

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

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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	9 th edition, 2016
2	Introduction to Probability Models	Sheldon M. Ross	Academic Press	13 th edition, 2024

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	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) -	

	<p>Converting FA to Regular Expressions, Converting Regular Expressions to FA, Pattern Matching and Regular Expressions, Regular grammar, Equivalence with FA - Conversion in both directions</p> <p>Properties of Regular Languages (Linz)</p> <p>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</p> <p>Context-Free Grammars and Applications (Linz)</p> <p>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</p>	11
3	<p>Pushdown Automata (Linz)</p> <p>Formal definition of a pushdown automaton, DPDA and NPDA, Examples of pushdown automata</p> <p>Equivalence NPDAs and CFGs (Proof not expected) - conversions in both directions</p> <p>Simplification of Context-Free Languages (Linz)</p> <p>Elimination of useless symbols and productions, Eliminating epsilon productions, Eliminating unit productions, Chomsky normal form, Greibach normal form,</p> <p>Properties of Context-Free Languages (Linz)</p> <p>The Pumping Lemma for Context-Free Languages (with formal proof), Closure and Decision Properties of Context-Free Languages (with formal proofs)</p>	11
4	<p>Turing Machines (Kozen)</p> <p>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</p> <p>Chomskian hierarchy, Linear bounded automaton as a restricted TM.</p> <p>Computability (Kozen)</p> <p>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.</p>	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)
Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	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 Distributions	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 (<i>Tuple representation</i>); 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
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

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

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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 Leiserson, Ronald L Rivest, Clifford Stein	PHI	3/e, 2009

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

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

SEMESTER S3

OBJECT ORIENTED PROGRAMMING

(Common to CS/CA/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	<p>Introduction to Java:</p> <p>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. [<i>Use proper naming conventions</i>]</p> <p>OOP Concepts :-</p> <p>Data abstraction, encapsulation, inheritance, polymorphism, Procedural and</p>	10

	<p>object oriented programming paradigm; Microservices.</p> <p>Object Oriented Programming in Java :- Declaring Objects; Object Reference; Introduction to Methods; Constructors; Access Modifiers; <i>this</i> keyword.</p>	
2	<p>Polymorphism :- Method Overloading, Using Objects as Parameters, Returning Objects, Recursion. Static Members, Final Variables, Inner Classes.</p> <p>Inheritance - Super Class, Sub Class, Types of Inheritance, The <i>super</i> keyword, protected Members, Calling Order of Constructors. Method Overriding, Dynamic Method Dispatch, Using <i>final</i> with Inheritance.</p>	8
3	<p>Packages and Interfaces – Packages - Defining a Package, CLASSPATH, Access Protection, Importing Packages.</p> <p>Interfaces - Interfaces v/s Abstract classes, defining an interface, implementing interfaces, accessing implementations through interface references, extending interface(s).</p> <p>Exception Handling - Checked Exceptions, Unchecked Exceptions, <i>try</i> Block and <i>catch</i> Clause, Multiple catch Clauses, Nested <i>try</i> Statements, <i>throw</i>, <i>throws</i> and <i>finally</i>, Java Built-in Exceptions, Custom Exceptions.</p> <p>Introduction to design patterns in Java : Singleton and Adaptor.</p>	9
4	<p>SOLID Principles in Java (https://www.javatpoint.com/solid-principles-java)</p> <p>Swings fundamentals – Overview of AWT, Swing v/s AWT, Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings–JFrame, JLabel, The Swing Buttons, JTextField.</p> <p>Event handling – Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model.</p> <p>Developing Database Applications using JDBC – JDBC overview, Types,</p>	10

	Steps, Common JDBC Components, Connection Establishment, SQL Fundamentals [<i>For projects only</i>] - Creating and Executing basic SQL Queries, Working with Result Set, Performing CRUD Operations with JDBC.	
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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
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks (8x2 =16 marks) 	<ul style="list-style-type: none"> • 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 subdivisions. E • Each question carries 6 marks. (4x6 = 24 marks) 	40

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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	<p>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.</p> <p>Verilog (Part 1) :- HDL Abstraction; Modern digital design flow - Verilog constructs: data types, the module, Verilog operators.</p>	11

2	<p>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.</p> <p>Modeling concurrent functionality in Verilog:- Continuous assignment - Continuous Assignment with logical operators, Continuous assignment with conditional operators, Continuous assignment with delay.</p>	11
3	<p>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.</p> <p>Structural design and hierarchy - lower level module instantiation, gate level primitives, user defined primitives, adding delay to primitives.</p>	8
4	<p>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.</p> <p>Finite State Machines :- Finite State Machines - logic synthesis for an FSM, FSM design process and design examples; Synchronous Sequential Circuits - Counters;</p> <p>Verilog (Part 2) : - Procedural assignment; Conditional Programming constructs; Test benches; Modeling a D flipflop in Verilog; Modeling an FSM in Verilog.</p>	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
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks. <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	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

	<p>policies – Deflation</p> <p>Taxation – Direct and Indirect taxes (merits and demerits) - GST</p> <p>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</p>	
4	<p>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</p>	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
<ul style="list-style-type: none"> Minimum 1 and Maximum 2 Questions from each module. Total of 6 Questions, each carrying 3 marks (6x3 =18marks) 	<ul style="list-style-type: none"> 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. <p style="text-align: center;">(4x8 = 32 marks)</p>	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. Pancerselvam	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	<p>Introduction to Environmental Ethics: Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles: Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics.</p> <p>Ecosystems and Biodiversity: Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.</p>	6
3	<p>Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.</p>	6
4	<p>Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. Environmental</p>	6

	<p>Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. Case Studies and Future Directions: Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.</p>	
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Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

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

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

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

*Can be taken from the given sample activities/projects

Evaluation Criteria:

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

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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 & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

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

Module-III

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

Module-IV

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

SEMESTER 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 Leiserson, Ronald L Rivest, Clifford Stein	PHI	3/e, 2009

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

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

Continuous Assessment (25 Marks)

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

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

2. Conduct of Experiments (7 Marks)

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

3. Lab Reports and Record Keeping (6 Marks)

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

4. Viva Voce (5 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER 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.

	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

	<ul style="list-style-type: none"> 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.	<p>Model a given Boolean function (SOP and POS) in Verilog using</p> <ul style="list-style-type: none"> a. continuous assignment with logical operators b. continuous assignment with conditional operators c. using gate level primitives
	<p style="text-align: center;">Part B</p> <p style="text-align: center;">(All experiments to be done using any circuit simulation softwares.)</p>
B1.	<p>Design and implement a combinational logic circuit for arbitrary functions (any two)</p> <ul style="list-style-type: none"> a) Code converters b) Half adder, full adder, half subtractor, full subtractor c) Multiplexer, Demultiplexer, Encoder, Decoder
B2.	<p>Design and implement combinational circuits using MSI devices: (any three)</p> <ul style="list-style-type: none"> 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.	<p>To design and implement the following shift registers using D flip flops</p> <ul style="list-style-type: none"> (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.
	<p style="text-align: center;">PART C</p> <p style="text-align: center;">using Verilog HDL</p> <p><i>For the all the experiments in part C:</i></p> <ul style="list-style-type: none"> 1. <i>Write Verilog program code in the IDE/Software (Other open source or online softwares such as Icarus Verilog / EDAplayground may be used)</i>

	<p>2. <i>Simulate the code using a test bench or by giving input values.</i></p> <p>3. <i>Synthesize the design and verify the waveforms</i></p>
C1.	<p>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</p> <p>a. continuous assignment with logical operators</p> <p>b. continuous assignment with conditional operators</p>
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.

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5. Record (5 Marks)

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