements, Techniques for achieving good QoS – Traffic shaping, Packet scheduling.	**12**

	IPv4 protocol, IP addresses, IPv6, Internet Control Protocols - Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First (OSPF) Protocol, Border Gateway Protocol (BGP), Internet multicasting.	
4	Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP) – Introduction, Remote procedure call. ELECTRICAL AND ELECTRONICS Transmission Control Protocol (TCP) – Introduction, TCP service model, TCP protocol, TCP segment header, Connection establishment & release. Application Layer –Domain Name System (DNS) – overview of DNS name space and Name servers, Electronic mail – Architecture and services- SMTP – IMAP - POP3, World Wide Web (WWW) - Architectural overview, HTTP, File Transfer Protocol (FTP).	**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 =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 computer networks, layered architecture, protocols and physical media used for setting up a network.	**K2**
CO2	Identify the role of Data link layer, role of the MAC sub layer and networking devices in Ethernets and wireless LANs	**K2**
CO3	Explain routing algorithms and congestion control algorithms and ways to achieve good quality of service, IP address classes, ICMP protocols and other external routing protocols.	**K2**
CO4	Explain the services provided by the transport layer and application layer.	**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**
CO2	**2**	**1**										**2**
CO3	**2**	**1**										**2**
CO4	**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	Computer Networks	Andrew S. Tanenbaum	Pearson Education India.	5^{th} edition
2	Data Communication and Networking	Behrouz A Forouzan	McGraw Hill Education	5^{th} edition

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	Larry L Peterson and Bruce S Dave	Morgan Kaufmann	5th edition
2	Computer Networking and the Internet	Fred Halsall		5th edition
3	Computer Networking: A Top-Down Approach	James F. Kurose, Keith W. Ross		6th edition
4	An Engineering Approach to Computer Networks	Keshav	Addison Wesley	1998
5	TCP/IP Illustrated Volume 1,	W. Richard Stevens.	Addison-Wesley	2005
6	Computer Networking with Internet Protocols,.	William Stallings	Prentice-Hall	2004

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106105183 https://nptel.ac.in/courses/106106091
2	https://nptel.ac.in/courses/106105183 https://nptel.ac.in/courses/106106091
3	https://nptel.ac.in/courses/106105183 https://nptel.ac.in/courses/106106091
4	https://nptel.ac.in/courses/106105183 https://nptel.ac.in/courses/106106091

SEMESTER: S5

AC MACHINES LAB

Course Code	**PCEEL507**	**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)	PCEET402	**Course Type**	Lab

Course Objectives:

1. Provide practical experience in operation and testing of synchronous and induction machines

Expt. No.	**Experiments**
PART A – INDUCTION MACHINES	
1	Load test on a 3-phase squirrel-cage induction motor (CO1) Objectives: a) Start the motor using star-delta starter / auto-transformer starter b) Determine the performance characteristics
2	**Load test on a 3-phase slip-ring induction motor (CO1)** Objectives: a) Start the motor using rotor resistance starter / auto-transformer starter b) Determine the performance characteristics
3	**No-load and blocked-rotor tests on a 3-phase squirrel-cage induction motor (CO1)** Objectives: a) Determine the equivalent circuit parameters b) Predetermine its performance at rated speed from equivalent circuit c) Predetermine its performance on full-load from circle diagram
4	**No-load and blocked-rotor tests on 3-phase pole-changing induction motor (CO1)** Objectives: a) Conduct no-load and blocked-rotor tests in two different pole configurations (example 4 pole and 8 pole) b) Predetermine its performance on full-load from circle diagrams in both cases

	OR
	Load test on 3-phase pole-changing induction motor (CO1) Objectives: a) Conduct load tests in two different pole configurations (example 4 pole and 8 pole) b) Determine the performance characteristics
5	**Variation of starting torque with rotor resistance in 3-phase slip-ring induction motor (CO1)** Objectives: a) Plot the variation of starting torque against rotor resistance b) Determine the external rotor resistance for which maximum starting torque is obtained
6	**Brake test on 1-phase induction motor (CO6)** Objectives: Plot the performance characteristics
7	**No-load and blocked-rotor tests on 1-phase induction motor (CO6)** Objectives: a) Determine the equivalent circuit b) Predetermine the efficiency on full-load from equivalent circuit
8	**3-phase induction machine working as motor and generator (CO2)** Objectives: Determine the performance of 3-phase induction machine working as motor and generator
9	**Speed control of 3-phase squirrel-cage induction motor using V/f technique (CO3)** Objectives: Perform the speed control of a 3-phase squirrel-cage induction motor by varying supply voltage and frequency
PART B –SYNCHRONOUS MACHINES	
10	**Voltage regulation of 3-phase synchronous generator by EMF and MMF method (CO4)** Objectives: a) Conduct OC and SC tests. b) Predetermine the full-load voltage regulation at different power factors.

11	**Voltage regulation of 3-phase synchronous generator by direct loading (CO4)** Objectives: a) Determine the voltage regulation at full-load or half full-load at any power factor. b) Compare the voltage regulation with emf method.
12	**Voltage regulation of 3-phase synchronous generator by Potier method (CO4)** Objectives: a) Conduct OC, SC and ZPFC tests. b) Predetermine the full-load voltage regulation at different power factors.
13	**V curves and Inverted V curves of synchronous machines (CO5)** Objectives: a) Synchronise the 3-phase alternator using dark lamp or bright lamp method b) Plot the V curves and inverted V curves of synchronous motor on no-load and half/full load. c) Plot the V curves and inverted V curves of synchronous generator on half/full load.
14	**Slip teston 3-phase salient-pole synchronous machines (CO4)** Objectives: a) Determine direct-axis and quadrature-axis synchronous reactances b) Predetermine the full-load voltage regulation at different power factors c) Predetermine the excitation and reluctance power with 120% excitation voltage and hence plot the power angle characteristics
NOTE: A minimum of TWELVE experiments are mandatory out of the fourteen listed.	

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	Analyze the performance of 3-phase squirrel cage and slip ring induction motor at different loads.	**K3**
CO2	Analyze the performance of line excited induction machine working in motoring and generating modes	**K3**
CO3	Apply V/f control techniques for the speed control of 3-phase induction motors	**K3**
CO4	Determine the voltage regulation of 3-phase cylindrical rotor type and salient pole type synchronous generators	**K3**
CO5	Construct V and inverter V curves of synchronous machines at constant load.	**K3**
CO6	Compute the efficiency of single-phase induction motor at a specified load.	**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					3	2		3
CO2	3	2		2					3	2		3
CO3	3	2		2					3	2		3
CO4	3	2		2					3	2		3
CO5	3	2		2					3	2		3
CO6	3	2		2					3	2		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	Electrical Machinery	P.S. Bimbhra	Khanna Publishers	7th edition 2021
2	Electric Machines	D P Kothari & I J Nagrath	Tata McGraw Hill	5th edition 2017

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

MICROPROCESSORS AND EMBEDDED SYSTEMS LAB

Course Code	**PCEEL508**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:2:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Lab

Course Objectives:

1. Achieve proficiency in 8051 microcontroller assembly language and embedded C programming.
2. Acquire practical experience with Arduino.

Expt. No.	Experiments
1	ALP programming for (a) Data transfer: Block data movement, exchanging data, sorting, finding largest element in an array. (b)Arithmetic operations: Addition, Subtraction, Multiplication and Division. Comparing square and cube of 16 bit numbers.
2	ALP programming for the implementation of counters: Hex up and down counters, BCD up/down counters.
3	(a)ALP programming for implementing Boolean and logical instructions: bit manipulation. (b)ALP programming for implementing conditional call and return instructions: Toggle the bits of port 1 by sending the values of 55H and AAH continuously, Factorial of a number.
4	ALP program for Generation of delay.
5	C program for stepper motor control.

6	C program for DC motor direction and speed control using PWM.
7	C program for alphanumerical LCD panel/keyboard interface.
8	C program for ADC interfacing.
9	Demo experiment using 8051 Microcontroller programming. ALP programming for implementation code conversion- BCD to ASCII , ASCII to BCD, ASCII to Decimal , Decimal to ASCII, Hexadecimal to Decimal and Decimal to Hexadecimal
10	a)Familiarization of Aurdino IDE. b)LED blinking with different ON/OFF delay timings with (i) inbuilt LED (ii) externally interfaced LED.
11	Arduino based voltage measurement of 12 V solar PV module /12 V battery and displaying the measured value using 12C LCD display..
12	Demo experiments on Arduino / Raspberry Pi to upload /retrieve temperature and humidity data to thing speak cloud.
13	Arduino based DC current measurement using Hall effect current sensor displaying the value using 12C LCD module.
14	Directional control of the DC motor using Arduino.
15	Interfacing of the relay with Arduino.
16	Building intrusion detection system with Arduino and Ultrasonic sensor.

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 and execute ALP programs for solving arithmetic and logical problems using microcontroller	**K3**
CO2	Develop embedded C programming using instruction sets of 8051	**K3**
CO3	Examine circuits for interfacing processor with various peripheral devices	**K4**
CO4	Design a microcontroller based system with the help of various interfacing devices	**K6**
CO5	Design an Arduino based system with the help of various interfacing devices	**K6**

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	The 8051 microcontroller	Kenneth Ayala	Cengage Learning	The 8051 microcontroller
2	Microprocessors and Microcontrollers	R. LylaB.Das	Pearson Education	Microprocessors and Microcontrollers

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The 8051 Microcontroller	I. ScottMacKenzie,Raphael C.-W.Phan		
2	The 8051 microcontroller and embedded systems	Muhammad Ali Mazidi	Pearson Education	

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

ELECTRICAL & ELECTRONICS ENGINEERING

SEMESTER S6

CONTROL SYSTEMS

Course Code	PCEET601	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)	PCEET503	Course Type	Theory

Course Objectives:

1. To introduce various classical tools for analysis of linear control system in time and frequency domain.
2. To provide a fundamental knowledge of modern control system.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Control Systems and its time domain analysis** *Review of Open loop and Closed loop control systems; Automatic control systems; Necessity and significance. (Not for evaluation) (1 hour)* *Time domain analysis of control systems:* Impulse and Step responses of first and second order systems - Pole dominance for higher order systems. Time domain specifications. (4 hours) *Error analysis:* Steady state error analysis and static error constants. (2 hours)	7
2	**Root Locus Analysis and Controllers:** *Root locus technique:* Construction of Root locus - stability analysis- effect of addition of poles and zeros; Effect of positive feedback systems on Root locus. (5 hours) *Controller design:* Types of controllers and their control action-	7

	proportional (P), integral (I), derivative (D), PID control. PID tuning using Ziegler-Nichols method. (2 hours)	
3	**Frequency domain analysis:** *Bode Plot:* Construction, Concept of gain margin and phase margin-stability analysis. (4 hours) Frequency domain specifications - correlation between time domain and frequency domain responses (Resonant peak and resonant frequency). Introduction to compensators. (Concept only). (2 hours) Polar plot: Gain margin and phase margin, Stability analysis. (2 hours) Nyquist stability criterion. Concept of Nichols Chart. (3 hours)	**11**
4	**State space representation of systems:** *Introduction to state-space modelling:* State variables, state equations. State variable representation of electrical systems. (2 hours) *Relationship between State space and Transfer function models:* Derivation of transfer functions from state equations. Controllable, Observable and Diagonal/Jordan canonical forms. Introduction to similarity transformations (concept only). (4 hours) *Solution of time invariant systems:* Solution of time response of autonomous systems and forced systems. State transition matrix - computation using Method of Laplace Transform and Cayley Hamilton theorem. (4 hours) *Controllability & Observability:* Definition, Kalman's test. (1 hour)	**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	Analyse the time domain responses of linear systems and predict and diagnose transient response parameters of the system for standard input functions.	**K2**
CO2	Analyse dynamics systems for their performance and stability using Root locus	**K3**
CO3	Apply frequency domain tools to analyse the performance of linear dynamic systems	**K3**
CO4	Represent and analyse dynamic systems using state-space.	**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	2	1	2	1	3	3	3			3	2
CO2	3	3	2	2	2	3	3	3			3	2
CO3	3	3	2	2	2	3	3	3			3	2
CO4	3	2	1	2	1	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	Modern Control Engineering	Katsuhiko Ogata	Pearson	5th edition, 2009
2	Control Systems Engineering	Norman S. Nise	Wiley	5th edition, 2009
3	Control Systems Engineering	I. J. Nagrath, M. Gopal	New Age	5th edition, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automatic Control Systems,	Kuo B. C.	Prentice Hall of India	9th edition, 2014
2	Control Systems Principles and Design	Gopal M.	Tata McGraw Hill.	4th edition, 2012
3	Modern Control Systems	Dorf R. C., Bishop R. H	Pearson Education India	12th edition, 2013

SEMESTER - S6

ELECTRICAL SYSTEM DESIGN AND ESTIMATION

Course Code	PCEET602	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 code)	Course Type	Theory

Course Objectives:

1. To create awareness regarding electrical symbols, Indian Standard codes, Indian Electricity acts and NEC norms
2. To enable students to design the various electrical installations with necessary precautions to ensure life safety, risk prevention and continuous operation of the system
3. To help in energy-efficient electrical design in compliance with codes and regulations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Awareness on IS Codes - IS 732, IS 3043, IS 2026- IS 3646-part 1 & 2 - IS 5216 part 1 & 2 Electricity supply code-2014, IE Act 1910, 2003, NEC LT system wiring components, selection of cables, wires, switches, distribution box, metering system, basics of star rating and labelling Principle of operation of Fuse, MCB, MCCB, ELCB/RCCB, isolator.	7
2	General requirements for electrical installations- Residential/ Commercial/ High rise building, method of load survey for electrical installation, Diversity factor Sizing and selection of wires, MSB, SSB, DB and protection devices. Design steps in electrical wiring, material estimation and development of single line diagrams. Electrical CAD (optional). Pre-commissioning test applicable to domestic installation	12

	Lighting design calculations - Definitions of Luminous flux, Luminous intensity, Illuminance. Illumination calculation, factors affecting Coefficients of Utilisation (CoU) - Light Loss Factor (LLF). Design and Estimation the quantity of material required in Electrical Installation for - Small residential building/Flat/Factory (Micro-Project)	
3	Indoor and Outdoor substation- selection of transformer, switch gears and protective devices, Procedure for HT connection, design and estimation the quantity of material required for substations, Pre-commissioning tests for transformers Industrial loads, selection of starters, cable and switchgears, Power factor improvement – kVAR calculation, correction methods Design of MSB & SSB including Motor Control Centre (MCC) - Selection of bus bars (CU & Al) and Switchgears Specifications of LT Breakers and other LT panel components (Basics only) Selection of industrial UG cables - Calculation of ampacity, voltage drop, short circuit withstand capacity	**10**
4	Standby DG Systems with AMF panel – Essential protections. UPS system and its design for residential application Selection and installation of elevators and lifts Earthing and Soil Resistivity calculation– Earth electrodes. Methods of earthing - Plate earthing - Pipe earthing - Rod earthing. Methods of improving earth resistance - Size of earth continuity conductor Substation earthing and design (Theory only), substation lightning protection (Theory only) Solar PV Power generation – Design and installation of standalone and grid interactive Solar PV system -Smart meter/Net meter	**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 =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 Indian standards and code of practice for efficient and effective energy usage with various electrical system design components.	**K2**
CO2	Design electrical wiring for residential and commercial consumers as per IS codes and NEC and integration of PV systems	**K3**
CO3	Design electrical installation for industrial consumers and high rise buildings.	**K3**
CO4	Analyse electrical system conditioning equipment and power backups.	**K4**
CO5	Design various earthing methods and protection	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1			2		2	2			2
CO2	3	3	3	1		2	2		2	1		2
CO3	3	3	3	1		2			2	1		2
CO4	3	3	3	1		2			2	1		2
CO5	3	3	3	1		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	National Electrical Code, Bureau of Indian Standards.		Bureau of Indian Standards.	
2	Electrical Systems Design	M. K. Giridharan	IK International Publishers, New Delhi	
3	Electrical Design Estimating Costing	K. B. Raina, S. K. Bhattacharya	NEW AGE; Reprint edition	
4	Residential Commercial and Industrial Systems	H. Joshi	McGraw Hill Education	

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	National Lighting Code 2010, Bureau of Indian Standards.			
2	National Building Code of INDIA 2016 - Bureau of Indian Standards.			
3	A Course in Electrical Installation Estimating and Costing.	J. B. Gupta	S.K. Kataria & Sons	Reprint 2013 edition (2013)
4	Electrical estimating and costing	S. Singh, and R. D. Singh	Dhanpat Rai and Co.	1997

SEMESTER S6

DIGITAL PROTECTION OF POWER SYSTEMS

Course Code	**PEEET631**	**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)	PCEET501, PBEET604	**Course Type**	Theory

Course Objectives:

1. To deliver fundamental concepts to design various electronic circuits to implement various relaying functions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction**: Need for protective systems, Zones of protection, Current transformers and voltage transformers (Electromagnetic and Capacitive voltage transformers), Principle of operation of magneto optic CT/ PT, effect on relaying philosophy. **Relays:** Over current relays - time-current characteristics of over current relays: definite time over current relays, inverse Definite Minimum time - directional over current relays, current setting and time setting - Numerical Problems - Differential relays: Operating and restraining characteristics, types of differential relays, Distance relays: impedance relays, reactance relays, mho relays (basic principles and characteristics only)	**9**
2	**Protection of Transmission Lines:** Schemes of distance protection, Differential line protection, Phase comparison line protection. **Protection of Bus-bar, Transformer and Generator & Motor**: Types of faults, differential protection: High impedance and low impedance differential protection schemes, harmonic restraint relay, Restricted Earth Fault Protection, frame leakage protection, stator and rotor protection against various types of faults.	**9**

3	**Digital (Numerical) Relays**: Basic Components of numerical Relays with block diagram, Processing Unit, Human machine Interface, Principle of operation, Comparison of numerical relays with electromechanical and static relays, Advantages of numerical relays - communication in protective relays (IEC 61850), Information handling with substation automation system (SAS) Signal Conditioning Subsystems: Surge Protection Circuits, Anti-aliasing filter, Conversion Subsystem, The Sampling Theorem, aliasing, Sample and Hold Circuit, Concept of analog to digital and digital to analog conversion, Idea of sliding window concept, Fourier, Discrete and fast Fourier transforms	**9**
4	**Signal processing techniques:** Sinusoidal wave based algorithms, Fourier Analysis based algorithms (half cycle and full cycle), Least squares based algorithm. Digital filters – Fundamentals of Infinite Impulse Response Filters, Finite Impulse Response filters, Filters with sine and cosine windows. **Wide Area Protection and Measurement:** Phasor Measurement Units, concept of synchronized sampling, Definition of wide-area protection, Architectures of wide-area protection, concept of Adaptive relaying, advantages of adaptive relaying and its application, Adaptive Differential protective scheme.	**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	Identify the relay protection scheme suitable for overcurrent, differential and distance protection.	**K3**
CO2	Develop the protection scheme for bus bars, transformers, generators, motors and distribution systems using appropriate protective relays	**K3**
CO3	Illustrate the operation of a numerical relay.	**K2**
CO4	Explain signal processing methods and algorithms in digital protection	**K2**
CO5	Infer emerging protection schemes in power systems	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2									
CO2	3		2									
CO3	3		2									
CO4	3		2									
CO5	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 Protection of Power System	A. T. Johns and S. K. Salman	Peter Peregrinus Ltd, UK	1995
2	Computer Relaying for Power Systems	A. G. Phadke and James S. Thorpe	Research study press Ltd, John Wiley & Sons, Taunton, UK	1988
3	Power System Protection and Switchgear	Badri Ram and D. N. Viswakarma	Tata McGraw Hill Education, Pvt Edition	2011
4	Digital Signal Processing in Power System Protection and Control	Waldemar Rebizant	Springer Publication	2008

Video Links (NPTEL, SWAYAM…)

Sl No	Link ID
1	https://archive.nptel.ac.in/courses/117/107/117107148/ (NPTEL lecture IIT Roorkee)

SEMESTER S6
OPERATING SYSTEMS

Course Code	PEEET632	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)	PEEET526	Course Type	PE - Theory

Course objectives:

1. To understand the overall working of computer system, trade-offs between performance and functionality and the division of jobs between hardware and software.
2. Introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system.
3. To understand the fundamentals about any operating system design

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Operating system overview – Functions, Boot Process Processes - Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination Inter-process communication - shared memory systems, Message passing systems.	8
2	Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come First Served, Shortest Job Firs, Priority scheduling, Round robin scheduling Process synchronization- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Monitors – Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.	10
3	Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock. Memory Management: Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.	10

4	File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods. Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling, Disk formatting.	**8**

Course Assessment Method
(CIE: -40 Marks, ESE: 60 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	***Assignment/ Micro project***	***Internal Ex-1***	***Internal Ex-2***	***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)**	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 the student will be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the relevance, structure and functions of Operating Systems in computing devices.	**K2**
CO2	Illustrate the concepts of process management and process scheduling mechanisms employed in Operating Systems.	**K2**
CO3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors	**K2**
CO4	Explain any one method for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems.	**K2**
CO5	Explain the memory management algorithms in Operating Systems.	**K2**
CO6	Explain the security aspects and algorithms for file and storage management in Operating Systems.	K2

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

CO PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3							1		2
CO2	2	3	3	2						1		2
CO3	2	3	3	2						1		2
CO4	2	3	3	2						1		2
CO5	2	3	3	2						1		2
CO6	2	3	3	2						1		2

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 System Concepts	Abraham Silberschatz, Peter Baer Galvin, Greg Gagne	Wiley India.	9th Edition, 2015

Text 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	Pearson, Global Edition	6th Edition, 2015.
2	Operating Systems	Garry Nutt, Nabendu Chaki, Sarmistha Neogy	Pearson Education	3rd Edition,
3	Operating Systems	D.M.Dhamdhere	Tata McGraw Hill	2nd Edition, 2011.
4	Operating Systems	Sibsankar Haldar, Alex A Aravind	Pearson Education	

Video Links (NPTEL, SWAYAM…)	
Sl No	**Link ID**
1	https://youtu.be/jciGIvn7UfM?si=iTyzYC1tztsAS8F4
2	https://youtu.be/I_7rthka2Is?si=kRo68aA_ozTBrNno

SEMESTER S6

HIGH VOLTAGE ENGINEERING

Course Code	**PEEET633**	**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 introduce basic terms and techniques applicable to high voltage ac and dc networks.
2. To learn about generation of different type of High voltage waveforms, their measurement and analysis.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Generation of High DC and AC Voltages- half-wave rectifier circuit-Cockroft-Walton voltage multiplier circuit- Electrostatic generator-Generation of high AC voltages-Cascaded Transformers- Series resonant circuit. Generation of Impulse Voltages and Currents- Impulse voltage-Impulse generator circuits- Multistage impulse generator circuit-Construction of impulse generator- Triggering of impulse generator-Impulse current generation.	9
2	High Voltage Measurement Techniques -Measuring Spark Gaps - Sphere-to-sphere Spark Gap -Rod-to-rod Spark Gap - Electrostatic Voltmeter-Field Sensors - Electrically Short Sensors, Electrically Long Sensors, Potential-free Probes, Generator-mode Sensors, Electro- optical and Magneto-optical Field Sensors - Voltage Dividers - Instrument Transformers - Measurements of R.M.S. Value, Peak Value and Harmonics - Current Measurement Dielectric measurements- Dissipation Factor and Capacitance, Insulation Resistance, Conductivity, Dielectric System Response-Partial discharge measuring technique- Requirements on a partial discharge measuring	9

	system - Measuring systems for apparent charge – Partial discharge measurements on high-voltage transformers, high-voltage cables, high-voltage gas-insulated substations. .	
3	Classification of Voltages and Overvoltages-Origin of Overvoltages – Representative Overvoltages- Performance Criterion –Withstand voltage. Insulation Coordination Procedure- Determination of Representative Voltages and Overvoltages-Continuous Power Frequency Voltage, Temporary Overvoltages, Slow-Front Overvoltages, Fast-Front Overvoltages Determination of Coordination Withstand Voltage (Ucw)-Deterministic Approach, Statistical Approach: Risk of Failure - Determination of Required Withstand Voltage (Urw)-Altitude Correction Factor, Safety Factor (Ks)- Selection of Standard Withstand Voltage (Uw)- Surge Arresters- Rated Voltage- Discharge Current- Impulse Current Tests- Residual Voltages- Arrester Durability Requirements.	**9**
4	High voltage Testing of insulators, bushings, isolators, circuit breakers, transformers, surge diverters, cables. Insulation Systems for AC Voltages -Cables, bushings and transformers-Insulation Systems for DC Voltages- Capacitors, HVDC bushings and Cables-Insulation Systems for Impulse Voltages -Electrical Stress and Strength -Energy Storage -Impulse Capacitors (Energy Storage or Surge Capacitors) Lightning Protection- Light and Laser Technology- X-ray Technology-Electrostatic Particle Precipitation, Ionization- Spark plugs.	**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	Identify different high voltage and current waveform generation circuits.	**K1**
CO2	Implement different sensing & measurement techniques for high voltage and current measurement.	**K3**
CO3	Describe insulation coordination and surge arrestor design.	**K2**
CO4	Implement different testing methods for equipments and applications of HV systems.	**K3**
CO5	Explain the various technologies for lightning protection.	**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											2
CO2	3											2
CO3	3						2					2
CO4	3						2					2
CO5	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	High Voltage Engineering	C. L. Wadhwa	New Age International	2011
2	High Voltage Engineering Fundamentals – Technology Applications	Andreas Kuchler	Springer	2018
3	High Voltage Engineering	Naidu M. S. and Kamaraju V.	Tata Mc Graw Hill	2004
4	High Voltage Engineering Fundamentals	Kuffel E. Zaengl S. and Kuffel J.	Elsevier India P Ltd	2005

SEMESTER S6

INTERNET OF THINGS

Course Code	PEEET634	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. This course aims to introduce IOT fundamentals.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to IoT technology:** Definitions of IoT, Characteristics of IoT devices – power, computational constraints, IoT Architectural view – Middleware based architecture, Service oriented architecture, M2M Communication and IoT, Typical application areas of IoT technology (case studies of at least four domains) - Energy management and Smart grid, IoT for Home, Cities, Environment monitoring, Agriculture, Supply chain and customer monitoring	**9**
2	**Components of IoT technology:** Identification/Addressing - Electronic Product Codes, RFID, ubiquitous code, IPv4, IPv6. Sensors and Actuators*. IoT Hardware**, IoT Software – overview of Operating systems, Firmware, Middle ware, Application software used in IoT. Connectivity for IoT devices – characteristics.	**9**
3	**Communication technologies for IoT :** Zigbee - key features, architecture, limitations, Bluetooth technology - bluetooth stack, piconet, scatternet, limitations, Bluetooth Low Energy (key features, architecture, limitations), Wifi (IEEE 802.11) technology – key features, limitations, Cellular technology – GSM, 3G, 4GLTE (overview), features, limitations, LoRa technology – features, LoRaWAN architecture, 6LoWPAN – features, protocol stack, Narrow Band (NB- IoT) – features, applications, Sigfox – features, applications	**9**

4	**IoT Data Management :** Storage technologies for IoT hardware – Volatile, Non-volatile, Embedded (MTP/OTP), external flash (NAND/NOR), DRAM, eflash, UFS, eMMC (overview of technologies). Cloud and IoT, Cloud computing – architecture, advantages of cloud computing, Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS). Case study of commercial cloud computing platforms like - Microsoft Azure IoT Suite, Google Cloud's IoT Platform, IBM Watson IoT Platform. IoT analytics	**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	Explain in a concise manner the architecture of IoT	**K2**
CO2	Identify various hardware and software components used in IoT	**K3**
CO3	Discuss the various communication technologies and interfaces in IoT	**K2**
CO4	Describe the usage of modern technologies like cloud computing for data management in IoT	**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	2	2	2								2
CO2	3	2	2	2								2
CO3	3	2	2	1								2
CO4	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	Internet of Things : Architecture and Design Principles"	Rajkamal	McGraw Hill (India) Private Limited.	2nd edition,2022
2	"Internet of Things (A Hands-on- Approach)"	Vijay Madisetti and Arshdeep Bahga	Orient Blackswan Private Limited - New Delhi	1st Edition,2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of things: A survey on enabling technologies, protocols, and applications	Al-Fuqaha	IEEE Communications Surveys & Tutorials	2015
2	The Internet of Things	Samuel Greengard	The MIT Press Essential Knowledge series Paperback	March 20, 2015
3	The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems	Ovidu Vermesan and Peter Friess	River Publishers	1st Edition, 2013
4	. Internet of Things - From Research and Innovation to Market Deployment	Peter Friess, Ovidiu Vermesan	River Publishers	1st Edition,2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/WUYAjxnwjU4?si=s58W-NKMrEQMaJ8m https://youtu.be/BXDxYh1EV2w?si=8oFtQB9vycC_c-t2
2	https://youtu.be/z3VEZPwl5gA?si=tNuzG_By-KBU3ks_ https://youtu.be/SXz0XR68dwE?si=1tVN1g9FQcGp87li https://youtu.be/TvzgzO6xKrY?si=gYzJstW51MTNsgKj
3	https://youtu.be/qko-f1VDhCM?si=0tWM_OHS395ESV_w https://youtu.be/d9QfVpCG00Y?si=qeHk8tPg_torr2yX https://youtu.be/1zQ8wbBozqI?si=7vOSHMt8OT3nQINO
4	https://youtube.com/playlist?list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE&si=rr5Fpuew5q9_Y4qg

SEMESTER S6

DIGITAL SIGNAL PROCESSING

Course Code	**PEEET636**	**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)	PCEET603/ PEEOT522	**Course Type**	Theory

Course Objectives:

1. To provide a thorough understanding of the realisation, design and analysis of DSP systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to DSP and Discrete Fourier transform:** Basic elements of DSP system. Advantages and applications. Review of Discrete-Time Fourier transform (DTFT) and its properties. Frequency domain sampling, Discrete Fourier transform (DFT) - DFT pair, properties of DFT, frequency response analysis of signals using the DFT, circular convolution using DFT, linear filtering based on DFT. Fast Fourier transform (FFT): Introduction, Radix -2 decimation in time FFT algorithm, Radix-2 decimation in frequency algorithm, IDFT using FFT algorithm.	**10**
2	**Realisation of Filters:** **Introduction to IIR and FIR systems.** Structures for IIR Systems: Direct-Form Structures, Cascade-Form Structures, Parallel-Form Structures, Lattice Structures for IIR Systems. **Structures for FIR Systems:** Direct-Form Structure, Cascade-Form Structures, Lattice Structure. Linear Phase FIR filters. Signal Flow Graphs and Transposed Structures.	**7**
3	**Design of Digital Filters:** General considerations, Causality and its implications, characteristics of practical frequency selective filters.	**10**

	IIR filter design: Discrete time IIR filter from analog filter (Butterworth), IIR filter (LPF, HPF, BPF, BRF) design by Impulse Invariance, Bilinear transformation. FIR filter design: Structures of FIR filter, Linear phase FIR filter Filter design using windowing techniques (Rectangular, Hanning, Hamming), frequency sampling Techniques.	
4	**Finite Word Length effects in Digital Filters:** Fixed point and floating-point number representations, Comparison, Truncation and Rounding errors. Quantization noise, Derivation for quantization noise power, coefficient quantization error, Product quantization error. Overflow error, Round-off noise power. Limit cycle oscillations due to product round-off and overflow errors, signal scaling. **Introduction to TMS320 Family:** Architecture, C24x CPU and other components; Assembly language Instructions, Instruction Set summary, simple programs. *Design & Implementation and Filter Structures: MATLAB functions and TMS320 Implementation (Demo/Assignment only)*	**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	Analyse discrete-time systems using DFT	**K2**
CO2	Realise IIR and FIR filters	**K3**
CO3	Design of IIR and FIR filters	**K3**
CO4	Analyse effect of word length in digital filters	**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	1	2	1	3	3	3			3	2
CO2	3	3	2	2	2	3	3	3			3	2
CO3	3	3	2	2	2	3	3	3			3	2
CO4	3	3	2	2	2	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: Principles, Algorithm & Application	John G. Proakis Dimitris G. Manolakis	Pearson	4th Edition
2	Discrete-Time Signal Processing	A. Oppenheim and R. Schafer	Pearson-Prentice Hall	2nd Edition

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Signal processing-A Practical Approach	Emmanuel C. Ifeachor, and Barrie W. Jervis	Pearson Education	2nd Edition
2	Digital Signal Processing	S. Salivahanan, A. Vallavaraj, and C. Gnapriya	Tata Mcgraw Hill	2nd Edition

SEMESTER S6

CLOUD COMPUTING

Course Code	**PEEET637**	**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**	**PE - Theory**

Course Objectives:

1. To enable learners to understand the concepts of cloud computing and its enabling technologies
2. Familiarize with mainstream cloud computing platforms and the services they offer.
3. To enable learners to have a basic understanding of virtualization, cloud security and cloud-based programming

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Traditional computing- Limitations. Overview of Computing Paradigms-Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges, Roles and Boundaries. Cloud delivery (service) models-Infrastructure-as-a-Service (IaaS), Platform-as-a-Service(PaaS),Software-as-a-Service (SaaS), XaaS (Anything-as-a-service)-Cloud deployment models- Public cloud, Community cloud, Private cloud, Hybrid cloud.	8
2	Introduction to virtualization-Virtualizing physical computing resources, Virtual Machines (Machine virtualization), Non-virtualized v/s Virtualized machine environments. Types of VMs- Process VM v/s System VM. Emulation, Interpretation and Binary translation. Virtualization layers. Hypervisors/VMM - Types of Hypervisors. Full Virtualization, Para Virtualization, Hardware-assisted virtualization, OS level virtualization.	8

	Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization.	
3	Resource provisioning techniques: Static and Dynamic Resource provisioning in cloud. Open Source Software platforms for Private Cloud : OpenStack, Eucalyptus, Open Nebula, Nimbus Popular public cloud platforms: AWS - AWS ecosystem, Compute services: EC2, Advanced compute services, Storage services: Amazon S3, Amazon EBS, Database services, other major services. Google Cloud: IaaS offerings-Compute Engine, Storage PaaS offerings-GAE. SaaS offerings. Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure VM, Compute services, Storage services	**11**
4	Cloud programming: Parallel Computing and Programming Paradigms, Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin Basics, Apache Spark Fundamentals of Cloud Security: Basic terms & concepts in security – Threat agents, Cloud security threat/risks, Trust. OS security – Virtual Machine security – Security of Virtualization – Security risk posed by Shared Images, Security risk posed by Management OS, Infrastructure security – Network Level, Host Level, Application Level, Security of the Physical systems, Identity and Access Management	**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	Explain the various cloud computing models and services	**K2**
CO2	Demonstrate the significance of implementing virtualization techniques	**K2**
CO3	Explain about the different private cloud platforms, and the services offered by popular cloud service providers	**K2**
CO4	Apply appropriate cloud programming methods to solve big data problems	**K3**
CO5	Describe the need for security mechanisms in cloud	**K2**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											2
CO2	2	2	2									2
CO3	2		1		3				1		1	2
CO4	2	3	3	3	3							2
CO5	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: Concepts, Technology and Architecture	Thomas Erl, Zaigham Mahmood, Ricardo Puttini	Prentice Hall	2013
2	Mastering Cloud Computing	Rajkumar Buyya, Christian Vecchiola,	McGraw Hill Education	2017

		S. Thamarai Selvi		
3	Cloud Computing	Sandeep Bhowmik	Cambridge University Press	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 Kaufmann publications	2018
2	Cloud Computing: Principles and Paradigms	Rajkumar Buyya, James Broberg, Andrzej M. Goscinski	Wiley	2013

Video Links (NPTEL, SWAYAM…)

Module No.	Link ID
Module - I	https://nptel.ac.in/courses/106105167
Module - II	https://nptel.ac.in/courses/106104182
Module - III	https://cloud.google.com/docs/ https://docs.aws.amazon.com/ https://learn.microsoft.com/en-us/azure/
Module - IV	https://nptel.ac.in/courses/106105167

SEMESTER 6

OPTIMIZATION TECHNIQUES

Course Code	**PEEET638**	**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**	**PE - Theory**

Course Objectives:

1. The broad objective of the course is to introduce classical optimization, its need and techniques suitable for application in engineering problems

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	Motivation and introduction to optimization in engineering practice	1
	Properties of single variable functions and optimality criteria, Region elimination methods, Polynomial estimation methods - quadratic estimation, Bisection method, Newton raphson method, Secant method, Cubic search method	5
	Functions of several variables, optimality criteria, Direct search method, Hooke-Jeeves pattern search method, Powell's method, Gradient search methods - Cauchy's method, Newton's method	5
		11
2	Formulation of linear programming models, Graphical solution in two variables, Standard form	3
	Simplex method, Duality, Dual simplex method - Karmarkar's method	6
		9

3	Equality constrained problems - Lagrange multipliers - Kuhn Tucker conditions - Kuhn Tucker theorems - Saddlepoint conditions - Second order optimality conditions - Generalized Lagrangian multiplier method	7
	Transformation methods - Concept of penalty - penalty functions - Method of Multipliers	3
		10
4	Constrained direct search - simple direct search method - Complex method - Random search methods	4
	Linearization methods for constrained Problems - Successive linear problems - Separable programming - Method of feasible directions - Simplex extensions for linearly constrained problems - Generalized reduced gradient method	5
		9

PS: Demonstrations of various techniques can be done using softwares like Scilab / Matlab / Octave or lower end softwares like Maxima

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	To evaluate the optimality criteria and methods for functions with single variable	**K4**
CO2	To evaluate the optimality criteria and methods for functions with several variables	**K4**
CO3	To understand and apply linear programming techniques for optimization	**K3**
CO4	To explore optimization techniques for constrained problems	**K3**
CO5	To explore search techniques and applications in optimization	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3			2	3						2
CO2	3	3			2	3						2
CO3	3	3			2	3						2
CO4	3	3			2	3						2
CO5	3	3			2	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	Engineering Optimization, Methods and Applications	A Ravindran, K M Ragsdell, G V Reklaitis	John Wiley and Sons	2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Linear Optimization	Dimitris Bertsimas, John N Tsitsiklis	Athena Scientific	1997
2	Stories about Maxima and Minima	V M Tikhomirov	American Mathematical Society	1990

SEMESTER S6

INTRODUCTION TO CONTROL SYSTEMS

Course Code	**OEEET611**	**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 code)	**Course Type**	Theory

Course Objectives:

1. To introduce various classical tools for analysis of linear control system in time and frequency domain.

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	**Introduction to Control Systems, mathematical modelling and Transfer function Based Analysis** Open loop and Closed loop control systems; Automatic control systems; Necessity and significance. (1 hour) *Modelling of LTI systems:* LTI Systems, Transfer function representation of differential equation in Laplace domain. Electrical, translational and rotational mechanical systems, DC servo-motor modelling. (4 hours). Block diagram representation - block diagram reduction. Signal flow graph - Mason's gain formula. (4 hours)	**9**
2	**Performance Analysis of Control Systems:** *Time domain analysis of control systems:* Impulse and Step responses of first and second order systems - Pole dominance for higher order systems. Time domain specifications. Steady state error analysis and static error constants (5 hours)	**8**

	Characteristic equation. Routh stability criterion. (3 hours)	
3	**Root Locus Analysis and Controllers:** *Root locus technique:* Construction of Root locus - stability analysis- effect of addition of poles and zeros; Effect of positive feedback systems on Root locus. (5 hours) *Controller design:* Types of controllers and their control action-proportional (P), integral (I), derivative (D), PID control. PID tuning using Ziegler-Nichols method. (3 hours)	**8**
4	**Frequency domain analysis:** *Bode Plot:* Construction, Concept of gain margin and phase margin-stability analysis. (4 hours) Frequency domain specifications - correlation between time domain and frequency domain responses (Resonant peak and resonant frequency). (2 hours) Polar plot: Gain margin and phase margin, Stability analysis. (2 hours) Nyquist stability criterion. Concept of Nichols Chart. (3 hours)	**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	To represent continuous time systems in the classical domain.	**K2**
CO2	Analyse the time domain responses of linear systems and predict and diagnose transient response parameters of the system for standard input functions.	**K2**
CO3	Analyse dynamics systems for their performance and stability using Root locus.	**K3**
CO4	Analyse dynamics systems for their performance and stability in frequency domain..	**K3**
CO5	To represent continuous time systems in the classical domain.	**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	2	1	2	1	3	3	3			3	2
CO2	3	2	1	2	1	3	3	3			3	2
CO3	3	3	2	2	2	3	3	3			3	2
CO4	3	3	2	2	2	3	3	3			3	2
CO5	3	2	1	2	1	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	Control Systems Engineering	Norman S. Nise	Wiley	5th Edition, 2009
2	Control Systems Engineering	I. J. Nagrath, M. Gopal	New Age	5th Edition, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automatic Control Systems,	Kuo B. C,	Prentice Hall of India	9th Edition,2014
2	Control Systems Principles and Design	Gopal M.	Tata McGraw Hill.	4th Edition, 2012
3	Modern Control Systems	Dorf R. C. , Bishop R. H	Pearson Education India	12th Edition, 2013
4	Modern Control Engineering	Katsuhiko Ogata	Pearson	5th Edition, 2009

SEMESTER S6

ENERGY MANAGEMENT

Course Code	OEEET612	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 code)	Course Type	Theory

Course Objectives:

1. To apply energy conservation principles and management techniques to different energy conversion systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**General aspects of energy management and energy audit: Energy Management –** Definition, General principles of energy management and energy management planning **Energy Audit:** Definition, need, types and methodologies. Instruments for energy audit, Energy audit report - Power quality audit Energy conservation in buildings: ECBC code (basic aspects), Building Management System (BMS).	**9**
2	**Energy Efficiency in Electrical Utilities:** Electricity transmission and distribution system, cascade efficiency. **Lighting**: Modern energy efficient light sources, life and efficacy comparison with older light sources, energy conservation in lighting. **Motors:** Development of energy efficient motors and the present status, techniques for improving energy efficiency, necessity for load matching and selection of motors for constant and variable loads. **Demand side Management:** Introduction to DSM, benefits of DSM, different techniques of DSM. **Power factor improvement,** numerical examples.	**9**

	Ancillary services: Introduction of ancillary services – Types of Ancillary services	
3	**Energy Management in Electrical Utilities:** **Boilers:** working principle - blow down, energy conservation opportunities in boiler. **Steam:** properties of steam, distribution losses, steam trapping. Identifying opportunities for energy savings in steam distribution. **Furnace:** General fuel economy measures, energy conservation opportunities in furnaces. **HVAC system:** Performance and saving opportunities in Refrigeration and Air conditioning systems. **Heat Recovery Systems:** Waste heat recovery system - Energy saving opportunities. **Cogeneration:** Types and schemes, optimal operation of cogeneration plants, combined cycle electricity generation.	9
4	**Energy Economics:** Economic analysis: methods, cash flow model, time value of money, evaluation of proposals, pay-back period, average rate of return method, internal rate of return method, present value method, life cycle costing approach. Computer aided Energy Management Systems (EMS).	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	Analyse the significance of energy management and auditing.	**K2**
CO2	Discuss the energy efficiency and management of electrical loads.	**K2**
CO3	Apply demand side management techniques	**K2**
CO4	Explain the energy management opportunities in industries.	**K2**
CO5	Compute the economic feasibility of the energy conservation measures	**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					1	1		1			
CO2	2		1	1		1	1					
CO3	2		1	1		1	1					
CO4	2		1	1		1	1					
CO5	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	Publications of Bureau of Energy Efficiency (BEE).			
2	Energy Management and Conservation Handbook	D. Yogi Goswami, Frank Kreith,	CRC Press	2007
3	Energy management Hand Book	Wayne C. Turner	The Fairmount Press, Inc.	1997
4	Energy Management and Conservation Handbook	D. Yogi Goswami, Frank Kreith	CRC Press	2007
5	Industrial energy conservation	Charles M. Gottschalk	John Wiley & Sons	1996

SEMESTER S6

RENEWABLE ENERGY SYSTEMS

Course Code	**OEEET613**	**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 understand energy scenario, energy sources and their utilization
2. To explore society's present needs and future energy demands
3. To study the principles of renewable energy conversion systems
4. To be exposed to energy conservation methods

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:** Principles of renewable energy; energy and sustainable development, fundamentals and social implications. Worldwide renewable energy availability, renewable energy availability in India, types of renewable energy. **Wind Energy:** Properties of wind, availability of wind energy in India, wind velocity and power from wind (numerical problems); major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and multi-blade system. Vertical axis - Savonius and Darrieus types.	9
2	**Solar Energy:** Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements - Pyrheliometers, Pyranometer, Sunshine Recorder. Solar Thermal systems: concentrating and non-concentrating collectors - Flat plate collectors; Solar tower electric power plant. Photovoltaic system for electric power generation	9

	– Classification of PV system - Principle of Solar cell, advantages, disadvantages and applications of solar photovoltaic system.	
3	**Biomass Energy:** Introduction; Principle of biomass energy generation - Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome type biogas plant; Urban waste to energy conversion; Biomass gasification (Downdraft). **Tidal Power:** Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, classification of tidal power plants - harnessing tidal energy, advantages and limitations.	**9**
4	**Ocean Thermal Energy Conversion:** Principle of working, classification, OTEC power stations in the world, environmental impacts associated with OTEC. Introduction to geothermal energy **Green Energy:** Introduction, Fuel cells: Classification of fuel cells – Hydrogen energy; Operating principles, Zero-energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.	**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	Describe the environmental aspects of renewable energy resources in comparison with various conventional energy systems, their prospects and limitations.	**K1**
CO2	Understand the concepts of wind energy.	**K1**
CO3	Describe the use of solar energy and the various components used in the energy production with respect to applications like-heating, cooling, desalination, power generation.	**K2**
CO4	Understand the concept of biomass energy resources and conversion principles of tidal energy.	**K2**
CO5	Acquire the basic knowledge of ocean thermal energy conversion. Understand the principle of green energy and hydrogen energy.	**K1**

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
CO2	3	3										2
CO3	3	3										2
CO4	3	3										2
CO5	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	Non-conventional energy sources	G. D. Rai	Khanna	4^{th} edition 2023
2	Renewable energy systems	Thomas E. Kissell, David M. Buchla, Thomas L. Floyd,	Pearson	2017
3	Non-Conventional Energy Resources	Sawhney G. S.	PHI Learning	2012
4	Renewable energy systems	Thomas E. Kissell, David M. Buchla, Thomas L. Floyd,	Pearson	Pearson 2017

SEMESTER S6

CONTROL SYSTEM LAB

(EE Branch)

Course Code	**PCEEL607**	**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)	PCEET302/ PCEET601	**Course Type**	Lab

Course Objectives:

1. To make the students learn how to determine the parameters experimentally and model the given system.
2. To make the students learn the experimental determination of responses of dynamic systems and analyse its behaviour.
3. To make the students learn the different analysis and controller design tools using appropriate simulation software

Expt. No.	Experiments
1	**Transfer Function and State Space Modelling of Armature and Field Controlled DC Motor.** **Objective:** Obtain the transfer function and state space model of the armature and field-controlled DC motor by experiment.
2	**Transfer function of A.C. Servo motor.** **Objective:** Obtain the transfer function of AC Servo motor by experiment.
3	**Synchro Transmitter and Receiver for open loop position control.** **Objective:** a) Plot the characteristics of synchro. Error study of the synchro transmitter and receiver pair as a simple open loop position control in Direct mode and Differential mode.

4	**Step response and frequency response of a second order system realised using passive components** **Objective**: Design a second order (RLC network) system to analyse the following: a. The effect of damping factor ($0<\xi<1$, $\xi = 1$, $\xi > 1$) for a step input . b. Verification of the delay time, rise time, peak overshoot and settling time with the theoretical values for $0<\xi<1$. c. Effect of damping ratio on frequency response. d. Verification of resonant peak, resonant frequency and bandwidth for $0<\xi<1$.
5	**Realisation of lead compensator.** **Objective:** Design, set up and analyse the gain and phase plots of a lead compensator by hardware experimentation using i) passive elements and ii) active components
6	**Realisation of lag compensator.** **Objective:** Design, set up and analyse the gain and phase plots of a lag compensator by hardware experimentation using: i) passive elements and ii) active components.
7	**Performance of a typical process control system** **Objective:** Study of performance characteristics and response analysis of a typical temperature/ Flow/ Level control system.
8	**System Identification and Modeling** **Objective:** Obtain the frequency response and identify the transfer function of the given system(black box),

9	**Step response and frequency response of a second order system using simulation** **Objective:** To analyse the response of the second order system (in experiment 1) using (MATLAB/SCILAB/similar softwares) a. The effect of damping factor ($0<\xi<1$, $\xi = 1$, $\xi > 1$) for a step input . b. Comparison of the delay time, rise time, peak overshoot and settling time with the experimental values for $0<\xi<1$. c. The effect of damping ratio on frequency response. d. Comparison of resonant peak, resonant frequency and bandwidth with the experimental values for $0<\xi<1$.
10	**Performance Analysis using Root-Locus and frequency Response Methods in MATLAB/SCILAB/similar softwares.** **Objective:** 1. Plot the i) root locus ii) Bode plot and iii) Nyquist plot and iv) Nichols chart for the given transfer functions and analyse the following: **Root Locus:** a. Determine the critical gain, frequency of oscillation at critical gain. b. The effect of gain, K on the stability. c. Determine the gain corresponding to a given damping ratio and obtain the step response of the system for the corresponding gain. d. The effect of the addition of poles and zeros on the given system. **Frequency response:** e.Determination of Gain Margin and Phase Margin (stable and unstable, minimum/non-minimum phase system)

	f. The effect of controller gain K on the stability margin g. The effect of the addition of poles and zeros on the given system (especially the poles at origin). h. Determine the stability of a given minimum and non-minimum phase system using Nyquist stability criterion. i. Determine the bandwidth of a given system from open loop frequency response using Nichols chart.
11	**Design of lag, lead and lag-lead compensator using root locus.** **Objective:** Design a suitable compensator for the given system to satisfy the given time domain specifications using MATLAB/SCILAB/ similar software.
12	**Design of lag, lead and lag-lead compensator using frequency response.** **Objective:** Design a suitable compensator for the given system to satisfy the given frequency domain specifications using MATLAB/SCILAB/ similar software.
13	**State Space Model, Analysis and Controller Design** **Objective:** Analyse the given system (eg. DC Servo motor modelled in experiment no.1 for **speed** control) in state space and design a controller by pole-placement technique using MATLAB/SCILAB/ similar software. a. Determine the open loop stability, controllability and observability b. Design a state-feedback controller by pole-placement technique for a given specification.
14	**PID Controller Design** **Objective:** Design a PID controller for the given system (eg. DC Servo motor modelled in experiment no. 1 for **position** control) using SIMULINK/ MATLAB based tool boxes. a. Design of P, PI, PD, PID controller using the Ziegler-Nichols method. b. Design of a suitable controller (P/PI/PD/PID) to meet the desired specifications using root locus/frequency response.

Note: 1. A minimum of **12 experiments** are compulsory.
2. Experiment No. **11, 12, and 13** are mandatory.

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	Identify and conduct suitable experiments to determine the parameters to model a physical system.	**K3**
CO2	Conduct suitable experiments and determine the performance specifications.	**K3**
CO3	Analyse a linear continuous time system model using simulation tools.	**K3**
CO4	Design suitable controllers/compensators to meet the performance requirements using simulation tools.	**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	2	2	2	3	3	3	3	2	3	2
CO2	3	3	2	2	2	3	3	3	3	2	3	2
CO3	3	3	2	2	2	3	3	3	3	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	2

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	Modern Control Engineering	Katsuhiko Ogata	Pearson	5th edition, 2009
2	Control Systems Engineering	Norman S. Nise	Wiley	5th edition, 2009
3	Control Systems Engineering	I. J. Nagrath, M. Gopal	New Age	5th edition, 2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automatic Control Systems,	Kuo B. C.	Prentice Hall of India	
2	Control Systems Principles and Design	Gopal M.	Tata McGraw Hill.	
3	Modern Control Systems	Dorf R. C., Bishop R. H	Pearson Education India	

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 S6

POWER SYSTEM LAB

Course Code	PCEEL609	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:2:0	ESE Marks	50
Credits	1	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCEET501	Course Type	Lab

Course Objectives:

1. To encourage students learn through analytical problem solving and practical implementation.
2. To motivate the students for self-learning
3. To make them ready for practical implementation of the knowledge that they have gained from theory.

Expt. No.	Experiments
	Software
1	**Y-Bus formulation:** Aim: (i) To formulate the bus admittance matrix of the given power system from its single line diagram, using basic MATLAB programming. (ii) To incorporate changes in basic topology.
2	**Transmission Line Modelling: ABCD constants** Aim: (i) To model the given medium transmission line using nominal T and nominal pi representation and to derive the ABCD constants using basic MATLAB programming.
3	Load Flow Analysis – Gauss-Siedel Method, Newton - Raphson Method, Fast Decoupled Method – Aim: (i) To conduct load flow analysis using Gauss-Siedel method, Newton-Raphson method, Fast Decoupled method and to study the effect of change in load/generation schedule.
4	**Load Flow Analysis** – Gauss-Siedel Method, Newton - Raphson Method, Fast Decoupled Method Aim: (i) To conduct load flow analysis using Gauss-Siedel method, Newton-Raphson method, Fast Decoupled method and to study the effect of change in real power/reactive power limits.
5	**Short Circuit Analysis** – Symmetrical Faults and Unsymmetrical Faults Aim: (i) To conduct short circuit analysis for symmetrical and unsymmetrical faults.
6	**Transient Stability Analysis** Aim: To conduct transient stability analysis of a given system and plot suitable graphs using MATLAB Simulink or dedicated software (if available)

7	**Automatic Generation Control –** Single Area, Two Area Aim: To implement Automatic Generation Control in MATLAB Simulink.
8	**Automatic Voltage Regulator** Aim: To implement Automatic Voltage Regulator in MATLAB Simulink.
9	**Ferranti Effect and Reactive Power Compensation** Aim: (i) To exhibit Ferranti effect in a lightly loaded long transmission line in MATLAB Simulink and to show the effect of reactive power compensation. (ii) To calculate Surge Impedance Loading of the line
10	**Plot the IV characteristics of a PV module and determine Maximum Power Point** Aim: To plot the IV characteristics of a PV module in MATLAB Simulink and determine the Maximum Power Point
	Hardware
11	**High Voltage Testing** – Power frequency /impulse
12	**High Voltage Testing** - DC
13	**Relay Testing** – Over current Relay / Earth Fault (Electromechanical / Static /Numerical) Aim: To draw the characteristics of the given relay.
14	**Relay Testing** –Voltage relay/ Impedance Relay (Electromechanical/Static/Numerical) Aim: To draw the characteristics of the given relay.
15	**Insulation Testing** – LT & HT Cable Aim: To determine the insulation resistance of the given LT & HT cable.
16	**Testing of CT and PT** Aim: To conduct ratio test of the given CT and PT.
17	**Testing of transformer oil** Aim: To determine the dielectric strength of the given sample of transformer oil.
18	**Testing of dielectric strength of solid insulating materials** Aim: To determine the dielectric strength of the solid insulating material given.
19	**Testing of dielectric strength of air** Aim: To determine the dielectric strength of air.
20	**Power factor improvement** Aim: To calculate the power factor of the given RL series circuit (transmission line) and design the capacitance required to improve the power factor to the desired value.

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 mathematical models and conduct steady state and transient analysis of power system networks using standard / dedicated software.	**K3**
CO2	Conduct appropriate tests for any power system component as per standards to analyse their performance.	**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	3	3	3
CO2	3	3	3	3	3				3	3	3	3

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

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

ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER S7

POWER SYSTEM OPERATION AND CONTROL

Course Code	PEEET741	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)	PCEET501, PBEET604	Course Type	PE -Theory

Course Objectives:

1. To introduce analysis techniques for the operation and control of power system.
2. To discuss load scheduling and scheduling of energy.
3. To study power system security and state estimation.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction- Optimum load dispatch - First order gradient method base point and participation factors. Economic dispatch versus unit commitment. Unit Commitment Solution Methods - Priority-List Methods – Security Constrained Unit Commitment.	9
2	Generation with limited supply-Take or pay fuel supply contract-Introduction to Hydrothermal coordination-Long range and short range scheduling Hydro-electric plant models-scheduling energy problems - types of scheduling problems. Scheduling energy - The Hydrothermal Scheduling Problem - Hydro scheduling with storage limitation - Introduction to Pumped storage hydro plants.	9
3	Inter change evaluation and power pools- Interchange contracts – Energy interchange between utilities - Interchange evaluation with unit commitment - Energy banking- power pools. Power system security- Factors Affecting Power System Security - Contingency Analysis: Detection of Network Problems - Generation Outages - Transmission Outages - An Overview of Security Analysis.	9
4	Introduction to State estimation in power system, Maximum Likelihood Weighted Least Squares Estimation - State Estimation of an AC Network - Sources of Error in State Estimation - Detection and Identification of Bad	9

	Measurements - Estimation of Quantities Not Being Measured - Network Observability and Pseudo-measurements - The Use of Phasor Measurement Units (PMUs) - Application of Power Systems State Estimation - Importance of Data Verification and Validation.	

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	Analyse various methods of generation scheduling.	**K4**
CO2	Formulate hydro-thermal scheduling problems.	**K5**
CO3	Evaluate power exchange in interconnected power systems.	**K5**
CO4	Analyse security issues in power system networks.	**K3**
CO5	Analyse various state estimation methods.	**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	3	3	3					3
CO2	3	3	3	3	3	3	3					3
CO3	3	3	3	3	3	3	3					3
CO4	3	3	3	3	3	3	3					3
CO5	3	3	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	Power Generation Operation and Control	Allen J. Wood & Bruce F. Wollenberg	John Wiley & Sons	3rd edition 2023
2	Power System Analysis	John Graigner & William Stevenson	McGraw Hill	1994
3	Power System State Estimation: Theory and Implementation	Ali Abur, Antonio Gomez	CRC Press	2004

SEMESTER S7

ENERGY MANAGEMENT AND AUDITING

Course Code	**PEEET742**	**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**	PE - Theory

Course Objectives:

1. To apply energy conservation principles and management techniques to different energy conversion systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**General aspects of energy management and energy audit: Energy Management –** Definition, General principles of energy management and energy management planning **Energy Audit:** Definition, need, types and methodologies. Instruments for energy audit, Energy audit report **-** Power quality audit Energy conservation in buildings: ECBC code (basic aspects), Building Management System (BMS).	**9**
2	**Energy Efficiency in Electrical Utilities:** Electricity transmission and distribution system, cascade efficiency. **Lighting**: Modern energy efficient light sources, life and efficacy comparison with older light sources, energy conservation in lighting. **Motors:** Development of energy efficient motors and the present status, techniques for improving energy efficiency, necessity for load matching and selection of motors for constant and variable loads. **Demand side Management:** Introduction to DSM, benefits of DSM, different techniques of DSM. **Power factor improvement,** numerical examples. **Ancillary services:** Introduction of ancillary services – Types of Ancillary services	**9**

3	**Energy Management in Electrical Utilities:** **Boilers:** working principle - blow down, energy conservation opportunities in boiler. **Steam:** properties of steam, distribution losses, steam trapping. Identifying opportunities for energy savings in steam distribution. **Furnace:** General fuel economy measures, energy conservation opportunities in furnaces. **HVAC system:** Performance and saving opportunities in Refrigeration and Air conditioning systems**.** **Heat Recovery Systems:** Waste heat recovery system - Energy saving opportunities. **Cogeneration:** Types and schemes, optimal operation of cogeneration plants, combined cycle electricity generation.	**9**
4	**Energy Economics:** Economic analysis: methods, cash flow model, time value of money, evaluation of proposals, pay-back period, average rate of return method, internal rate of return method, present value method, life cycle costing approach. Computer aided Energy Management Systems (EMS).	**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	Analyse the significance of energy management and auditing.	**K2**
CO2	Discuss the energy efficiency and management of electrical loads.	**K2**
CO3	Apply demand side management techniques	**K2**
CO4	Explain the energy management opportunities in industries.	**K2**
CO5	Compute the economic feasibility of the energy conservation measures	**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					1	1		1			
CO2	2		1	1		1	1					
CO3	2		1	1		1	1					
CO4	2		1	1		1	1					
CO5	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	Publications of Bureau of Energy Efficiency (BEE).			
2	Energy Management and Conservation Handbook	D. Yogi Goswami, Frank Kreith,	CRC Press	2007
3	Energy management Hand Book	Wayne C. Turner	The Fairmount Press, Inc.	1997
4	Energy Management and Conservation Handbook	D. Yogi Goswami, Frank Kreith	CRC Press	2007
5	Industrial energy conservation	Charles M. Gottschalk	John Wiley & Sons	1996

SEMESTER S7

SPECIAL ELECTRICAL MACHINES

Course Code	**PEEET743**	**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**	PE -Theory

Course Objectives:

1. Describe the constructional details, working and drive circuits of various types of special electrical machines

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Stepper motors – basic principle - types - variable reluctance, permanent magnet, hybrid types – constructional features - principle of operation – comparison - modes of operation – monofilar and bifilar windings – modes of excitation – one phase ON mode, two phase ON mode, half-step mode – micro-stepping - static and dynamic characteristics – open-loop and closed loop control - applications – numerical problems.	**9**
2	Synchronous Reluctance Motor – Constructional details - principle of operation - phasor diagram - torque equation - applications. Switched reluctance motors – constructional details - principle of operation - torque equation – characteristics - power converter circuits - control of SRM - rotor position sensors- torque pulsations – sources of noise - noise mitigation techniques - applications.	**9**
3	PM Brushless DC motor- constructional details - permanent magnets – different types - demagnetization characteristics – arrangement of permanent magnets – magnetization of permanent magnets – axial and parallel magnetizations- principle of operation – Control of BLDC motor - applications. Permanent Magnet Synchronous Motors - construction - principle of operation – Control of PMSM – self-control – sensor-less control– applications - comparison with BLDC motors	**9**

4	Linear Electric Machines: Linear motors – different types – linear reluctance motor - linear synchronous motors – construction – comparison. Linear Induction Motor – Construction- Thrust Equation, Transverse edge and end effects- Equivalent Circuit, Thrust-Speed characteristics, Applications. Single Phase Special Electrical Machines- AC series Motor, Repulsion Motor, Hysteresis Motor, Universal Motor- Construction - principle of operation - 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 =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 constructional details, working and drive circuits for various types of stepper motor.	**K2**
CO2	Explain the constructional details, working and drive circuits for switched and synchronous reluctance motor.	**K2**
CO3	Explain the constructional details, working and drive circuits for brushless DC motor and permanent magnet synchronous motor.	**K2**
CO4	Explain the constructional details and working of linear induction motor	**K2**
CO5	Explain the constructional details and working of single-phase special electrical machines.	**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	2										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3
CO5	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	Special Electrical Machines	E. G. Janardhanan	PHI Learning Private Limited	Ist edition 2014
2	Special Electrical Machines	K. Venkataratnam	Universities Press	Ist edition, 2008
3	A detailed study on Special Electrical Machines	V. Vedanarayanan	Notion Press	Ist edition, 2021
4	Brushless PM and Reluctance Motor Drives	T. J. E. Miller	Clarendon Press, Oxford	1989
5	Permanent magnet synchronous and Brushless DC motor Drives	R. Krishnan	CRC Press.	Ist edition 2016

SEMESTER S7

DISCRETE TIME CONTROL SYSTEMS

Course Code	PEEET744	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 strong foundation on the analysis and design techniques on classical and modern control theory in discrete domain

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Analysis of Sampled Data Systems:** Review of Z Transforms; Sampling Theorem, Impulse Sampling, Sampling Rate Selection, Data Hold – ZOH, FOH, Pulse Transfer Function, Control configurations. Mapping between the s-plane and the z-plane. Stability analysis of closed-loop system in the z-plane, Jury's test, Schur-Cohn test, Bilinear Transformation, Routh-Hurwitz method in w-plane.	9
2	**Design of Compensators:** Direct design based on root locus: Design of Lag Compensator, Design of Lead Compensator, Design of Lead-Lag Compensator. Digital Controller Design in Frequency Domain: Direct design based on frequency response, Design of Lag Compensator, Design of Lead Compensator, Design of Lag-Lead Compensator, Realization of digital controllers.	11
3	**Discrete-time State Space System:** State variable model of discrete data systems with S/H devices - State transition equations, state diagrams. Relationship between state space representation and pulse transfer function, Transformation to canonical forms and phase variable form. Solution of state equation, Computation of state transition matrix using	9

	Cayley-Hamilton theorem and z-transform method.	
4	**Design using State Space approach:** Discretization of continuous time state-space equations, Controllability, Observability. State feedback controller design via Pole Placement. State Observer Design: Full order observers and Reduced order observers.	**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 =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	Model and analyse discrete-time system using pulse transfer function approach.	**K3**
CO2	Design digital compensators for linear systems.	**K3**
CO3	Model and analyse discrete-time system using state space approach.	**K3**
CO4	Design discrete-time state feedback controllers and observers for a linear system.	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3			3	2
CO2	3	3	2	2	2	3	3	3			3	2
CO3	3	3	2	2	2	3	3	3			3	2
CO4	3	3	2	2	2	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 control system analysis and design	Philips and Nagle	Prentice Hall	1984
2	Discrete Time Control Systems	K. Ogata	PHI Learning Private Limited, New Delhi	2009.
3	Digital control and State Variable methods	M. Gopal	Tata McGraw –Hill	1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Control Systems	B C Kuo	2nd Ed., Oxford University Press	1992
2	Digital control systems Theory, hardware software.	Constantine H. Houpis and Gary B. Lamont	McGraw Hill Book Company	1985
3	Digital control systems Volume I, Fundamentals , Deterministic control	Isermann	Springer Verlag	2nd revised edition 1989
4	Digital Control of Dynamic Systems	G.F.Franklin, J. David Powell and M. Workman		3rd Ed.

SEMESTER S7

DIGITAL IMAGE PROCESSING

Course Code	**PEEET746**	**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**	PE -Theory

Course Objectives:

1. To introduce the fundamental concepts of Digital Image Processing and study the various transforms required for image processing.
2. To study spatial and frequency domain image enhancement and image restoration methods.
3. To understand image compression and segmentation techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Digital Image Fundamentals: Image representation, Types of images, Elements of DIP system, Basic relationship between pixels, Distance Measures, Simple image formation model. Brightness, contrast, hue, saturation, Mach band effect. Colour image fundamentals-RGB, CMY, HIS models, 2D sampling and quantization.	**9**
2	2D Image transforms: DFT, Properties, Walsh transform, Hadamard transform, Haar transform, DCT, KL transform and Singular Value Decomposition. Image Compression: Image compression model, Lossy, lossless compression, Concept of transform coding, JPEG Image compression standard.	**9**
3	Image Enhancement: Spatial domain methods: Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing spatial Filters, Sharpening spatial Filters. Frequency domain methods: low pass filtering, high pass filtering,	**9**

	homomorphic filtering.	
4	Image Restoration: Degradation model, Inverse filtering- removal of blur caused by uniform linear motion, Minimum Mean Square Error (Wiener) Filtering. Image segmentation: Region based approach, clustering , Segmentation based on thresholding, edge based segmentation, Hough Transform.	**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 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 different components of image processing system	**K2**
CO2	Analyse the various concepts and mathematical transforms necessary for image processing	**K3**
CO3	Illustrate the various schemes of image compression	**K3**
CO4	Analyze the filtering and restoration of images	**K3**
CO5	Understand the basic image segmentation techniques	**K2**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		1							2
CO2	3	3	3		1							2
CO3	3	3	3		1							2
CO4	3	3	3		1							2
CO5	3	3	3		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	Digital Image Processing	Gonzalez Rafel C	PEARSON	4TH
2	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	McGraw Hill	Ist

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Kenneth R Castleman	Pearson Education	2/e,2003
2	Fundamentals of digital image processing	Anil K Jain	PHI	1988
3	Digital Image Processing	Pratt William K	John Wiley	4/e,2007

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc24_ee133/preview
2	https://nptel.ac.in/courses/117105135
3	https://www.youtube.com/watch?v=KiJo4-IijL4
4	https://archive.nptel.ac.in/courses/117/105/117105135/

SEMESTER S7

POWER QUALITY

Course Code	PEEET751	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	PE - Theory

Course Objectives:

1. To introduce the fundamental concepts of power quality, different power quality issues and its mitigation methods.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Power quality phenomenon** - Sources and effects of power quality problems, Need for concern of Power quality **Types of power quality disturbances** –Transients – classification and origin, Short duration voltage variation – interruption, sag, swell, Long duration voltage variation, voltage unbalance, waveform distortion - notching, harmonics and voltage flicker **Power Quality issues of Grid connected Renewable Energy Systems** – operating conflicts	9
2	**Harmonics -** mechanism of harmonic generation, Triplen harmonics, **Harmonic sources** – switching devices, arcing devices and saturable devices, Effects of harmonics on power system equipment and loads – transformers, capacitor banks, motors and telecommunication systems, Effect of triplen harmonics on neutral current, line and phase voltages. **Harmonic analysis using Fourier series and Fourier transforms** – simple numerical problems	9
3	**Harmonic indices** (CF, DF, THD, TDD, TIF, DIN, C – message weights), Displacement and total power factor **Overview of power quality standards**: IEEE 519, IEEE 1433 and IEC 61000 **Power quality Monitoring:** Objectives and measurement issues, different monitoring instruments – Power quality analyzer, harmonic spectrum analyzer, flicker meters	9

4	**Mitigation of Power quality problems** - Harmonic elimination - Design simple problems and analysis of passive filters to reduce harmonic distortion – demerits of passive filters – description of active filters - shunt, series, hybrid filters, sag and swell correction using DVR Power quality conditioners - DSTATCOM and UPQC - Configuration and working **Power factor correction** – Single phase active power factor converter – circuit schematic and control block diagram **Grounding and wiring**– reasons for grounding – wiring and grounding problems - solutions to these problems	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	Identify the sources and effects of power quality problems.	**K2**
CO2	Apply Fourier concepts for harmonic analysis.	**K3**
CO3	Explain the important aspects of power quality monitoring.	**K2**
CO4	Examine power quality mitigation techniques.	**K2**
CO5	Discuss power quality issues in grid connected renewable energy 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	2				2		1				2
CO2	3	3										2
CO3	3	3			3							2
CO4	3	3	2					1				2
CO5	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	Electrical Power System Quality	R. C. Dugan, M. F. Me Granaghen, H. W. Beaty	McGraw-Hill	2012
2	Power Quality	C. Sankaran	CRC Press	2002
3	Understanding Power Quality Problems	Math H. Bollen	Wiley-IEEE Press	1999
4	Power Quality problems and mitigation techniques	Bhim Singh, Ambrish Chandra and Kamal Al-Haddad	John Wiley and Sons Ltd	2015

SEMESTER S7

NONLINEAR CONTROL SYSTEMS

Course Code	**PEEET752**	**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 concept of nonlinear systems
2. To impart knowledge about different strategies adopted in the analysis of nonlinear systems
3. To familiarize with the design of different types of nonlinear controllers

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to nonlinear systems:** Basic characteristics of nonlinear systems. Examples. State-space representation of nonlinear systems. Classification of nonlinearities. Phase plane analysis: Concept of phase plane, singular points. Definition of stability – asymptotic stability, instability; Construction using isocline method. Classification of equilibrium points; Systems with multiple equilibria. Periodic orbits - limit cycles.	**10**
2	**Lyapunov Stability Theory:** Lyapunov's direct method - Definite functions - Stability theorems; - Variable gradient method – La-Salle theorems. Stability of linear systems - Lyapunov equation for time-invariant systems - Lyapunov's linearization (indirect) method - Region of attraction (concept only).	**7**
3	**Frequency domain Analysis of Feedback systems:** Describing function method: Analysis through harmonic linearization- Determination of describing function of nonlinearities. Application of describing function for stability analysis of autonomous system with	**10**

	single nonlinearity (relay, dead zone and saturation only). Feedback Stabilisation, Kalman-Yakubovitch-Popov lemma (Concept only); Stability Analysis of feedback systems, Circle Criterion.	
4	**Nonlinear Control Design:** Lie Derivatives and Lie Brackets; Feedback linearization, Input state linearization and input – output linearization of SISO systems. (3 hours) Design via linearization - regulation via integral control; gain scheduling, tracking. Concepts of other nonlinear controllers – sliding mode, backstepping.	**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	Analyse the qualitative behaviour of nonlinear systems about their equilibrium points.	**K3**
CO2	Analyse the stability of nonlinear systems.	**K3**
CO3	Analyse the behaviour of nonlinear systems using frequency domain analysis.	**K2**
CO4	Design feedback controller for nonlinear systems.	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3			3	2
CO2	3	3	2	2	2	3	3	3			3	2
CO3	3	2	1	2	1	3	3	3			3	2
CO4	3	3	2	2	2	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	Nonlinear Systems	Hassan K Khalil	Prentice - Hall International (UK)	2002
2	Applied Nonlinear Control	Jean-Jacques E. Slotine and Weiping Li	Prentice-Hall, NJ	1991

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Nonlinear Control Systems: An Introduction	Alberto Isidori	Springer-Verlag	1985
2	Nonlinear System Analysis, Stability and Control	M. Vidyasagar	Prentice-Hall, India	1991

SEMESTER S7

DEEP LEARNING

Course Code	PEEET753	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 understanding of probability theory, linear algebra and machine learning	Course Type	Theory

Course Objectives:

1. To introduce the building blocks used in deep learning like neural networks, deep neural networks, convolutional neural networks and recurrent neural networks
2. To learn and understand various learning and optimization techniques such as Gradient Descent, Adam
3. To solve a wide range of problems in Computer Vision and Natural Language Processing

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Neural Network:** Introduction to neural networks -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Activation functions - Sigmoid, Tanh, ReLU, Softmax, Risk minimization, Loss function, Training MLPs with Backpropagation, Practical issues in neural network training - The problem of Overfitting, Vanishing and Exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational challenges. Applications of neural networks	9
2	**Deep Learning:** Introduction to Deep Learning, Deep Feed Forward network, Training deep learning models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Batch, Mini-batch and Stochastic GD, AdaGrad, RMSProp, Adam	9
3	**Convolutional Neural Network (CNN):** Introduction to CNN - Convolution and Pooling, Convolution and Pooling as	9

	an infinitely strong prior, variants of convolution functions, Efficient convolution algorithms, Applications - Computer Vision	
4	**Recurrent Neural Network (RNN):** Introduction to RNN - Computational graphs, RNN design, Encoder-decoder sequence to sequence architectures, Deep RNNs, Modern RNN - LSTM and GRU, Applications - Natural Language Processing (NLP),	**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 the basic concepts of neural networks and its practical issues	**K2**
CO2	Outline the standard regularization and optimization techniques for deep neural network	**K2**
CO3	Implement the foundation layers of convolutional neural networks, pooling and convolution	**K2**
CO4	Implement sequence model using recurrent neural 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				2						3
CO2	3	3				2						3
CO3	3	3				2						3
CO4	3	3	3	2	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	Neural Networks and Deep Learning	Charu C. Aggarwal	Springer	2018
2	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms	Nikhil Buduma and Nicholas Locascio	O'Reilly Media	2017
3	Deep Learning	Ian Goodfellow, Yoshua Bengio,Aaron Courville	MIT Press	2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Neural Networks and Deep Learning	Michael Nielsen	http://neuralnetworksanddeeplearning.com/	2018
2	Neural Networks: A Classroom Approach	Satish Kumar	Tata McGraw-Hill Education	2014
3	Artificial Neural Networks	Yegnanarayana, B	PHI Learning Pvt. Ltd	2009

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/105/106105215/
2	https://archive.nptel.ac.in/courses/106/106/106106184/
3	https://archive.nptel.ac.in/courses/106106201/
4	https://archive.nptel.ac.in/courses/106106224/

SEMESTER S7

COMPUTER VISION

Course Code	**PEEET754**	**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**	PE - Theory

Course Objectives:

1. To develop the knowledge of various methods, algorithms and applications of Computer Vision.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of image processing techniques: Digital filters, linear filters-Homomorphic filtering, Point operators- Histogram, neighbourhood operators, thresholding Mathematical morphology, Binary shape analysis, Binary shape analysis, Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform ,connectedness, object labelling and counting, Boundary descriptors – Chain codes. Properties of Binary Regions, Geometric Features, Statistical Shape Properties	**9**
2	Feature Detection and Image Synthesis,Edge detection – edges, lines, active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts, energy- based methods- Cranny's Algorithm, Corner detection, Harris corner detection algorithm. Hough transform-Line and curve detection.	**9**
3	Shape from X - Shape from shading, Photometric stereo, Texture Occluding contour detection. Motion Analysis- Regularization theory,Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method. Structure from motion	**9**
4	Object recognition-Shape correspondence and shape matching PCA,SVM, LDA, Bayes rule andML methods. Eigen faces,Face detection, Face recognition, Application: Scene analysis Examples of real time applications: In-vehicle vision system.	**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 digital filtering operations for CV applications.	**K2**
CO2	Apply basic morphological and boundary operators for Computer vision applications	**K3**
CO3	Apply edge, corner detection algorithms to locate objects in an image.	**K3**
CO4	Apply optical flow algorithms to detect moving objects in a video.	**K3**
CO5	Analyse a given scene using appropriate computer vision algorithms to detect/recognize objects and to implement it in real time practical applications.	**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	2		2						2	3
CO2	3	3	2		2						2	3
CO3	3	3	3		2						2	3
CO4	3	3	3		2						2	3
CO5	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	Computer and Machine Vision -Theory Algorithm and Practicalities	E. R .Davies	Academic Press,	2012.
2	Computer Vision: Algorithms and Applications	Richard Szeliski	ISBN 978-1- 84882-935-0, Springer	2011
3	Computer Vision: A Modern Approach	David Forsyth and Jean Ponce	Pearson India	2002

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning,	Goodfellow, Bengio, and Courville,	MIT Press,.	2006
2	Mastering OpenCV with Practical Computer Vision Projects	Daniel Lelis Baggio, et al	Packt Publishing Limited,	2012
3	Computer Vision: Models, Learning, and Inference,	Simon J D Prince	Cambridge University Press	2012
4	Digital Image Processing and Computer Vision,	R. J. Schalkoff	John Wiley,	2004
5	Programming Computer Vision with Python: Tools and algorithms for analyzing images	Jan Erik Solem,	O'Reilly Media,	2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc19_cs58/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs93/preview
3	https://onlinecourses.nptel.ac.in/noc24_ee38/preview

SEMESTER S7

DESIGN OF SOLAR PV SYSTEMS

Course Code	**OEEET721**	**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**	OE -Theory

Course Objectives:

1. To introduce a solar PV system and its grid integration aspects.
2. To give insight to basic knowhow for the implementation of Solar PV system

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction** - Basic Concept of Energy -Source of Solar Energy -Formation of the Atmosphere - Solar Spectrum. Solar Constant -Air Mass -Solar Time-Sun–Earth Angles-Solar Radiation-Instruments to Measure Solar Radiation-Pyrheliometer –Pyranometer - Sunshine Recorder -Solar Radiation on a Horizontal Surface - Extra-terrestrial Region.- Terrestrial Region -Solar Radiation on an Inclined Surface -Conversion Factors -Total Solar Radiation on an Inclined/Tilted Surface -Monthly Average Daily Solar Radiation on Inclined Surfaces .	9
2	**Solar Thermal system**-Principle of Conversion of Solar Radiation into Heat, –Solar thermal collectors –General description and characteristics –Flat plate collectors –Heat transfer processes –Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – performance evaluation. Applications -Solar heating system, Air conditioning and Refrigeration system, Pumping system, solar cooker, Solar Furnace, Solar Greenhouse - Design of solar water heater	9
3	**Solar PV Systems**-Introduction -Fundamentals of Semiconductor and Solar Cells - Photovoltaic Effect -Solar Cell (Photovoltaic) Materials - Basic Parameters of the Solar Cell - Generation of Solar Cell (Photovoltaic) Materials-.Photovoltaic (PV) Module and PV Array - Single-Crystal Solar	9

	Cell Module, Thin-Film PV Modules, III–V Single Junction and Multifunction PV Modules-Emerging and New PV Systems -Packing Factor of the PV Module - Efficiency of the PV Module -Energy Balance Equations for PV Modules -Series and Parallel Combination of PV Modules.- Effect of shadowing-MPPT Techniques-P&O , incremental conductance method- Maximum Power Point Tracker (MPPT) using buck-boost converter.	
4	**Solar PV Systems** –stand-alone and grid connected -Design steps for a Stand-Alone system – Storage batteries and Ultra capacitors. Design PV powered DC fan and pump without battery-Design of Standalone System with Battery and AC or DC Load. Life cycle costing, Growth models, Annual payment and present worth factor, payback period, LCC with examples. Introduction to simulation software for solar PV system design	**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	Explain the basics of solar energy conversion systems.	**K1**
CO2	Design a standalone PV system.	**K3**
CO3	Demonstrate the operation of a grid interactive PV system.	**K2**
CO4	Utilize life cycle cost analysis in the planning of Solar PV System	**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
CO2	3	3	3									2
CO3	3	3	2									2
CO4	3	3	2	1	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	Solar Photovoltaics: Fundamentals, Technologies And Applications	Chetan Singh Solanki	PHI	3rd Edition
2	Solar Energy-Fundamentals, Design, Modelling and Applications	G.N. Tiwari:	Narosa Publishers	2002
3	Grid Integration of Solar Photovoltaic Systems,	D.P. Kothari, M Jamil.	CRC Press	2018
4	Solar Photovoltaics: Fundamentals, Technologies And Applications	Chetan Singh Solanki	PHI	3rd Edition

SEMESTER: S7

HYBRID AND ELECTRIC VEHICLES

Course Code	**OEEET722**	**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**	OE -Theory

Course Objectives:

1. Familiarise with the hybrid and electric vehicles and its drive train topologies
2. Discuss the propulsion unit for electric vehicles
3. Choose proper energy storage system for electric vehicles.
4. Selection of battery management strategy and study of various communication protocols for EV

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Hybrid and Electric Vehicles**: History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles. **Vehicle Dynamics & Load Forces :** mathematical models to describe vehicle performance, vehicle load forces (concept only): aerodynamic drag ,rolling resistance , grading resistance, vehicle acceleration, calculation of motor power from traction torque. **Hybrid Electric Drive-trains**: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies (Block diagram only), power flow control in various hybrid drive-train topologies (Block diagram only). **Electric Drive-trains**: Basic concept of electric traction, introduction to various electric drive-train topologies (Block diagram only), power flow control in electric drive-train topologies (Block diagram only).	**10**
2	**Electric Drives:** Block diagram, Introduction to electric motors used in hybrid and electric vehicles.	**8**

	DC Motor Drives: Introduction, Configuration and control of separately excited DC motors Motoring using a PM DC Machine - DC motor drive using DC-DC converter - Generating/Braking using a PM DC Machine (concept only) **Induction Motor Drives**: Introduction, Speed control of induction motor, V/f control of induction motor (block diagram only)	
3	**Battery based energy storage systems**: Types of battery-battery parameters-units of battery energy storage - capacity rate, - cell voltage - specific energy - cycle life - self-discharge- static battery equivalent circuit model - series-parallel battery pack equivalent circuits **Other storage topologies (Basics only)**: Fuel Cell based energy storage systems- Supercapacitors- flywheel- Hybridization of different energy storage devices **Types of charging stations** (Basics only)- AC Level 1 & 2, DC - Level 3 (block diagram only) -Types of Connectors - CHAdeMO, CCS Type1 and 2, GB/T - PIN diagrams and differences	**10**
4	**Battery management system**: Introduction to energy management strategies, Classification of Battery management system (concept only) **Vehicle Communication protocols**: Need & requirements - Functions of Control Pilot (CP) and Proximity Pilot (PP) pins, Communication Protocols - CAN, LIN, FLEXRAY (Basics only)- Power line communication (PLC) in EV **Autonomous Vehicles**: Levels of automation, significance & effects of automation in vehicles	**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 =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	Familiarise with the hybrid and electric vehicles and its drive train topologies	**K2**
CO2	Discuss the propulsion unit for electric vehicles	**K3**
CO3	Choose proper energy storage system for electric vehicles	**K3**
CO4	Selection of battery management strategy and study of various communication protocols for EV	**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
CO2	3											3
CO3	3											3
CO4	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	Electric and Hybrid Vehicles: Design Fundamentals, 2003	Iqbal Hussein	CRC Press,	2003
2	Elementary Concepts of Power Electronic Drives:	K Sundareswaran,	CRC Press, Taylor & Francis Group	
3	Electric Drives	Krishnan	PHA	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electrical Engineering – Introduction to Hybrid and Electric Vehicles	NPTEL (notes)		

SEMESTER S7

INTRODUCTION TO ENERGY STORAGE SYSTEMS

Course Code	OEEET723	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	OE - Theory

Course Objectives:

1. To introduce the importance and application of energy storage systems.
2. To familiarize with different energy storage technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Need and role of energy storage systems in power system, General considerations, Energy and power balance in a storage unit, Mathematical model of storage system: modelling of power transformation system (PTS)-Central store (CS) and charge–discharge control system (CDCS), Econometric model of storage system. Thermal energy: General considerations -Storage media- Containment-Thermal energy storage in a power plant, Potential energy: Pumped hydro-Compressed Air.	9
2	Kinetic energy: Mechanical- Flywheel, Power to Gas: Hydrogen- Synthetic methane. Electro chemical energy: Batteries-Battery parameters: C-rating–SoC – DoD -Specific Energy- Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Superconducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.	9
3	Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated power systems with renewable powersources, Storage role in an integrated power system with grid-connected renewablepowersources.	9

4	Smart grid, Smart micro grid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Management and control hierarchy of storage systems. Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Battery SCADA, Hybrid energy storage systems: configurations and 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 =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	Identify the role of energy storage in power systems.	**K3**
CO2	Classify thermal, kinetic and potential energy storage systems and their applications.	**K3**
CO3	Compare electrochemical, electrostatic and electromagnetic storage technologies.	**K3**
CO4	Illustrate energy storage technology in renewable energy integration.	**K2**
CO5	Summarise energy storage technology applications for smart grids.	**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)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1					1					
CO2	3	1					1					
CO3	3	1					1					
CO4	3	1					1					
CO5	3	1					1					

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	Energy Storage for Power Systems	A.G.Ter- Gazarian	TheInstitution of Engineering and Technology (IET) Publication, UK,	Second Edition, 2011
2	Energy Storagein Power Systems	Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt	Wiley Publication	2016.
1	Energy Storage for Power Systems	A.G.Ter- Gazarian	TheInstitution of Engineering and Technology (IET) Publication, UK,	Second Edition, 2011
2	Energy Storagein Power Systems	Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt	Wiley Publication	2016.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits	D. Rastler	Electric Power Research Institute (USA)	Technical Update, December 2010
2	The Role of Energy Storage with Renewable Electricity Generation	Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan	National Renewable Energy Laboratory (NREL)	January 2010
3	Electrical energy management of virtual power plants in distribution networks with renewable energy resources and energy storage systems	P. Nezamabadi and G. B. Gharehpetian	IEEE Power Distribution Conferenc	2011

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=o6Afp-MI_tQ&list=PLLy_2iUCG87AjWoOk0A3y4hpGQVTdtl6G&index=12 (NPTEL lecture IIT Roorkee)
2	https://www.youtube.com/watch?v=yar51GJVqgg (NPTEL lecture IIT Guwahati)
3	https://www.youtube.com/watch?v=frWxC5KL8kE (NPTEL lecture IIT Guwahati)
4	https://www.youtube.com/watch?v=AZIS_MCw8Qc (NPTEL lecture IIT Kanpur)

SEMESTER 8

ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER S8

SMART GRID TECHNOLOGIES

Course Code	PEEET861	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	PE - Theory

Course Objectives:

1. To introduce various advancements in the area of smart grid.
2. To introduce distributed energy resources and micro-grid.
3. To introduce cloud computing, cyber security and power quality issues in smart grids.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Smart Grid:** Evolution of electric grid, Definitions, Need for smart grid, Smart grid drivers, Functions of smart grid, Opportunities and barriers of smart grid, Difference between conventional grid and smart grid, Concept of resilient and self- healing grid. Components and architecture, Inter-operability, Impacts of smart grid on system reliability, Present development and international policies in smart grid, Smart grid standards. **Information and Communication Technology in Smart Grid:** Wired and wireless communication -radio mesh, ZIGBEE, 3G, 4G and 5G. Digital PLC, DSL, Wi-Max, LAN, NAN, HAN, Wi-Fi, Bluetooth, Bluetooth Low Energy (BLE), Li-Fi. Communication Protocols in Smart grid, Introduction to IEC 61850 standard and benefits, IEC Generic Object-Oriented Substation Event - GOOSE, Substation model.	9
2	**Smart grid Technologies Part I:** Introduction to smart meters, Electricity tariff, Real Time Pricing- Automatic Meter Reading (AMR) - System, Services and Functions, Components of AMR Systems, Advanced Metering Infrastructure (AMI). Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid (V2G), Grid to Vehicle (G2V), Smart Sensors, Smart energy efficient end use devices, Home & Building Automation. Intelligent Electronic	9

	Devices (IED) and their application for monitoring & protection: Digital Fault Recorder (DFR), Digital Protective Relay (DPR), Circuit Breaker Monitor (CBM), Phasor Measurement Unit (PMU), Standards for PMU. Time synchronization techniques, Wide Area Monitoring System (WAMS), control and protection systems (Architecture, components of WAMS, and applications: Voltage stability assessment, frequency stability assessment, power oscillation assessment, communication needs of WAMS, remedial action scheme).	
3	**Smart grid Technologies Part II:** Smart substations, Substation automation, Feeder automation, Fault detection, Isolation, and Service Restoration (FDISR), Geographic Information System (GIS), Outage Management System (OMS). Introduction to Smart distributed energy resources and their grid integration, Smart inverters, Concepts of microgrid, Need and application of microgrid – Energy Management- Role of technology in demand response- Demand side management, Demand side Ancillary Services, Dynamic line rating.	**9**
4	**Cloud computing in smart grid:** Private, Public and hybrid cloud. Types of cloud computing services- Software as a Service (SaaS), Platform as a service (PaaS), Infrastructure as a service (IaaS), Data as a service (DaaS), Cloud architecture for smart grid. **Cyber Security** - Cyber security challenges and solutions in smart grid, Cyber security risk assessment, Security index computation. **Power Quality Management in Smart Grid**- Fundamentals, Power Quality (PQ) & Electromagnetic Compatibility (EMC) in smart grid, Power quality conditioners for smart grid. Case study of smart grid.	**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	Explain the basic concept of distributed energy resources, micro-grid and smart grid	**K2**
CO2	Choose appropriate Information and Communication Technology (ICT) in smart grid	**K2**
CO3	Select infrastructure and technologies for consumer domain of smart grid	**K2**
CO4	Select infrastructure and technologies for smart substation and distribution automation	**K2**
CO5	Formulate cloud computing infrastructure for smart grid considering cyber security	**K3**
CO6	Categorize power quality issues and appraise it in smart grid context	**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	2										
CO2	3	3	3	3	2							
CO3	3	3	3	3	2							
CO4	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	Smart Grid Infrastructure Technology and Solutions	Stuart Borlase	CRC Press	2nd edition
2	Smart Grid: Fundamentals of Design and Analysis	James Momoh	Wiley	2012
3	Microgrids and Active Distribution Networks	S. Chowdhury	Institution of Engineering and Technology	2009
4	Smart Grids Technology and Applications	Janaka Ekanayake, Kythira Liyanage, Jianzhong Wu, Akihiko Yokohama, Nick Jenkins-	Wiley	2012
5	Smart Grids Technology and Applications	Janaka Ekanayake, Kythira Liyanage, Jianzhong Wu, Akihiko Yokohama, Nick Jenkins	Wiley	2012
6	Cybersecurity for the Electric Smart Grid: Elements and Considerations	Barker, Preston, Price, Rudy F	Nova Science Publishers Inc	2012

SEMESTER S8

HVDC AND FACTS

Course Code	**PEEET862**	**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)	PCEET403	**Course Type**	PE - Theory

Course Objectives:

1. To introduce HVDC concepts and analysis of HVDC systems.
2. To provide a detailed study of FACTS devices.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to HVDC System:** Comparison of AC and DC Transmission - Types of HVDC system - Current Source Converters - Analysis without and with overlap period. Voltage Source Converters (VSC) - VSC with AC current control and VSC with AC voltage control **HVDC Controls** - Functions of HVDC Controls - Equivalent circuit for a two terminal DC Link - Control Basics for a two terminal DC Link - Current Margin Control Method - Current Control at the Rectifier - Inverter Extinction Angle Control - Hierarchy of Controls	**9**
2	**Introduction to FACTS:** Power flow in Power Systems – Voltage regulation and reactive power flow control in Power Systems - Power flow control -Constraints of maximum transmission line loading - Needs and emergence of FACTS - Types of FACTS controllers-Advantages and disadvantages Transmission line compensation- Uncompensated line -shunt compensation - Series compensation -Phase angle control.	**9**
3	**Shunt and Series Facts Devices:** Static shunt Compensator - Objectives of shunt compensations - Variable impedance type VAR Generators -TCR, TSR, TSC, FC-TCR (Principle of operation and schematic) and - STATCOM (Principle of operation and schematic). Static Series compensator - Objectives of series compensations-Variable impedance type series compen-	**9**

	sators - GCSC. TCSC, TSSC (Principle of operation and schematic) Switching converter type Series Compensators-(SSSC) (Principle of operation and schematic)	
4	**UPFC AND IPFC:** Unified Power Flow Controller: Circuit Arrangement, Operation of UPFC- Basic principle of P and Q control- independent real and reactive power flow control- Applications Introduction to interline power flow controller (IPFC) (Principle of operation and schematic) Thyristor controlled Voltage and Phase angle Regulators (Principle of operation and schematic)	**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	Analyse current source and voltage source converters for HVDC systems	**K4**
CO2	Describe the control schemes for HVDC systems	**K2**
CO3	Explain the need for FACTS devices	**K2**
CO4	Classify reactive power compensators in power system	**K2**
CO5	Interpret series and shunt connected FACTS devices for power system applications	**K2**
CO6	Explain the dynamic interconnection mechanisms of FACTS devices	**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			2							
CO2	3	3			2							
CO3	3	3			2							
CO4	3	3			2							
CO5	3	3			2							
CO6	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	HVDC and FACTS Controllers	Vijay K Sood	Springer	2004
2	Understanding FACTS	N.G. Hingorani and L.Gyugyi	IEEE Press	2000
3	High Voltage DC Transmission	K.R.Padiyar	Wiley	1993
4	FACTS Controllers in Power Transmission and distribution	K.R.Padiyar	New age international Publishers	2007
5	Flexible AC Transmission systems (FACTS)	Y.H. Song and A.T.Jones	IEEE Press	1999
6	Reactive Power control in Power systems	T.J.E. Miller	John Wiley	1982

SEMESTER S8

MECHATRONIC SYSTEMS

Course Code	PEEET863	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 code)	Course Type	PE - Theory

Course Objectives:

1. To familiarise mechatronic systems with fundamental knowledge in sensors and actuators achieve conceptual understanding of mechatronic systems
2. To enhance the fundamental knowledge in microprocessors and microcontrollers
3. To learn the fundamentals of system models and controllers
4. To understand control actions such as Proportional, derivative and integral and study its significance in industrial applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Mechatronics: Introduction, Examples of Mechatronic systems, Electric circuits and components, Semiconductor Electronics, Transistor Applications Sensors and transducers: Performance terminology of sensors, Displacement, Position & Proximity Sensors-I, Displacement, Position & Proximity Sensors-II, Force, Fluid pressure, Liquid flow sensors, temperature, light sensor, Acceleration and Vibration measurement, Semiconductor sensor and MEMS, SAW	3 3 3
2	Actuators and mechanisms: Mechanical Actuation System, Hydraulic & Pneumatic Actuation System, Electrical Actuation System-I, Electrical Actuation System-II, Data Presentation system Signal conditioning: Introduction to signal processing & Op-Amp, Op-Amp as signal conditioner, Analogue to Digital Converter, Digital to Analogue Converter, Artificial intelligence	5 5
3	Microprocessors and microcontrollers: Digital circuits-I, Digital circuits-II,	5

	Microprocessor Micro Controller, Programming of Microcontrollers Modeling and system response: Mechanical system model, Electrical system model, Fluid system model, Dynamic response of systems, Transfer function and frequency response.	**5**
4	Closed loop controllers: P, I, PID Controllers, Digital Controllers, Program Logic Controllers, Input/output & Communication systems, Fault findings Mechatronics designs, examples and case studies	**5** **2**

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	Comprehend the importance of sensors and actuators with application to mechatronic systems	**K2**
CO2	Identify actuator mechanisms and signal conditioning processes	**K2**
CO3	Select microprocessors and microcontrollers for the implementation in mechatronic system	**K2**
CO4	Analyse the models and responses of different systems	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					1						1
CO2	3					1						1
CO3	3					1						1
CO4	3	3	3	2	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	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	W. Bolton	Pearson Education	4th Edition 2010
2	Introduction to Mechatronics and Measurement Systems	Michael B. Histand, David G. Alciatore	McGraw-Hill Series in Mechanical Engineering	2003
3	Mechatronics system design. CL-Engineering	Shetty, Devdas, and Richard A. Kolk.		2010.
4	Mechatronics: an introduction.,	Bishop, Robert H.	CRC Press	2017.
5	Intelligent Mechatronic Systems: Modeling, Control and Diagnosis	R. Merzouki, A. K. Samantaray, P. M. Pathak, B. Ould Bouamama	Springer, London	2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/112/107/112107298/
2	https://archive.nptel.ac.in/courses/112/107/112107298/
3	https://archive.nptel.ac.in/courses/112/107/112107298/
4	https://archive.nptel.ac.in/courses/112/107/112107298/

SEMESTER S8

ELECTRONIC COMMUNICATION

Course Code	PEEET864	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:3:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GYEST104, PBEET304	Course Type	PE - Theory

Course Objectives:

1. To acquire knowledge about analog and digital communication systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Analog Communication:** Introduction to communication systems, Classification of channels, Need for modulation. Amplitude modulation: Equation and frequency spectrum of AM signal, Double-side band suppressed carrier (DSB-SC) modulation, Single sideband modulation (SSB), comparison of spectrum, power and efficiency of all the three variants, Amplitude modulator circuits -balanced modulator, AM demodulators – Envelope detector.	9
2	**Angle Modulation:** Frequency and phase modulation, Narrow and wide band FM and their spectra, Modulation and demodulation techniques for FM, pre-emphasis and de-emphasis, FM transmitter and receiver, Noise in receivers, Noise figures, Performance of analog modulation schemes in AWGN: SNR and figure of merit for different schemes.	9
3	**Digital baseband communication:** Elements of digital communication system. Sources, channels and receivers, Sampling and Reconstruction of Analog Signals: Nyquist Sampling Theorem, Ideal Reconstruction Filter, Pulse Amplitude Modulation (PAM), Time division multiplexing with PAM, Pulse Code Modulation (PCM), A-law and mu-law quantization.	9
4	**Digital bandpass communication**: Digital bandpass communication system, Bandpass modulation techniques:	9

	Amplitude shift keying, Phase shift keying, Frequency shift keying, Methods of generation and detection, Signal constellations, M-ary digital modulation schemes, Quadrature phase shift keying, Minimum shift keying, Quadrature amplitude modulation.	

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	Explain the working of Amplitude modulator and demodulator circuits using mathematical relations.	**K2**
CO2	Explain the characteristics of various analog modulation schemes in terms of spectra, power and efficiency.	**K3**
CO3	Understand the various processing blocks of a digital communication system.	**K2**
CO4	Apply the knowledge of digital modulation in digital transmission.	**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											
CO2	3	2										
CO3	3											1
CO4	3	2										1

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	Kennedy's Electronic Communication Systems	Kennedy, Davis and Prasanna	Tata McGraw Hill	6th Edition, 2018
2	Electronic Communication Systems – Fundamentals through Advanced	Wayne Tomasi	Pearson	5th edition, 2008
3	Communication Systems	Simon Haykin and Michael Mohre	Wiley	5th Edition,2021
4	Principles of Communication Systems	Taub& Schilling	McGraw-Hill	4th edition, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of Communications	Rodger E. Ziemer& William H. Tranter	Wiley	7the edition, 2014
2	Communication System Engineering	J. G. Proakis and M. Salehi	Pearson Education	2nd Edition, 2018.
3	Digital and Analog Communication Systems	Leon W. Couch	Prentice Hall	8th edition, 2012
4	Modern Digital and Analog Communication Systems	B. P. Lathi, Zhi Ding	Oxford University Press	4th edition, 2011

SEMESTER S8

INTRODUCTION TO ROBOTICS

Course Code	**OEEET831**	**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**	OE - Theory

Course Objectives:

1. To familiarise mechatronic systems with fundamental knowledge in sensors and actuators achieve conceptual understanding of mechatronic systems
2. To enhance the fundamental knowledge in microprocessors and microcontrollers
3. To learn the fundamentals of system models and controllers
4. To understand control actions such as Proportional, derivative and integral and study its significance in industrial applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Definitions-** Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom; Robot considerations for an application- number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, Operating environment, point to point control or continuous path control	7
2	**Sensors and Actuators** Sensor classification- touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, noncontact type Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, Linear actuators, selection of motors **Robotic configurations and end effectors** Robot configurations-PPP, RPP,	10

	RRP, RRR; features of SCARA, PUMA Robots; Classification of robots based on motion control methods and drive technologies; 3R concurrent wrist; Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot.	
3	**Kinematics and Motion Planning** Robot Coordinate Systems- Fundamental and composite rotations, homogeneous co-ordinates and transformations, Kinematic parameters, D-H representation, Direct Kinematics. The Arm equation- forward Kinematic analysis of a typical robots upto 3 DOF. Motion Planning- joint space trajectory planning-cubic polynomial, linear trajectory with parabolic blends; Cartesian space planning, Point to point vs continuous path planning.	**9**
4	**Dynamics and Control of Robots** Building of a servo controlled robot – 1R two link chain, construction of link and joint and mounting of encoder, actuator, etc. Dynamics- Dynamic model of a robot using Lagrange's equation, dynamic modelling of 1DOF robot, including motor and gearbox, 2R planar manipulator. Control Techniques- Transfer function and state space representation, Performance and stability of feedback control, PID control of a single link manipulator, selection of PID controller gains; nonlinear nature of manipulators, and need for nonlinear control techniques.	**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	Familiarise with anatomy, specifications and applications of Robots	**K2**
CO2	Choose the appropriate sensors and actuators for robots	**K2**
CO3	Choose appropriate Robotic configuration and gripper for a particular application	**K2**
CO4	Obtain kinematic model of robotic manipulators	**K3**
CO5	Plan trajectories in joint space and Cartesian space	**K3**
CO6	Develop dynamic model and design the controller for robotic manipulators	**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	1										3
CO2	2	1										3
CO3	2	1										3
CO4	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	Introduction to Robotics	S K Saha	McGraw Hill Education (India) Private Limited	2014
2	Fundamentals of robotics – Analysis and control	Robert. J. Schilling	Prentice Hall of India	1996.
3	Robotics and Control	R K Mittal and I J Nagrath	Tata McGraw Hill, New Delhi	2003
4	Introduction to Robotics: Mechanics and control	John. J. Craig	Pearson Education Asia	4^{th} Edition, 2018
5	Robotics-Fundamental concepts and analysis	Ashitava Ghosal	Oxford University press.	2006
6	Robotics Technology and Flexible Automation	S. R. Deb	McGraw-Hill Education LLC	Second Edition,

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/107/106/107106090/
2	https://archive.nptel.ac.in/courses/107/106/107106090/
3	https://archive.nptel.ac.in/courses/107/106/107106090/
4	https://archive.nptel.ac.in/courses/107/106/107106090/

SEMESTER S8

PLC AND AUTOMATION

Course Code	OEEET832	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:1:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Learn the roles, architectures, and interfacing techniques of computer-based measurement and control systems, including HMI and hardware integration.
2. Gain hands-on experience with PLC programming and simulation, and understand the functionalities and interfacing of Distributed Control Systems for process control.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to computer based control system** -Role of computers in measurement and (process) control Basic components of computer based measurement and control systems Architecture – computer based process control system –Centralised, Distributed and Hierarchical. Human Machine Interface (HMI) Hardware for computer based process control system, Interfacing computer system with process. Architecture of DDC, SCADA and DCS. **Programmable logic Controller (PLC)**: Introduction, Evolution, Relay VS PLC VS Computer	9
2	PLC- Hardware and Internal Architecture-Input –output devices .Basics of Ladder Programming, on/off instructions, internal relay, jump instructions, data handling instruction, data manipulation instructions, Arithmetic and Comparison ,PID and other important instructions	9
3	Timers and Counters in PLC. Problems. Design Development and Simulation of PLC Programme Program on Temperature control Valve sequencing, Conveyor belt control and Control of a process.	9

	PLC Installation, trouble shooting and maintenance, Design of Alarms and Interlocks, Networks of PLC Distributed Control System- DCS - Evolution– Various Architectures – Comparison – Local control unit	
4	DCS -LCU Languages-Process interfacing issues-communication facilities-Operator interface-Low level and High level Operator interface- Displays - Engineering interfaces – Low level and high level engineering interfaces – Factors to be considered in selecting DCS – Other key issues in DCS – Packaging and Power system issues.	**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

Micro projects on automation using PLC and DCS for student group comprising of 3 students.
Report – 5 marks
Working Model – 15 Marks

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	Understand the basic architecture and components of computer-based measurement and control systems.	**K2**
CO2	Understand the human-machine interfaces (HMI) and learn the hardware and interfacing techniques needed to integrate computer systems with process controls.	**K2**
CO3	Create and troubleshoot PLC programs using ladder logic for various applications.	**K5**
CO4	Understand and apply the architecture and interfaces of Distributed Control Systems in various process control settings.	**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											
CO2	3											
CO3	3				2							
CO4	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	Instrument Engineer's Handbook – Process Control,	B G Liptak	CRC Press	4th edtion
2	Understanding Distributed Processor Systems for Control,	Samel M. Herb	ISA Publication	1st edition 1999
3	Programmable Logic Controllers – Principles and Applications.	John W.Webb & Ronald A. Reiss,	PHI	5th edition
4	Computer Control of Processes,	M. Chidambaram	Alpha Science International Ltd	1st edition 2002

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Process Software and Digital Networks, CRC Press.	B G Liptak	CRC	3rd edition
2	Programmable Logic Controllers – Programming Methods and Applications, Pearson Education.	John R. Hackworth & Frederick D. Hackworth Jr	Pearson	1st edition 2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc21_me67/preview
2	https://onlinecourses.nptel.ac.in/noc21_me67/preview
3	https://onlinecourses.nptel.ac.in/noc21_me67/preview
4	https://onlinecourses.nptel.ac.in/noc21_me67/preview

SEMESTER S8

MECHATRONIC SYSTEMS AND CONTROL

Course Code	**OEEET833**	**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 code)	**Course Type**	OE - Theory

Course Objectives:

1. To familiarise mechatronic systems with fundamental knowledge in sensors and actuators achieve conceptual understanding of mechatronic systems
2. To enhance the fundamental knowledge in microprocessors and microcontrollers
3. To learn the fundamentals of system models and controllers
4. To understand control actions such as Proportional, derivative and integral and study its significance in industrial applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Mechatronics: Introduction, Examples of Mechatronic systems, Electric circuits and components, Semiconductor Electronics, Transistor Applications Sensors and transducers: Performance terminology of sensors, Displacement, Position & Proximity Sensors-I, Displacement, Position & Proximity Sensors-II, Force, Fluid pressure, Liquid flow sensors, temperature, light sensor, Acceleration and Vibration measurement, Semiconductor sensor and MEMS, SAW	3 3 3
2	Actuators and mechanisms: Mechanical Actuation System, Hydraulic & Pneumatic Actuation System, Electrical Actuation System-I, Electrical Actuation System-II, Data Presentation system Signal conditioning: Introduction to signal processing & Op-Amp, Op-Amp as signal conditioner, Analogue to Digital Converter, Digital to Analogue Converter, Artificial intelligence	5 5

3	Microprocessors and microcontrollers: Digital circuits-I, Digital circuits-II, Microprocessor Micro Controller, Programming of Microcontrollers Modeling and system response: Mechanical system model, Electrical system model, Fluid system model, Dynamic response of systems, Transfer function and frequency response.	5 5
4	Closed loop controllers: P, I, PID Controllers, Digital Controllers, Program Logic Controllers, Input/output & Communication systems, Fault findings Mechatronics designs and case studies	5 2

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	Comprehend the importance of sensors and actuators with application to mechatronic systems	**K2**
CO2	Identify actuator mechanisms and signal conditioning processes	**K2**
CO3	Select microprocessors and microcontrollers for the implementation in mechatronic system	**K2**
CO4	Analyse the models and responses of different systems	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					1						1
CO2	3					1						1
CO3	3					1						1
CO4	3	3	3	2	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	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	W. Bolton	Pearson Education	4th Edition 2010
2	Introduction to Mechatronics and Measurement Systems	Michael B. Histand, David G. Alciatore	McGraw-Hill Series in Mechanical Engineering	2003
3	Mechatronics system design. CL-Engineering,	Shetty, Devdas, and Richard A. Kolk.		2010
4	Mechatronics: an introduction.,	Bishop, Robert H.	CRC Press	2017
5	Intelligent Mechatronic Systems: Modeling, Control and Diagnosis	R. Merzouki, A. K. Samantaray, P. M. Pathak, B. Ould Bouamama	Springer, London	2003

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/112/107/112107298/
2	https://archive.nptel.ac.in/courses/112/107/112107298/
3	https://archive.nptel.ac.in/courses/112/107/112107298/
4	https://archive.nptel.ac.in/courses/112/107/112107298/

SEMESTER S4

COURSE NAME: 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	2Hr. 30 Min
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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.]**	9hrs
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.]**	9hrs
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. **[Text 1: Relevant topics from sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6,**	9hrs

	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.]**	**9hrs**

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 fundamental concepts of graph theory such as types of graphs, degree of a vertex, graph isomorphism, connectedness.	K2 K2
CO2	Understand the concepts of Euler graphs, Hamiltonian graphs and connectivity.	K2 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 K3
CO4	Illustrate various representations of graphs using matrices and and apply vertex coloring in real life problems.	K3 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	Narsingh Deo	Prentice Hall India Learning Private Limited;	1st, 1979

	Computer Science			

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, 2015
2	Introduction to Graph Theory	Robin J. Wilson	Longman Group Ltd.	2010
3	Graph Theory with Applications	J.A. Bondy and U.S.R. Murty	Elsevier Science Publishing Co., Inc	1976

Video Links (NPTEL, SWAYAM…)		
Sl. No	**Module No.**	**Link ID**
1	Module - I	https://onlinecourses.nptel.ac.in/noc22_ma10/preview
2	Module - II	https://onlinecourses.nptel.ac.in/noc22_ma10/preview
3	Module - III	https://onlinecourses.nptel.ac.in/noc21_cs48/preview
4	Module - IV	https://onlinecourses.nptel.ac.in/noc21_cs48/preview

SEMESTER S4

COURSE NAME: Mathematics for Electrical Science - 4

(Group B)

Course Code	GBMAT401	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2Hr. 30 Min.
Prerequisites (if any)	Basic calculus	Course Type	Theory

Course Objectives:

1. To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To familiarize students with the basics of random processes essential for their subsequent study of analog and digital communication.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson 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]**	9hrs
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.	9hrs

	[Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]	
3	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and t-distribution), Hypotheses and Test Procedures, Type I and Type II error, z Tests for Hypotheses about a Population Mean (for large sample), t Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. **[Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]**	**9hrs**
4	Random process concept, classification of process, Methods of Description of Random process, Special classes, Average Values of Random Process, Stationarity- SSS, WSS, Autocorrelation functions and its properties, Ergodicity, Mean-Ergodic Process, Mean-Ergodic Theorem, Correlation Ergodic Process, Distribution Ergodic Process. **[Text 2: Relevant topics from Chapter 6]**	**9hrs**

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	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using z-tests and the one-sample t-test.	**K3**
CO4	Analyze random processes by classifying them, describing their properties , utilizing autocorrelation functions, and understanding their applications in areas like signal processing and communication systems..	**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	9th edition, 2016
2	Probability, Statistics and Random Processes	T Veerarajan	The McGraw-Hill	3rd edition,2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. & Pillai, S.U.,	McGraw Hill.	4th edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Elsevier	4th edition, 2004
3	Probability and Random Processes	Palaniammal, S.	PHI Learning Private Limited	3rd edition, 2015
4	Introduction to Probability	David F. Anderson, Timo, Benedek	Cambridge	2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
Module I	https://archive.nptel.ac.in/courses/117/105/117105085/
Module II	https://archive.nptel.ac.in/courses/117/105/117105085/
Module III	
Module IV	https://archive.nptel.ac.in/courses/117/105/117105085/

Mathematics for Physical Science - 4 (C Group)			
Course Code	**GCMAT401**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2Hr. 30 Mns.
Prerequisites (if any)	**NIL**	**Course Type**	Theory

Course objectives:

- To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
- To provide the students with the basics of various numerical methods to develop problem solving skills used in various engineering disciplines.

	Syllabus	**Contact Hours**
Module-I	Concept of Random variables- Types of random variables, Discrete random variables - probability mass function, Cumulative distribution function, Expected values, Variance. Continuous random variable - probability density functions, Cumulative distribution function, Expected values, Variance. Jointly distributed random variables - Joint probability mass function, marginal probability mass function, Joint probability density function, marginal probability density function, independent random variables, conditional distributions. **(Text 1: Relevant topics from 3.1, 3.2, 3.3, 4.1, 4.2, 5.1)**	**9hrs**
Module-II	The Binomial probability distribution, the Poisson probability distribution, the Uniform distribution, the Normal distribution, Standard Normal Distribution, Mean and Variance, the Exponential and Gamma distributions. **(Text 1: Relevant topics from sections 3.4, 3.6, 4.1, 4.3, 4.4)**	**9hrs**
Module- III	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and t-distribution), Hypotheses and Test Procedures, Type I and Type II error, z Tests for Hypotheses about a Population Mean (for large sample), t Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. **[Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]**	**9hrs**
Module- IV	Newton-Raphson Method, Gauss Elimination Method ,Gauss - Jordan Method, Numerical solution of ordinary differential equations-Euler's method, Modified Euler's method, Runge - Kutta method of 2nd Order, Numerical solution of Laplace equation –Jacobi's Method, Curve Fitting by Method of Least Squares - Straight lines, Parabola. **(Text 2: Relevant topics from sections 2.5,4.2,7.5,8.4,8.5,9.4**	**9hrs**

Course Assessment Method (CIE: -40 Marks, ESE: 60 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	*Assignment/ Micro project*	*Internal Ex-1*	*Internal Ex-2*	*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)**	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 the student will 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	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using z-tests and the one-sample t-test.	**K3**
CO4	Apply numerical methods to find solutions of linear system of equations, ordinary differential equations and Laplace equations.	**K3**

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

Course Articulation Matrix (Mapping of course outcomes with program outcomes)**:**

	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

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	Probability and Statistics for Engineering and the Sciences	Jay L. Devore	Cengage	8th edition, 2012

2	Introductory Methods of Numerical Analysis	S S Sastry	PHI Learning Pvt Limited	5th edition,2012

Reference Books				
SL No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. & Pillai, S.U.,	McGraw Hill	4^{th} edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6^{th} edition, 2020
3	Introductory methods of Numerical analysis	S.S. Sastry	PHI Learning Pvt. Ltd.	5^{th} edition, 2012
4	Numerical methods for Engineers	Steven C. Chapra, Raymond P. Canale	McGraw Hill Education	8^{th} edition, 2021

Video Links (NPTEL, SWAYAM etc):	
Module I	https://archive.nptel.ac.in/courses/117/105/117105085/
Module II	https://archive.nptel.ac.in/courses/117/105/117105085/
Module III	https://archive.nptel.ac.in/courses/117/105/117105085/
Module IV	https://archive.nptel.ac.in/courses/111/107/111107105/

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SEMESTER S3/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 - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	6
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	6

Course Assessment Method

(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks **(6x3 =18 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 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

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B. TECH DEGREE EXAMINATION, ...

Course Code: UCHUT346

Course Name: Engineering Economics

Max. Marks: 50		Duration: 2 hours 30 minutes

		PART A		
		Answer all questions. Each question carries 3 marks	CO	Marks
1		What are the central problems of an economy?	CO1	(3)
2		Point out any three applications of price elasticity of demand.	CO1	(3)
3		What is the social cost of production?	CO2	(3)
4		Distinguish between direct and indirect tax?	CO3	(3)
5		What is esteem value?	CO4	(3)
6		Write a short note on process planning.	CO4	(3)
		PART B		
		Answer any one full question from each module. Each question carries 8 marks		
		Module 1		
9	a)	Suppose a country is producing at a point inside the production possibility curve. Draw a PPC and examine this situation.		(5)
	b)	State the law of demand. Point out its any two exceptions of this law.		(3)
10	a)	A consumer purchased 10 units of a commodity when his income was Rs.50000. Later when his income increased to Rs.60000, he purchased 8 units only. Estimate income elasticity. What type of a commodity is this?		(5)
	b)	Why the Cobb-Douglas production function is linearly homogenous?		(3)
		Module 2		
11	a)	What is oligopoly? Why price is rigid under oligopoly?		(4)
	b)	The cost function of a firm is given as $TC=1000+10Q-6Q^2+Q^3$.. Estimate fixed cost, variable cost and marginal cost when output is 10 units.		(4)
12	a)	Suppose a firm is earning super normal profit under monopolistic market condition. Explain this situation by drawing a diagram.		(5)
	b)	Distinguish between fixed cost and variable cost.		(3)
		Module 3		
13	a)	What is inflation? How does inflation affect fixed income group in the society.		(4)

	b)	What should be the public revenue policy of the government when there is inflation?		(2)
	c)	Distinguish between final goods and intermediate goods.		(2)
14	a)	From the data given below (In Rs. Crores) estimate GDPmp and national income. Private final consumption expenditure = 1000, Government expenditure = 500, Invest expenditure = 700, Net exports = 300, Depreciation = 200, NFIA=(-200) and Net indirect tax = 100		(5)
	b)	What are the monetary policy measures to control inflation?		(3)
Module 4				
15	a)	Examine the procedures of value engineering.		(5)
	b)	Suppose a firm sells its product at a price of Rs.10 per unit and its average variable cost is Rs.6. If the firm spend Ra.10000 as rent every month, estimate its break-even level of output.		(3)
16	a)	1. Suppose the initial investment of a project is Rs. 3000 (Crores) and the cost of capital or the opportunity cost of capital is 10 percent. Estimate NPV of the project based on the cash flows given below. Year 1 2 3 4 5 Cash flow (In Crores) 1000 900 800 700 600		(5)
	b)	Briefly explain cost benefit analysis		(3)

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