SEMESTER 3

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence and Machine Learning)

SEMESTER S3

MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-3

(Group A)

Course Code	**GAMAT301**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Basic calculus	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	60

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

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

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

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

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

SEMESTER S3

THEORY OF COMPUTATION

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

Course Code	**PCCST302**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST205	**Course Type**	Theory

Course Objectives:

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

CONCEPTS IN MACHINE LEARNING

Course Code	PBCMT304	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 equip the learners to understand the basic and advanced concepts and algorithms in machine learning.
2. To enable the learners to use 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** - Naive 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, Issues in Back Propagation Learning (Vanishing and Exploding Gradient Problems, Local Minima and Saddle Points, Overfitting, Slow Convergence, Sensitivity to the selection of the Initial weights, Computational Cost), Use of Adaptive Learning Rate Methods (Back Propagation Algorithm with Momentum, Adaptive Gradient Descent Algorithm (ADAGRAD), Root Mean Square Propagation (RMSProp), Adaptive Momentum Estimation (ADAM)) **Decision Trees** – Information Gain, Gain Ratio, ID3 algorithm	**13**
4	**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**

Suggestion on Project Topics

Students may identify a real life problem that can be solved using the concepts of machine learning. They may either use a standard dataset or build their own, for the purpose of applying machine learning algorithms. Besides, they may make use of various evaluation parameters to measure the efficiency of the methods. A few sample questions are given below.

1. **Classification of Handwritten Digits**: Classify handwritten digits (0-9) from the MNIST dataset using various machine learning algorithms and compare their performance. This will involve pre-processing the data, applying different classification techniques and using ensemble methods to improve accuracy.

2. **Predicting Student Examination Performance Based on Internal Marks**: Develop a real life dataset using the historical data of your institution. Use various machine learning algorithms to build models to predict students' final examination scores based on their internal assessment marks and evaluate their performance. Use ensemble methods to improve accuracy of prediction. Also, segment the students using clustering techniques to identify potential students at academic risk so that the educators can make timely interventions.

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

<table>
<tr><th>Part A</th><th>Part B</th><th>Total</th></tr>
<tr><td>2 Questions from each module.
Total of 8 Questions, each carrying 2 marks
(8x2 =16 marks)</td><td>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)</td><td>40</td></tr>
</table>

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:

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

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

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	1/e, 1997
2	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1/e, 1995
3	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	1/e, 2012
4	The Elements of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer	2/e, 2007
5	Foundations of Machine Learning	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar	MIT Press	1/e, 2012

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

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;	11

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks. **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Summarize the basic concept of different number systems and perform conversion and arithmetic operations between different bases.	**K2**
CO2	Interpret a combinational logic circuit to determine its logic expression, truth table, and timing information and to synthesize a minimal logic circuit through algebraic manipulation or with a Karnaugh map.	**K2**
CO3	Illustrate the fundamental role of hardware description languages in modern digital design and be able to develop the hardware models for different digital circuits.	**K3**
CO4	Develop MSI logic circuits using both the classical digital design approach and the modern HDL-based approach.	**K3**
CO5	Develop common circuits based on sequential storage devices including counter, shift registers and a finite state machine using the classical digital design approach and an HDL-based structural approach.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Logic Circuits & Logic Design with Verilog	Brock J. LaMeres	Springer International Publishing	2/e, 2017
2	Digital Design and Computer Architecture - RISC-V Edition	Sarah L. Harris, David Harris	Morgan Kaufmann	1/e, 2022

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

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

SEMESTER S3

ECONOMICS FOR ENGINEERS

(Common to All Branches)

Course Code	**UCHUT346**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ 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	7TH 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 S3

DATA STRUCTURES LAB

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

Course Code	PCCSL307	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GYEST204	Course Type	Lab

Course Objectives:

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

Expt. No.	Experiments
1	Find the sum of two sparse polynomials using arrays
2	Find the transpose of a sparse matrix and sum of two sparse matrices.
3	Convert infix expression to postfix (or prefix) and then evaluate using stack,
4	Implement Queue, DEQUEUE, and Circular Queue using arrays.
5	Implement backward and forward navigation of visited web pages in a web browser (i.e. back and forward buttons) using doubly linked list operations.
6	Implement addition and multiplication of polynomials using singly linked lists.
7	Create a binary tree for a given simple arithmetic expression and find the prefix / postfix equivalent.
8	Implement a dictionary of word-meaning pairs using binary search trees.
9	Find the shortest distance of every cell from a landmine inside a maze.
10	We have three containers whose sizes are 10 litres, 7 litres, and 4 litres, respectively. The 7-litre and 4-litre containers start out full of water, but the 10-litre container is initially empty. We are allowed one type of operation: pouring the contents of one container into another, stopping only when the source container is empty or the destination container is full. We want to know if there is a sequence of pourings that leaves exactly 2 litres in the 7 or 4-litre container. Model this as a graph problem and solve.
11	Implement the find and replace feature in a text editor.
12	Given an array of sorted items, implement an efficient algorithm to search for specific item in the array.

13	Implement Bubble sort, Insertion Sort, Radix sort, Quick Sort, and Merge Sort and compare the number of steps involved.
14	The General post office wishes to give preferential treatment to its customers. They have identified the customer categories as Defence personnel, Differently abled, Senior citizen, Ordinary. The customers are to be given preference in the decreasing order - Differently abled, Senior citizen, Defence personnel, Normal person. Generate the possible sequence of completion.
15	Implement a spell checker using a hash table to store a dictionary of words for fast lookup. Implement functions to check if a word is valid and to suggest corrections for misspelled words.
16	Simulation of a basic memory allocator and garbage collector using doubly linked list
17	The CSE dept is organizing a tech fest with so many exciting events. By participating in an event, you can claim for activity points as stipulated by KTU. Each event i gives you A[i] activity points where A is an array. If you are not allowed to participate in more than k events, what's the max number of points that you can earn?
18	Merge K sorted lists into a single sorted list using a heap. Use a min-heap to keep track of the smallest element from each list. Repeatedly extract the smallest element and insert the next element from the corresponding list into the heap until all lists are merged.

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Model a real world problem using suitable data structure and implement the solution.	**K3**
CO2	Compare efficiency of different data structures in terms of time and space complexity.	**K4**
CO3	Evaluate the time complexities of various searching and sorting algorithms.	**K5**
CO4	Differentiate static and dynamic data structures in terms of their advantages and application.	**K3**

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

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

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

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

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

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

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

Continuous Assessment (25 Marks)

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

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

2. **Conduct of Experiments (7 Marks)**

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

3. **Lab Reports and Record Keeping (6 Marks)**

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

4. **Viva Voce (5 Marks)**

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

4. **Viva Voce (10 Marks)**

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

5. **Record (5 Marks)**

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

SEMESTER S3

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

(Artificial Intelligence and Machine Learning)

SEMESTER S4

MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-4

(Group A)

Course Code	**GAMAT401**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

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

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

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

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

SEMESTER S4

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

(Common to CM/AM)

Course Code	**PCCMT402**	**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 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 Planning.

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	**Blind Search strategies:-** 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, Cryptarithmetic problems, Means-end analysis; Local search strategies - Simple Hill Climbing, Simulated Annealing; Adversarial search - Games, Optimal Decision in games, The minimax algorithm, Alpha–beta pruning.	**12**
3	**Knowledge-Based Agents** :-	**12**

	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.	
4	**Planning:-** Classical planning - Algorithms for Classical Planning, Forward state-space search for planning, Backward search for planning, Planning as Boolean satisfiability, Heuristics for Planning, Domain-independent pruning, State abstraction in planning, Hierarchical Planning, High-level actions, Searching for primitive solutions, Searching for abstract solutions, Planning and Acting in Nondeterministic Domains, Time, Schedules, and Resources.	**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	Explain how intelligent agents can solve problems.	**K2**
CO2	Use the different types of search methods to solve various problems.	**K3**
CO3	Apply knowledge representation and examine resolution in propositional logic and first order logic.	**K3**
CO4	Choose a sequence of actions for intelligent agents to accomplish a task by applying appropriate planning strategies.	**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://www.youtube.com/watch?v=RFdZMGJHrTc

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*	**11**

	Implementation, 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

DATABASE SYSTEMS

(Common to CM/AM)

Course Code	**PBCMT404**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	4	**ESE Marks**	40
Credits	3:0:0:1	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To equip the students with a comprehensive understanding of fundamental DBMS concepts as well as the principles and applications of NoSQL databases
2. To 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 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 and Normalization**:- Functional Dependencies-Basic definition- Normalization- First, Second and Third normal forms.	11

	Transaction Management :- Transaction Processing - Introduction, problems and failures in transaction, Desirable properties of transaction, Characterizing schedules based on recoverability and serializability; Concurrency Control with Two-Phase Locking Techniques- 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**

Suggestions on Project Topics

The students should identify a suitable project topic based on the concepts discussed in the syllabus and implement using the tools such as MySQL, Oracle, SQL Server etc. (for relational databases) or FireBase, MongoDB etc. (for NoSQL databases). The UI part (if applicable) may be developed using any programming language such as JAVA or Python. A few sample project topics are given below.

1. Design and implement a normalized database schema for the following requirement.

   A library wants to maintain the record of books, members, book issue, book return, and fines collected for late returns, in a database. The database can be loaded with book information. Students can register with the library to be a member. Books can be issued to students with a valid library membership. A student can keep an issued book with him/her for a maximum period of two weeks from the date of issue, beyond which a fine will be charged. Fine is calculated based on the delay in days of return. For 0-7 days: Rs 10, For 7 – 30 days: Rs 100, and for days above 30 days: Rs 10 will be charged per day.

2. Design and implement an e-commerce product catalogue using a NoSQL database with the following CRUD operations:

   - *Add new products to the catalogue.*
   - *Update product details (e.g., price, stock quantity).*
   - *Delete products from the catalogue.*
   - *Add / Delete categories and Update category details.*
   - *Add / Delete suppliers and Update Supplier details.*

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	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 and execute basic to advanced SQL queries to effectively retrieve, filter, and manipulate data from relational databases.	**K3**
CO5	Demonstrate a comprehensive understanding of NoSQL database concepts	**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					2	2	3
CO3	3	3	3	3	3							3
CO4	3	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	Fundamentals of Database Systems [Module 1,2,3,4]	Ramez Elmasri, Shamkant Navathe	Pearson	7/e, 2017
2	Making Sense of NoSQL: A guide for managers and the rest of us [Module 4]	Dan McCreary, Ann Kelly	Manning	1/e, 2014

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 A., H. F. Korth, S. Sudarshan	McGraw Hill	7/e, 2011
2	Beginning Database Design Solutions	Rod Stephens	Wiley	2/e, 2023
3	NoSQL Distilled	Pramod J. Sadalage, Martin Fowler	Addison-Wesley	1/e, 2012
4	NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), - Vol 1	Olivier Pivert	Wiley	1/e, 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/

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 – Factory method, Abstract Factory method, Singleton method, Prototype method, Builder method. Structural Design Pattern and its types – Adapter, Bridge, Proxy,	**9**

	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)**	9

	Feature Selection - Importance of feature selection, Techniques for feature 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. (Practice of Visualization of a discrete time signal and operations on the DT	**8**

	signal using python. Demonstration of sampling and reconstruction using Python/Matlab.)	
2	Discrete-Time Fourier Transform for Aperiodic Sequences - Properties of the Discrete-Time Fourier Transform (Periodicity, Linearity, Translation (Time Shifting), Modulation (Frequency-Domain Shifting), Conjugation, Time Reversal, Convolution, Multiplication, Frequency-Domain Differentiation, Differencing, Parseval's theorem, Even/Odd symmetry, real sequences) DTFT of periodic sequences - Frequency Spectra of Sequences, Bandwidth of Sequences, Energy density spectra, Characterizing LTI Systems Using the Fourier Transform.	**10**
3	Discrete time systems - Block diagram representation and mathematical representation of discrete-time systems-Some common elements of Discrete-time systems (adder, constant multiplier, signal multiplier, unit delay, unit advance), Recursive DT systems and non recursive discrete time systems, Relaxed system, Linearity and time invariance property of a DT system. Discrete time LTI systems - Discrete time convolution, Properties of Convolution, Characterizing LTI Systems and Convolution - Impulse response of an LTI system, Difference equation, Properties of an LTI system - Causality, Memory, Invertibility, BIBO Stability, Eigen Sequences/ eigen functions for discrete-Time LTI Systems.	**9**
4	**Z transform** - motivation for z transform, Relationship Between z Transform and Discrete-Time Fourier Transform, Region of Convergence for the z Transform. Properties of z transform - Translation (Time Shifting), Complex Modulation (z-Domain Scaling), Conjugation, Time Reversal, Upsampling (Time Expansion, Downsampling, Convolution, z-Domain Differentiation, Differencing, Initial and Final Value Theorems Determination of the Inverse z Transform LTI systems and difference equations, Characterizing LTI systems using z transform, Transfer function of an LTI system. Solving Difference Equations Using the Unilateral z Transform Block Diagram Representation of Discrete-Time LTI Systems, Interconnection of LTI systems.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Demonstrate the concept and different types of DT signals and the effect of different operations on the signals.	**K2**
CO2	Explain how DTFS can be used to represent a periodic DT signal.	**K2**
CO3	Apply the concept of DTFT for an aperiodic signal to determine the frequency spectrum.	**K3**
CO4	Utilize the properties of a DT system based on its impulse response and z transform.	**K3**
CO5	Identify the response of a DT LTI system to an arbitrary input sequence.	**K3**

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

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

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

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

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

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

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

SEMESTER S4

SOFT COMPUTING

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

Course Code	**PECST417**	**CIE Marks**	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Soft Computing. Difference between Hard Computing & Soft Computing. Applications of Soft Computing. Artificial Neurons Vs Biological Neurons. Basic models of artificial neural networks – Connections, Learning, Activation Functions. McCulloch and Pitts Neuron. Hebb network, Perceptron Networks– Learning rule, Training and testing algorithm. Adaptive Linear Neuron– Architecture, Training and testing algorithm.	10
2	Fuzzy logic, Fuzzy sets – Properties, Fuzzy membership functions, Features of Fuzzy membership functions. operations on fuzzy set. Linguistic variables, Linguistic hedges Fuzzy Relations, Fuzy If-Then Rules, Fuzzification, Defuzzification– Lamda cuts, Defuzzification methods. Fuzzy Inference mechanism - Mamdani and Sugeno types.	9
3	Evolutionary Computing, Terminologies of Evolutionary Computing, Concepts of genetic algorithm. Operators in genetic algorithm - coding, selection, cross over, mutation. Stopping condition for genetic algorithm.	8

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

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

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

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

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

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

	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

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 sweep algorithm, Bentley-Ottmann algorithm (Text 3, Chapter 7)	**9**
2	**Polygon Triangulation and Voronoi Diagrams:-** Polygon Triangulation - Definition and applications, Triangulation of	**9**

	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)	
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	9

	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 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

COMPUTER ORGANIZATION

(Common to CM/AM)

Course Code	**PECMT415**	**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**	Theory

Course Objectives

1. To introduce principles of computer organization and the basic architectural concepts using RISC.
2. To impart 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.	9
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.	9
3	**Memory Systems:** Introduction; performance analysis; Caches - basic concepts, Cache mapping, Cache replacement, Multiple-Level Caches,	9

	Reducing Miss Rate, Write Policy; Virtual Memory - Address Translation; Page Table; Translation Lookaside Buffer; Memory Protection.	
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.	**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

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.

- Ability to analyze the requirement and construct computer components.

End Semester Examination Marks (ESE):

In Part A, all questions need 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	Identify the basic structure and functional units of a digital computer and the features of RISC architecture.	**K2**
CO2	Analyze the single cycle processor, pipelining, and the associated problems.	**K4**
CO3	Evaluate and implement the memory organization in modern computer systems.	**K5**
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/

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: 40 marks, ESE: 60 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 =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**.	**6**

	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 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 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.	**6**

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

Continuous Internal Evaluation Marks (CIE):

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

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

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

*Can be taken from the given sample activities/projects

Evaluation Criteria:

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

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

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

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

Suggested Activities/Projects:

Module-II

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

- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

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

Module-IV

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

SEMESTER S4

OPERATING SYSTEMS LAB

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

Course Code	**PCCSL407**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GYEST204	**Course Type**	Lab

Course Objectives:

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

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

4	Create a new process using a **fork** system call. Print the parent and child process IDs. Use the **pstree** command to find the process tree for the child process starting from the **init** process.
5	Write a program to add two integers (received via the command line) and compile it to an executable named "**myadder**". Now write another program that creates a new process using a **fork** system call. Make the child process add two integers by replacing its image with the "**myadder**" image using **execvp** system call.
6	Create a new process using a **fork** system call. The child process should print the string "**PCCSL407**" and the parent process should print the string "**Operating Systems Lab**". Use a **wait** system call to ensure that the output displayed is "**PCCSL407 Operating Systems Lab**"
7	**Inter-process Communication (https://www.linuxdoc.org/LDP/lpg/node7.html)** (a) Using Pipe – Evaluate the expression $\sqrt{b^2 - 4ac}$. The first process evaluates b^2. The second process evaluates $4ac$ and sends it to the first process which evaluates the final expression and displays it. (b) Using Message Queue - The first process sends a string to the second process. The second process reverses the received string and sends it back to the first process. The first process compares the original string and the reversed string received from the second one and then prints whether the string is a palindrome or not. (c) Using Shared Memory - The first process sends three strings to the second process. The second process concatenates them to a single string (with whitespace being inserted between the two individual strings) and sends it back to the first process. The first process prints the concatenated string in the flipped case, that is if the concatenated string is "**Hello S4 Students**", the final output should be "**hELLO s4 sTUDENTS**"
8	Write a multithreaded program that calculates the mean, median, and standard deviation for a list of integers. This program should receive a series of integers on the command line and will then create three separate worker threads. The first thread will determine the mean value, the second will determine the median and the third will calculate the standard deviation of the integers. The variables representing the mean, median, and standard deviation values will be stored globally. The worker threads will set these values, and the parent thread will output the values once the workers have exited.

9	Input a list of processes, their CPU burst times (integral values), arrival times, and priorities. Then simulate FCFS, SRTF, non-preemptive priority (a larger priority number implies a higher priority), and RR (quantum = 3 units) scheduling algorithms on the process mix, determining which algorithm results in the minimum average waiting time (over all processes).
10	Use semaphores to solve the readers-writers problem with writers being given priority over readers.
11	Obtain a (deadlock-free) process mix and simulate the banker's algorithm to determine a safe execution sequence.
12	Obtain a process mix and determine if the system is deadlocked.
13	Implement the deadlock-free semaphore-based solution for the dining philosopher's problem.
14	Simulate the address translation in the paging scheme as follows: The program receives three command line arguments in the order ● size of the virtual address space (in megabytes) ● page size (in kilobytes) ● a virtual address (in decimal notation) The output should be the physical address corresponding to the virtual address in <frame number, offset> format. You may assume that the page table is implemented as an array indexed by page numbers. (NB: If the page table has no index for the page number determined from the virtual address, you may just declare a page table miss!)
15	Simulate the FIFO, LRU, and optimal page-replacement algorithms as follows: First, generate a random page-reference string where page numbers range from 0 to 9. Apply the random page-reference string to each algorithm, and record the number of page faults incurred by each algorithm. Assume that demand paging is used. The length of the reference string and the number of page frames (varying from 1 to 7) are to be received as command line arguments.
16	Simulate the SSTF, LOOK, and CSCAN disk-scheduling algorithms as follows: Your program will service a disk with 5,000 cylinders numbered 0 to 4,999. The program will generate a random series of 10 cylinder requests and service them according to each of the algorithms listed earlier. The program will be passed the initial position of the disk head (as a parameter on the command line) and will report the total number of head movements required by each algorithm.

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

Continuous Assessment (25 Marks)

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

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

2. **Conduct of Experiments (7 Marks)**

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

3. **Lab Reports and Record Keeping (6 Marks)**

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

4. **Viva Voce (5 Marks)**

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER S4

ARTIFICIAL INTELLIGENCE LAB

(Common to CM/AM)

Course Code	**PCCML408**	**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 experience the implementation of the AI techniques appropriate to solve a particular problem.
2. To teach how to apply AI algorithms to solve real world problems.

Expt. No.	**Experiments (***Using Python / LISP***)**
1	Solve the Tic-Tac-Toe problem using the Breadth First Search technique.
2	Solve the Water jug problem using the Depth First Search technique.
3	A crypt-arithmetic puzzle is a type of mathematical puzzle in which digits are assigned to alphabetical letters or symbols. The end goal is to find the unique digit assignment to each letter so that the given mathematical operation holds true. Solve the puzzles i) EAT + THAT = APPLE ii) POINT + ZERO = ENERGY iii) CROSS + ROADS = DANGER
4	Consider the Blocks World Domain Game which starts with an initial state consisting of a fixed number of blocks arranged in 3 stacks and can move only top blocks of the stacks and have to achieve a goal state that is a particular arrangement of blocks by moving these blocks. Blocks World is a planning problem where the goal state is known beforehand and the path to the Goal state is more important. Implement the best first search algorithm and try out a minimum of 3 different heuristic functions and compare the results with valid reasoning. Use a priority queue for the OPEN list to make it computationally efficient. An example of Initial State is: E B F D A C Correspondingly, the Goal State: A D B

	E F C
5	Implement A* algorithm to solve the Missionaries and Cannibals problem.
6	Implement an agent that can solve the Block World problem optimally (in the minimum number of moves) for an arbitrary initial arrangement of blocks (A-Z, 26 blocks maximum) using Generate & Test and Means-Ends Analysis techniques.
7	Implement Simulated Annealing Search Algorithm for solving the 8-puzzle problem.
8	Implement and test hill climbing based search algorithms to solve Travelling Salesman Problem.
9	Develop a program to construct a pruned game tree using Alpha-Beta pruning. Take the sequence, [5, 3, 2, 4, 1, 3, 6, 2, 8, 7, 5, 1, 3, 4] of MINIMAX values for the nodes at the cutoff depth of 4 plies. Assume that branching factor is 2, MIN makes the first move, and nodes are generated from right to left.
10	Solve the wumpus world problem using the logical reasoning method.
11	Solve and implement the tower of Hanoi problem by planning.

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 various search strategies for solving real life AI problems.	**K3**
CO2	Use logical reasoning methods to solve AI problems.	**K3**
CO3	Choose the correct planning strategy for solving AI problems.	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	-	-	-	-	-	2	3
CO2	3	2	2	2	3	-	-	-	-	-	*2*	3
CO3	3	2	2	2	3	-	-	-	-	-	*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	Artificial Intelligence: 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://youtu.be/pKeVMlkFpRc?si=MTXHLZb9Le0tQwtc
2	https://youtu.be/sUNz_-YUPfw?si=3McRqcTYLmIdJQ48
3	https://youtu.be/3C6ZLS-gfXU?si=XGDejaePCnwXdRgI

Continuous Assessment (25 Marks)

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

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

2. Conduct of Experiments (7 Marks)

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

3. **Lab Reports and Record Keeping (6 Marks)**
    - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
    - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.
4. **Viva Voce (5 Marks)**
    - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

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

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**
    - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
    - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
    - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
    - Creativity and logic in algorithm or experimental design.
2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**
    - Setup and Execution: Proper setup and accurate execution of the experiment or programming task.
3. **Result with Valid Inference/Quality of Output (10 Marks)**
    - Accuracy of Results: Precision and correctness of the obtained results.
    - Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.
4. **Viva Voce (10 Marks)**
    - Ability to explain the experiment, procedure results and answer related questions
    - Proficiency in answering questions related to theoretical and practical aspects of the subject.
5. **Record (5 Marks)**
    - Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 5

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence and Machine Learning)

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:

1. To gain a foundational understanding of algorithms and their analysis.
2. To develop problem-solving skills using various algorithm design paradigms like divide and conquer, dynamic programming, etc.
3. 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	**11**

	– Control Abstraction, Merge Sort, Strassen's Matrix Multiplication, Analysis.	
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

DEEP LEARNING CONCEPTS

Course Code	**PCCMT503**	**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 give the learners an understanding about the foundations of deep learning architecture and applications.
2. To equip the learners with the necessary skills to set up neural network architecture and use it for real life problem solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Review of Neural Networks:-** Biological Neuron vs. Artificial Neuron, Activation Functions (*Step, Sign, Sigmoid, Softmax, tanh, ReLU, LreLU, EReLU* functions), Single Layer Perceptron, Linear Separability, XOR Problem, Multilayer Perceptron, Back-propagation algorithm.	**9**
2	**Convolutional Neural Networks (CNN):-** CNN-Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Convolution and Pooling as infinitely strong prior, Variants of Convolution Operation, Efficient Convolution Computation Methods, Popular CNN Architectures (*ResNet, Alexnet,VGGNet, Inception*)	**11**
3	**Recurrent Neural Networks (RNN):-** Model of a typical RNN, Computation Graph, Bidirectional RNNs, Encoder – decoder sequence to sequence architectures, BPTT for training RNN, Deep	**11**

	Recurrent Networks, Recursive Recurrent Networks, Long Short Term Memory Networks (LSTM), Gated Recurrent Networks (GRU)	
4	**Unsupervised Deep Learning Models:-** AutoEncoders(AE), Types of AutoEncoders (Undercomplete AE, Sparse AE, Deep AE, Contractive AE, Denoising AE, Convolutional AE, Variational AE), Boltzmann machines, Types of Boltzmann machines (*Restricted Boltzmann Machines, Deep Belief Networks, Deep Boltzmann Machines*) **Applications of Deep Learning:-** Speech Processing, Computer Vision, Natural Language Processing, Word Embedding Techniques (*TF-IDF, Word2Vec, GloVe*)	**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	Illustrate fundamental neural network architectures and algorithms, including Multilayer Perceptron and Back-propagation.	**K3**
CO2	Design and evaluate various deep learning architectures, including feed-forward networks, Convolutional Neural Networks (CNNs), and their applications in real-world problems	**K3**
CO3	Develop and utilize Recurrent Neural Networks (RNNs) and Long Short-Term Memory Networks (LSTMs) for sequence modelling and natural language processing tasks.	**K3**
CO4	Use unsupervised learning techniques such as Autoencoders and Boltzmann machines 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	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	Deep Learning	Ian Goodfellow, Yoshua Bengio and Aaron Courville	MIT Press	1/e, 2016
2	Neural Networks and Deep Learning	Charu C Agarwal	Springer	2/e, 2023
3	Neural Networks and Deep Learning	Michael A. Nielsen	Determination Press	2/e, 2015
4	Learning Deep Architectures for AI: 4 (Foundations and Trends in Machine Learning)	Yoshua Bengio	now Publishers Inc.	1/e, 2009
5	Deep Learning: A Practitioner's Approach	Josh Patterson, Adam Gibson	O'Reilly Media	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.	Umberto Michelucci	APRESS	1/e, 2018
2	Deep Learning with Keras	Antonio Gulli, Sujit Pal	Packt Publishers	1/e, 2017
3	Deep Learning with Python	Francois Chollet	Manning Publications	1/e, 2017

Video Links (NPTEL, SWAYAM…)	
Sl. 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 S5

INTRODUCTION TO COMPUTER VISION

Course Code	**PBCMT504**	**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 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.	**11**
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	**11**

	Image Gradients - Computing the Image Gradient, Gradient Based Edge and Corner Detection. Filters as Templates - Normalized Correlation and Finding Patterns.	
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 (Recap) 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	**11**
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.***	**11**

Suggestion on Project Topics

Real life problems in the domain of computer vision may be identified, solved and implemented using different algorithms. A few suggestions are given below.

1. Build a system capable of detecting and classifying objects (like pedestrians, vehicles, traffic signs) in real-time from video feeds in autonomous vehicles. You can explore different algorithms like YOLO, R-CNN etc.
2. Develop a machine learning model to automatically detect and classify diseases from medical images, such as X-rays, MRIs, or CT scans. This could be applied to specific conditions like detecting tumors, pneumonia, or diabetic retinopathy.

3. Develop a machine learning model that utilizes edge detection and linear filtering techniques to enhance object detection and recognition in images.

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 basic concepts and terminologies like Camera Calibration, Stereopsis in computer vision	**K2**
CO2	Use filters for feature extraction and finding patterns.	**K3**
CO3	Build different machine learning models for computer vision.	**K3**
CO4	Implement and analyse segmentation and object detection models	**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								2
CO2	3	3	3	3	3							2
CO3	3	3	3	3	3							2
CO4	3	3	3	3	3							2

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	Pearson	2/e, 2012
2	Emerging Topics in Computer Vision	Gerald Medioni and Sing Bing Kang	Prentice Hall	1/e, 2004
3	Practical Machine Learning for Computer Vision: End-to End Machine Learning for Images	Valliappa Lakshmanan, Martin Görner, and Ryan Gillard	O'Reilly	1/e, 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	Richard Szeliski	Springer	1/e, 2011
2	Image Segmentation: Principles, Techniques, and Applications	Tao Lei and Asoke K. Nandi	Wiley	1/e, 2022
3	Deep Learning in Computer Vision Principles and Applications	Mahmoud Hassaballah and Ali Ismail Awad,	CRC Press	1/e, 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

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 XP, FDD, DSDM, Crystal.	9

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

EXPERT SYSTEMS

Course Code	**PECMT522**	**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 knowledge about how expert systems can solve complex problems by reasoning through bodies of knowledge.
2. To explore the different stages in the development of an expert system.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Expert Systems:-** Introduction, Characterization and History of Expert Systems, Programming Languages and Expert System Tools, Knowledge Acquisition Problems, Knowledge Acquisition with Specialized Programming Environments, Architecture of Expert Systems, Use and Usability of Expert Systems, Potential Benefits and Modes of Use, Expert Systems as Knowledge Media, Criteria for Expert System Domains. Knowledge representations, Productions, Semantic Nets, Schemata, Frames, Logic and Sets, Propositional Logic, First Order Predicate Logic, Universal Quantifier, Existential Quantifier.	**9**
2	**Methods of inference:-** Trees, lattices, and graphs, state and problem spaces, AND-OR trees and goals, Deductive logic and syllogisms, methods of inference, rules of inference, limitations of propositional logic, logic systems, resolution, resolution systems and deduction, shallow and causal reasoning, forward and backward chaining.	**9**

3	Uncertainty, Type of Errors, Errors and Induction, Classical Probability, Experimental and Subjective Probabilities, Compound Probability, Conditional Probability, Hypothetical Reasoning and Backward Induction, Temporal Reasoning and Markov Chains, Odds of Belief, Sufficiency and Necessity, Uncertainty in Inference Chains, Implications of Combining Evidence, Inference Nets, Propagation of Probabilities.	**9**
4	How to Select an Appropriate Problem, The Stages in the Development of an Expert System, Types of Errors to Expect in the Development Stages, Software Engineer and Expert Systems, The Expected Life Cycle of an Expert System, Life Cycle Model. Expert System Examples - MYCIN,DART.	**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 difference between expert systems and conventional systems and how knowledge is represented in expert systems	**K2**
CO2	Use different methods of inference to solve problems using expert systems.	**K3**
CO3	Solve problems by applying methods for reasoning under uncertainty.	**K3**
CO4	Choose an appropriate problem for expert systems and understand the different stages in the development of an expert system.	**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									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	Expert Systems - Principles and Programming.	J. Giarratano and G. Riley	PWS Publishing Company	4/e, 2004
2	Systematic Introduction to Expert Systems	Frank Puppe	Springer	1/e, 1993
3	Introduction to Expert Systems	Peter Jackson	Addison Wesley Longman	3/e, 1999

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Expert systems: Design and Development	Durkin, J.	Macmillan	1/e, 1994
2	The Engineering of Knowledge-Based Systems	Gonzalez and D. Dankel	Prentice Hall	1/e, , 1994

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=nE5c5w4aizU
2	https://www.youtube.com/watch?v=4D2lT3efLPE
3	https://www.youtube.com/watch?v=1lKsSiEsJ18
4	https://www.youtube.com/watch?v=lyrFcgqFmIk&t=232s

SEMESTER S5

FUZZY SYSTEMS

Course Code	PECMT523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

3	**Fuzzification and Defuzzification Methods :-** Fuzzy inference – Zadeh rule, Mamdani rule. Development of membership Functions – Intuition, Inference, Rank ordering, Inductive reasoning. Defuzzification to Scalars - Max membership principle, Centroid method, Weighted average method, Mean max membership, Center of sums, Center of largest area, First (or last) of maxima.	**9**
4	**Fuzzy Inference Systems** :- Approximate Reasoning, Fuzzy (Rule-Based) Systems – Multiple conjunctive antecedents, Multiple disjunctive antecedents, Aggregation of fuzzy rules, Graphical Techniques of Inference. Fuzzy Controllers -Mamdani FIS, Larsen Model.	**9**

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

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain fuzzy logic based problem solving	**K2**
CO2	Summarize the concepts of crisp sets, crisp relations, crisp logic with fuzzy sets, fuzzy relations and fuzzy logic	**K3**
CO3	Develop fuzzy systems by selecting appropriate membership functions, fuzzification and defuzzification methods	**K3**
CO4	Develop solutions using graphical and rule-based methods	**K3**
CO5	Make use of fuzzy logic inference to solve real world problems	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fuzzy Logic with Engineering Applications	Timothy J. Ross	John Wiley and Sons	3/e, 2010
2	Fuzzy Sets and Fuzzy Logic: Theory and Applications	George J. Klir and Bo Yuan	Pearson	1/e, 2015

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

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

SEMESTER 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 :-**	**8**

	Video Compression - Analog video, Digital Video, Motion Compensation. MPEG standards MPEG, H.261	
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

INTRODUCTION TO COMPILER DESIGN

Course Code	**PECMT527**	**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 the compiler construction process, including lexical analysis, parsing, semantic analysis, code generation, and optimization.
2. To enable the learner to design, implement, and test a compiler for a simple language, utilizing tools including LEX and YACC for lexical analysis and parsing, respectively.
3. To learn to use code optimization techniques to improve the efficiency of generated code.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Compilers – The Translation Process, Major Data Structures, Other Issues, Bootstrapping and Porting. Scanning Process – Finite state automata and Regular expressions (Basic idea only). Use of LEX to generate automatic scanners (basic idea only). Parsing Process – Context free Grammars (Basic idea only), Parse Trees and Abstract Syntax Trees, Ambiguity.	**10**
2	Top-down Parsing - Recursive Descent, LL(1), First and Follow. Error Recovery in Top-down Parsers. Bottom-up Parsing - Overview of Bottom -up parsing, Shift-reduce parser, LR(0) Items and LR(0) Parsing, SLR(1) parsing, General LR(1) and LALR(1) Parsing.	**10**
3	Semantic Analysis: Attributes and attribute grammars. Dependency graphs and Evaluation order, Synthesized and Inherited attributes.	**8**

	Intermediate code generation – Three address code, P – code. Intermediate code as a synthesized attribute.	
4	Generation of Target code from intermediate code – Code generation of Data structure references- address calculation, array references, if and while statements. Code Optimization Techniques: Principal sources of code optimization, Classification of optimizations, Data Structures and Implementation Techniques for Optimizations.	**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 lexical analysis techniques to build a scanner for a given language specification.	**K2**
CO2	Construct parse trees for input programs using parsing algorithms and detect syntactic errors.	**K3**
CO3	Develop semantic analysis techniques to check program correctness.	**K3**
CO4	Develop intermediate code representations by applying intermediate code generation techniques.	**K3**
CO5	Utilize code optimization strategies to improve performance of the machine code.	**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	Compiler Construction - Principles and Practice	Kenneth C Louden	Cengage	1/e, 2007

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, 2013
2	Engineering a Compiler	Keith D. Cooper Linda Torczon	Morgan Kaufman	3/e, 2023
3	Modern Compiler Implementation in C	Andrew W. Appel	Cambridge University Press	2004
3	The Theory and Practice of Compiler Writing	Tremblay and Sorenson	Tata McGraw Hill	1/e, 1984
4	System Programming and Operating Systems	D. M. Dhamdhere	Tata McGraw Hill	2/e, 2001

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1-4	https://onlinecourses.nptel.ac.in/noc20_cs13/preview

SEMESTER S5

CONCEPTS IN SOCIAL NETWORK ANALYSIS

Course Code	PECMT528	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 understand the concepts of semantic web and related applications.
2. To impart the idea of knowledge representation using ontology.
3. To explore human behaviour in social web and related communities and various forms of social network visualization.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:-** Introduction to Semantic Web – Limitations of Current Web, Development of Semantic Web, Emergence of the Social Web; Social Network Analysis – Development of Social Network Analysis, Key Concepts and Measures in Social Network Analysis; Electronic Sources for Network Analysis – Electronic Discussion Networks, Blogs and Online Communities, Web-Based Networks, Applications of Social Network Analysis.	8
2	**Modelling, Aggregating and Knowledge Representation:-** Ontology and Their Role in Semantic Web – Ontology-Based Knowledge Representation; Ontology Languages for the Semantic web – Resource Description Framework, Web Ontology Language; Modelling and Aggregating Social Network Data – State-of-the-art in Network Data Representation, Ontological Representation of Social Individuals, Ontological Representation of Social Individuals, Ontological Representation of Social Relationships, Aggregating and Reasoning with Social Network Data, Advanced Representations.	8

3	**Extraction and Mining Communities in Web Social Networks:-** Extracting evolution of Web Community from a Series of Web Archive, Detecting Communities in Social Networks, Definition of Community, Evaluating Communities, Methods for Community Detection and Mining, Applications of Community Mining Algorithms, Tools for Detecting Communities Social Network Infrastructures and communities, Decentralized Online Social Networks, Multi-Relational Characterization of Dynamic Social network communities.	**8**
4	**Predicting Human Behaviour for Social Communities:-** Understanding and Predicting Human Behavior for Social Communities, User Data Management, Inference and Distribution, Enabling New Human Experiences, Reality Mining, Context–Awareness, Privacy in Online Social Networks, Trust in Online Environment, Trust Models Based on Subjective Logic, Trust Network Analysis, Trust Transitivity Analysis, Combining Trust and Reputation, Trust Derivation Based on Trust Comparisons, Attack Spectrum and Counter Measures. **Visualization of Social Networks:-** Graph theory, Centrality, Clustering, Node-Edge Diagrams, Matrix Representation, Visualizing Online Social Networks, Visualizing Social Networks with Matrix-Based Representations, Matrix and Node-Link Diagrams, Hybrid Representations.	**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	Design and develop semantic web for the analysis of social networks.	**K3**
CO2	Demonstrate how knowledge can be represented using ontology.	**K3**
CO3	Explain how human behaviour can be predicted for social communities.	**K2**
CO4	Use various mechanisms to visualize social 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									2
CO2	3	3	3									2
CO3	3	3	3									2
CO4	3	3	3									2

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Social Networks and the Semantic Web	Peter Mika	Springer /b S Publication	1/e, 2010
2	Handbook of Social Network Technologies and Applications	Borko Furht	Springer-Verlag New York Inc.	1/e, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Web Mining and Social Networking – Techniques and applications	Guandong Xu ,Yanchun Zhang and Lin Li	Springer-Verlag New York Inc.	1/e, 2011
2	Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively	Dion Goh and Schubert Foo	Idea Group	1/e, 2007
3	Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling	Max Chevalier, Christine Julien and Chantal Soulé-Dupuy	Information Science Reference	1/e, 2009
4	The Social Semantic Web	John G. Breslin, Alexander Passant and Stefan Decker	Springer	1/e, 2009

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_cs117/preview

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 preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, text mining and web mining, and apply these techniques in real-world scenarios

SYLLABUS

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

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

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

End Semester Examination Marks (ESE):

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. • Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the key process of data mining and data warehousing concepts in application domains.	**K2**
CO2	Apply appropriate pre-processing techniques to convert raw data into suitable format for practical data mining tasks	**K3**
CO3	Illustrate the use of classification and clustering algorithms in various application domains	**K3**
CO4	Comprehend the use of association rule mining techniques	**K3**
CO5	Explain advanced data mining concepts and their applications in emerging domains	**K2**

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

CO-PO Mapping Table:

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

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

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

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

SEMESTER S5

OBJECT ORIENTED PROGRAMMING CONCEPTS

Course Code	**PECMT535**	**CIE Marks**	60
Teaching Hours/Week (L:T:P:R)	3:0:0:0	**ESE Marks**	40
Credits	5/3	**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 :-** 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 :-**	**12**

	Data abstraction, encapsulation, inheritance, polymorphism, Procedural and 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.	**10**
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.	**10**
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	**12**

	Managers, Exploring Swings–JFrame, JLabel, The Swing Buttons, JTextField. **Event handling –** Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model**.** **Developing Database Applications using JDBC –** JDBC overview, Types, Steps, Common JDBC Components, Connection Establishment, SQL Fundamentals [***For projects only***] - Creating and Executing basic SQL Queries, Working with Result Set, Performing CRUD Operations with JDBC.	

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

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

It must accept a considerable amount of information from the user for processing.

It must have a considerable amount of data to be stored permanently within the computer - as plain files / using databases..

It must process the user provided data and the stored data to generate some output to be displayed to the user.

Examples : -

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

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

Functionalities

Book Management:

Add, remove, and update book details.

Search books by title, author, ISBN, and genre.

User Management:

Register new users.

Search users by user ID and name.

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.

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.

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

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.

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.

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.

End Semester Examination Marks (ESE):

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. • Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the 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 and evaluate event-driven Java GUI applications with database connectivity using Swing and JDBC.	**K5**

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 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:

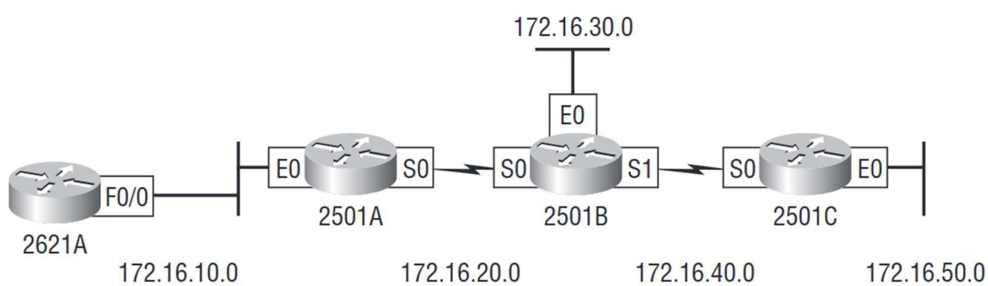
1. To provide hands-on experience in network programming using Linux System calls and network monitoring tools.
2. To comprehend the implementation of network protocols and algorithms, and configuration of network layer services using network simulators.

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?

<table>
<tr><td></td><td>(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?</td></tr>
<tr><td colspan="2">Socket programming based</td></tr>
<tr><td>5</td><td>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.</td></tr>
<tr><td>6</td><td>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</td></tr>
<tr><td>7</td><td>Implement a multi-user chat server using TCP as the transport layer protocol.</td></tr>
<tr><td>8</td><td>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.</td></tr>
</table>

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	IP address
2621	F0/0	172.16.10.1
2501A	E0	172.16.10.2
2501A	S0	172.16.20.1
2501B	E0	172.16.30.1
2501B	S0	172.16.20.2
2501B	S1	172.16.40.1
2501C	S0	172.16.40.2
2501C	E0	172.16.50.1

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

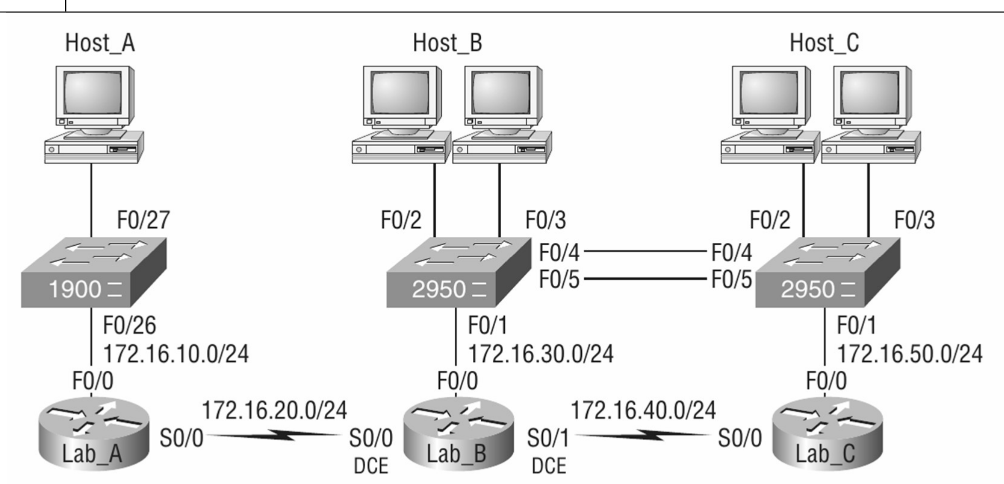


Figure 2: A portion of your college campus network

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.

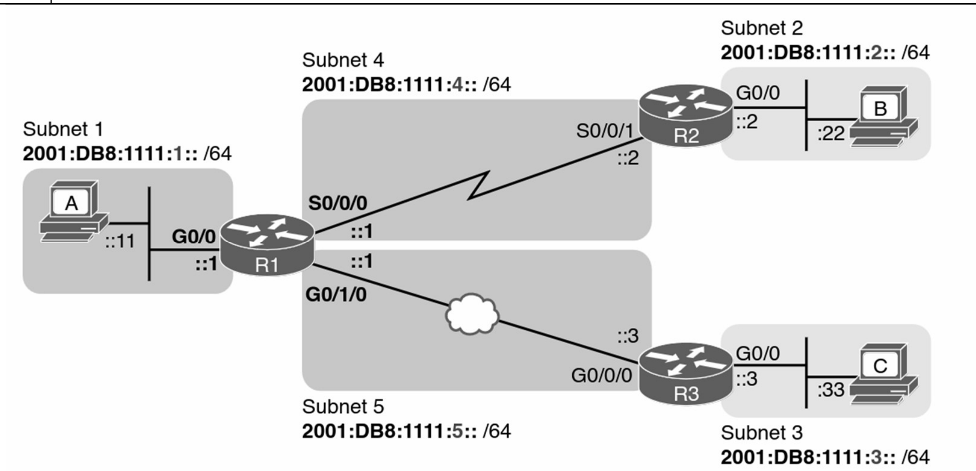


Figure 3: An IPv6 network

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 S5

DEEP LEARNING LAB

Course Code	**PCCML508**	**CIE Marks**	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	**ESE Marks**	50
Credits	2	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	UCEST105	**Course Type**	Lab

Course Objectives:

1. To get hands-on experience in machine learning.
2. To enable the learners to develop deep learning models for computer vision and natural languages using python.

Expt. No.	Experiments
1	Implement and demonstrate Single, Multi variable and Polynomial Regression for a given set of training data stored in a .CSV file and evaluate the accuracy.
2	Write a Python program to implement KNN classifiers and calculate the accuracy, precision, and recall for your data set.
3	Assuming a set of data that need to be classified, use a Naive Bayes classifier to perform this task and evaluate the accuracy.
4	Write a Python program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
5	Implement hierarchical clustering algorithm on a given dataset to categorize the data.
6	Implement k means clustering algorithm on a given dataset to categorize the data.
7	Build an Artificial Neural Network using Backpropagation algorithm on a given dataset and test the same with appropriate dataset.
8	Implement Feed forward neural network with three hidden layers for classification on CIFAR-10 dataset. Analyse the impact of optimization and weight initialization techniques such as Xavier initialization, Kaiming Initialization, dropout and regularization techniques,and visualize the change in performance.
9	Digit classification using CNN architecture for MNIST dataset. Identify the performance change through pre-trained networks such as VGGNet or GoogleNet.
10	Implement a simple RNN for review classification using IMDB dataset.Analyze and visualize the performance change while using LSTM and GRU instead of simple RNN.
11	Implement time series forecasting prediction for NIFTY-50 dataset.
12	Implement a shallow auto encoder and decoder network for machine translation(by using any dataset in Kaggle such as English to Hindi neural translation dataset).

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 machine learning models in python for regression, classification and clustering tasks using algorithms such as naïve bayes, decision tree, ANN.	**K3**
CO2	Implement a deep learning model for computer vision tasks and increase the performance of the model through hyper parameter tuning.	**K3**
CO3	Develop a recurrent neural network for sequence modelling such as text or time series data and analyse the performance change through LSTM and GRU.	**K3**
CO4	Develop an algorithm for machine translation using python.	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2						2
CO2	3	3	3	1	2	2						2
CO3	3	3	3	2	2	2						2
CO4	3	3	3	2	2	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	Hands–On Machine Learning with Scikit–Learn and TensorFlow	Aurelien Geron	O'Reilly	3/e, 2022
2	Deep Learning with Python	François Chollet	Manning	2/e, 2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning	EthemAlpaydin	MIT Press	2/e, 2010
2	The Engineering of Knowledge-Based Systems	Goodfellow, I., Bengio,Y., and Courville, A.	MIT Press	1/e, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	**https://c.d2l.ai/berkeley-stat-157/**
2	**https://onlinecourses.nptel.ac.in/noc20_cs95/preview**
3	**https://nptel.ac.in/courses/108105103**

Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**
   - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
   - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.
2. **Conduct of Experiments (7 Marks)**
   - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
   - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
   - Teamwork: Collaboration and participation in group experiments.
3. **Lab Reports and Record Keeping (6 Marks)**
   - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
   - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.
4. **Viva Voce (5 Marks)**
   - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

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

Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**
   - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
   - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
   - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
   - Creativity and logic in algorithm or experimental design.

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

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

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

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

4. **Viva Voce (10 Marks)**

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

5. **Record (5 Marks)**

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

SEMESTER 6

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence and Machine Learning)

SEMESTER S6

INTRODUCTION TO NATURAL LANGUAGE PROCESSING

Course Code	PCCMT601	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 fundamental NLP tasks, applications, and language processing challenges.
2. To explore basic machine learning techniques, including neural networks and transformers, used in NLP.
3. To impart rule-based and machine learning approaches, emphasizing pre-trained models and transfer learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to NLP:-** NLP Tasks and Applications; Language-Building Blocks; Challenges of NLP; Machine Learning for NLP - Neural Networks, Transformers; Approaches to NLP - Transformer-Based NLP, Pre-trained Language Models; Ethics in NLP	**8**
2	**Pre-Processing Text Representation & Information Extraction:-** NLP System Pipeline - Modern Approaches, Including Transfer Learning; Text Representation - Word Embeddings (Word2Vec, GloVe, FastText), Transformer-based Embeddings (BERT, GPT). **Advanced Feature Engineering techniques:-** Information Extraction - Deep Learning approaches, Relation Extraction using Transformers; Advanced NER techniques.	**12**
3	**Text Classification, Relation Detection, and Information Retrieval:-** Text Classification - Transformer-Based Classifiers, Fine-Tuning Pre-Trained Models; Relation Detection and Classification - Supervised and Lightly Supervised Approaches, Evaluation of Relation Analysis Systems;	**12**

	Information Retrieval - Term weighting, Document scoring, Inverted Index, Neural IR, Transformer-Based IR models, Evaluation of IR Systems.	
4	**QA Systems, Machine Translation, and Large Language Models:-** Question-Answering Systems - Transformer-Based QA models, Open-Domain QA; Machine Translation - Neural Machine Translation (NMT), Transformer-Based NMT, Multilingual NLP Models; Introduction to Large Language Models - GPT-3, GPT-4, and their applications	**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	Explain foundational NLP tasks, challenges, and the integration of neural networks and transformers in modern NLP systems.	**K2**
CO2	Demonstrate advanced pre-processing techniques, feature engineering, and text representation methods, including transformer-based models.	**K3**
CO3	Use NLP models for text classification, relation detection, and information retrieval, focusing on the use of transformers and large language models.	**K3**
CO4	Demonstrate NLP applications such as machine translation and QA systems using state-of-the-art large language models, considering ethical implications.	**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*

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 Education	2/e, 2013
2	Foundations of Statistical Natural Language Processing	Christopher Manning, Hinrich Schütze	MIT 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	Natural Language Understanding	James Allen	Pearson	1/e, 1994
2	Natural Language Processing with Transformers: Building Language Applications With Hugging Face	Leandro Von Werra, Lewis Tunstall and Thomas Wolf	O'Reilly Media	1/e, 2022
3	Natural language processing: a Paninian perspective	Akshae Bharti, Vineet Chaitanya and Rajeev Sangal	Prentice Hall India	1/e, 1995

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_cs45/preview

SEMESTER S6

GENERATIVE AI

Course Code	**PCCMT602**	**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)	PCCMT503	**Course Type**	Theory

Course Objectives:

1. To impart the foundational understanding about the principles and concepts behind generative AI models, including GANs, VAEs and Transformer-based architectures like GPT.
2. To educate the learners to apply ethical considerations in the use of generative AI for the responsible use and deployment of generative models.
3. To enable the learners to understand the significance of prompt engineering and cost optimization in generative AI.

SYLLABUS

Module No.	**Syllabus Description**	**Contact Hours**
1	Generative Modeling - Introduction, Generative Vs. Discriminative Modeling, Advances in Machine Learning, The Rise of Generative Modeling, The Generative Modeling Framework, Challenges of Generative Modeling, Ethical Considerations in Generative AI, Bias and Fairness in Generative AI systems, responsible use and deployment of generative models.	**8**
2	Autoencoders - Autoencoders, The Encoder, The Decoder, Joining the Encoder to the Decoder, Analysis of Autoencoder, Variational Autoencoders; Kullback–Leibler (KL) divergence loss function; Generative Adversarial Network - Introduction to GANs, The Discriminator, The Generator, Training the GAN, GAN Challenges, Oscillating Loss, Mode Collapse, Uninformative Loss, Hyper parameters.	**10**

3	Recurrent Neural Network (RNN). Architecture of RNN, Long Short-Term Memory (LSTM), Architecture of LSTM, Gated Recurrent Unit (GRU), Architecture of GRU, Encoder-Decoder Models, Question-Answer Generator using RNN and Encoder-Decoder, Architecture, Attention mechanisms, Transformer Architecture, Self Attention, Analysis of the Transformer, BERT, GPT-2 ,Large Language Models (LLM).	**10**
4	Cost Optimization in the Development and Operation of Generative AI Applications, Fine Tuning and customizability, Parameter Efficient Fine Tuning Methods, Prompt Tuning, Prefix Tuning, P-Tuning, IA3, Low-Rank Adaptation, Prompt Engineering, Clear and Direct Prompts, Adding Qualifying Words for Brief Responses, Breaking Down the Request, In-context learning (ICL) in LLMs.	**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 difference between generative and discriminative models and the need to ensure responsible use of generative models.	**K2**
CO2	Use Variational Autoencoders and GAN to generate new content and enhance existing data.	**K3**
CO3	Solve real life problems using various neural network based language models.	**K3**
CO4	Illustrate the significance of Cost Optimization and Prompt Engineering in Generative AI 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	2	2	2	-	2	-	3	-	-	-	2
CO2	3	3	3	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	Generative Deep Learning	David Foster	O’Reily	1/e, 2019
2	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT press	1/e, 2016
3.	Large Language Model-Based Solutions: How to Deliver Value with Cost-Effective Generative AI Applications.	Shreyas Subramanian	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	Deep Learning Illustrated	Jon Krohn, Grant Beyleveld, Aglae Bassens	Pearson	1/e, 2020
2	Prompt Engineering for Generative AI	James Phoenix, Mike Taylor	O'Reilly	1/e, 2024
3	GANs in Action: Deep learning with Generative Adversarial Networks	Jakub Langgr, Vladimir Bok	Manning	1/e, 2019

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	Deep Generative Models: An Introduction (https://www.youtube.com/watch?v=v_ksUIpToGk)
2	Generative Adversarial Networks-Part 01 (https://www.youtube.com/watch?v=LMpyYPzxQ9w)
3	Introduction to Transformer Architecture (https://www.youtube.com/watch?v=cVbGNL0N2RI)
4	Generative Adversarial Networks-Part 02 (https://www.youtube.com/watch?v=X3SJ2mRodF0)

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

TOPICS IN COMPUTING SYSTEMS

Course Code	**PECMT632**	**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	**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	**9**

	Virtualization. Virtual clusters and resource management. Live VM migration steps, migration of memory, files and network resources.	
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

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 Schema,	9

	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	**10**

	Cryptosystems, Applications for Public-Key Cryptosystems, 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.	**10**
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]	**12**

	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.	**11**
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.	**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

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

DATA HANDLING AND VISUALIZATION

Course Code	PECMT695	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	40
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To introduce students to fundamental knowledge in various data handling and visualization techniques using R programming language.
2. To highlight the security aspects involved in data visualization.
3. To apply data visualization tools in solving complex problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Visualization – Need and purpose, External representation – Difficulty in Validation, Data Abstraction: Dataset types – Attribute types – Semantics, Task Abstraction – Analyse, Produce, Search, Query, Four levels of validation – Validation approaches – Validation examples. Marks and Channels. Data Visualization tools.	10
2	Arrange tables-: Categorical regions – Spatial axis orientation – Spatial layout density, Arrange spatial data: Geometry – Scalar fields – Vector fields – Tensor fields. Arrange networks and trees-: Connections, Matrix views – Containment, Map color: Color theory, Color maps and other channels	12
3	The R Environment - Command Line Interface and Batch processing, R Packages, Variables, Data Types, Vectors - vector operations and factor	10

	vectors, List - operations, Data Frames, Matrices and arrays, Control Statements, Branching and looping - For loops, While loops, Controlling loops. Functions - Function as arguments, Named arguments.	
4	Importing data from Text files and other software, Exporting data, importing data from databases - Database Connection packages, Missing Data - NA, NULL, Transformations, Binning Data, Subsets, summarizing functions. Data Cleaning, Finding and removing Duplicates, Sorting, Analyzing Data, Summary statistics, Statistical Tests- Continuous Data, Discrete Data, Power tests, Common distributions - type arguments. Probability distributions, Normal distributions.	**12**

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

1. Visualizing Demographic Data

   Use R to import demographic data (e.g., census data) and create visualizations that highlight population distribution, age groups, education levels, and income categories across different regions.

2. Financial Market Analysis

   Import stock market data and create visualizations that help analyze market trends, price movements, and trading volumes.

3. Visualizing Traffic Patterns

   Import traffic data and visualize patterns of vehicle movement, congestion areas, and the impact of different factors like time of day or weather.

End Semester Examination Marks (ESE):

In Part A, all questions need 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	Summarize the key techniques and theory used in visualization	**K2**
CO2	Design and evaluate various methodologies present in data visualization.	**K5**
CO3	Illustrate uses of conditional and iterative statements in R programs.	**K3**
CO4	Evaluate the use of Probability distributions and basic statistical functions with R programs	**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							3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Visualization Analysis and Design	Tamara Munzner	CRC Press	1/e,2014
2	R Data Visualization Cookbook	Atmajitsinh Gohil	Packt	1/e, 2015
3	R in a Nutshell	Joseph Adler	O'reilly	2/e, 2012
4	Security Data Visualization: Graphical Techniques for Network Analysis	Greg Conti	NoStarch Press Inc	1/e, 2007

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Designing Data Visualizations: Representing Informational Relationships	Julie Steele, Noah Iliinsky	O'Reilly.	1/e, 2011
2	R for Everyone- Advanced analytics and graphics, Addison Wesley data analytics series, Pearson	Jared P Lander	Pearson	1/e, 2014
3	Data Visualization: A Successful Design Process	Andy Kirk	Packt	1/e, 2014

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://www.youtube.com/watch?v=qdnM8Fpvdqc
2	https://www.youtube.com/watch?v=MUP2m46uw8I

SEMESTER S6

CONCEPTS IN DATA ANALYTICS

Course Code	PBCMT604	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 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, Association Between Ordinal and Continuous Variables, Visualization of Variables from Different Scales.	**9**

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**

Suggestion on Project Topics

Students may select a suitable real world scenario and perform data analysis using appropriate tools. A few sample topics are given below.

1. Develop a system to analyse social media posts for sentiment and detect trends over time. The system will gather posts from various social media platforms, analyse the sentiment of these posts, and identify trending topics or keywords. The insights gained can be used for market research, brand monitoring, or understanding public opinion.
2. Develop a system to detect and analyse topics from social media posts. The system will collect posts related to specific keywords or hashtags, perform topic modelling to identify and categorize main discussion themes, and visualize topic trends over time.
3. Develop a system to analyse and mine data from student marks to uncover patterns, trends, and insights related to academic performance. The system will process historical student performance data to identify factors influencing grades, detect patterns in performance, and provide predictive analytics to assist in improving student outcomes.

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 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	Apply appropriate clustering and classification algorithms for various applications and extend data analytics methods to the new domains of data.	**K3**
CO5	Demonstrate the basics of text analytics and text classification.	**K3**
CO6	Design and implement real world applications in the domain of data analytics.	**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
CO4	3	3	3									3
CO5	3	3	3									
CO6	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	Introduction to Statistics and Data Analysis	Christian Heumann and Michael Schomaker	Springer	1/e, 2016
2	Data Mining Concepts and Techniques	Jiawei Han and Micheline Kamber	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, Prabhakar Raghavan, Hinrich Schutze	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…)	
Sl. No.	**Link ID**
1	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs15/
2	https://onlinecourses.swayam2.ac.in/cec19_cs01/preview

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 Keying	**9**

	(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	**8**

	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	**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

ARTIFICIAL INTELLIGENCE

Course Code	**OECMT615**	**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,	**8**

	propositional vs. first order inference, unification & lifts forward chaining, Backward chaining.	
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	Artificial Intelligence – 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 S6

NATURAL LANGUAGE PROCESSING LAB

Course Code	**PCCML607**	**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 learners to design and implement natural language processing systems for real world applications.
2. To enable the learners to experience hands-on knowledge on natural language processing.

Expt. No.	Experiments
1	Acquire text data from a standard dataset such as “20 Newsgroup” (https://www.kaggle.com/datasets/crawford/20-newsgroups). Perform text extraction, clean-up, and pre-processing tasks such as tokenization, stemming, lemmatization, and stop-word removal.
2	Implement basic vectorization approaches like One-Hot Encoding, Bag of Words, and TF-IDF, comparing these methods on a sample dataset.
3	Explore word embeddings using Word2Vec, GloVe, and Doc2Vec. Visualize word embeddings and analyse their effectiveness in capturing semantic relationships.
4	Create a pipeline for text classification, including feature extraction and model selection (e.g., Naïve Bayes, Logistic Regression, SVM). Apply it to a sentiment analysis task.
5	Tune hyper-parameters for Naïve Bayes, Logistic Regression, and SVM models to improve sentiment classification accuracy
6	Develop a Named Entity Recognition (NER) system using sequence labelling techniques that handles ambiguity in NER, Evaluate the NER model.
7	Build a general IE pipeline, focusing on extracting structured information such as names, dates, and relations from unstructured text.
8	Implement supervised learning approaches to relation detection and classification. Apply them to extract relationships between entities in a text corpus.
9	Build an inverted index, applying term weighting and document scoring techniques. Use it to evaluate the performance of an IR system on a sample dataset.
10	Implement a basic neural network model for machine translation and a factoid question-answering system, including question processing, passage retrieval, and answer generation.
	Practice Questions (Optional)
1	Load a text dataset. Apply tokenization, stop-word removal, and stemming/lemmatization. Compare the results before and after pre-processing.
2	Convert a text dataset into feature vectors using One-Hot Encoding and TF-IDF. Compare their effectiveness and sparsity.

3	Train Word2Vec embeddings on a dataset. Visualize using PCA or t-SNE. Analyse word relationships.
4	Implement a Naïve Bayes classifier for sentiment analysis. Test different Laplace smoothing values and observe the impact.
5	Train a logistic regression model on a text dataset. Compare L1 and L2 regularization effects on performance.
6	Implement an SVM model using linear, polynomial, and RBF kernels. Compare their performance on sentiment classification
7	Develop an NER system using sequence labelling. Test with different features (e.g., POS tags) and evaluate with F1 score.
8	Handle ambiguous entities (e.g., "Apple") in an NER system. Implement strategies to resolve ambiguity and evaluate effectiveness.
9	Build an information extraction pipeline to extract entities and relationships from unstructured text. Evaluate extraction accuracy.
10	Implement a supervised model for relation detection and classification. Evaluate its performance using precision, recall, and F1 score.
11	Construct an inverted index for a text corpus. Implement search functionality for keyword retrieval and analyse performance.
12	Implement TF-IDF for term weighting and document scoring. Test with a sample query and evaluate the results
13	Develop a basic factoid question-answering system. Implement question processing, passage retrieval, and answer extraction.
14	Implement a neural network model for machine translation using a parallel corpus. Train and evaluate the model's translation accuracy.

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 explain foundational concepts and techniques in Natural Language Processing, including text pre-processing and vectorization.	**K3**
CO2	Implement and apply various text representation techniques, such as One-Hot Encoding and TF-IDF, in practical NLP tasks.	**K3**
CO3	Study the effectiveness of different machine learning models for tasks like text classification and named entity recognition.	**K3**
CO4	Evaluate NLP models and pipelines using relevant metrics such as precision, recall, and F1 score.	**K4**
CO5	Design and develop advanced NLP systems, including question-answering and machine translation models.	**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
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	Natural Language Processing with Python	Steven Bird, Ewan Klein and Edward Loper	O'Reilly Media	1/e, 2009
2	Natural Language Processing: Python and NLTK	Nitin Hardeniya, Jacob Perkins, Deepti Chopra, Nisheeth Joshi, Iti Mathur	Packt Publishing	1/e, 2016
3	Speech and Language Processing	Daniel Jurafsky and James H. Martin	Pearson Education India	2/e, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Natural Language Understanding	James Allen	Pearson	2/e, 1994
2	Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems	Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta and Harshit Surana	O'Reilly Media	1/e, 2020

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://www.youtube.com/playlist?list=PLoROMvodv4rMFqRtEuo6SGjY4XbRIVRd4

Continuous Assessment (25 Marks)

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

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

2. **Conduct of Experiments (7 Marks)**

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

3. **Lab Reports and Record Keeping (6 Marks)**

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

4. **Viva Voce (5 Marks)**

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

4. **Viva Voce (10 Marks)**

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

5. **Record (5 Marks)**

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

SEMESTER 7

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence and Machine Learning)

SEMESTER S7

FORMAL METHODS IN SOFTWARE ENGINEERING

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

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

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction :-** Stages in software development; software defects –causes of software defects; techniques for dealing with software defects-Testing and verification, formal methods and tools.	9
2	**Ensuring reliability in the design phase :-** Conceptual modelling, the tool Alloy, conceptual modelling in Alloy, Analysing Alloy models, Fixing bugs in modelling, How Alloy works? Show that the Konigsberg Bridge Problem has no solution.	9
3	**Verification by Model Checking :-** Verifier for Concurrent C (VCC): a Hoare-Triple- based tool for Verifying Concurrent C, intra procedure verification of programs, ghost statements.	9
4	**Program Verification:-** Inter-procedure verification of programs in VCC, function contracts, pure functions, loop invariants, proving total correctness of programs in VCC.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the need and use of formal methods and tools in software engineering.	**K2**
CO2	Demonstrate conceptual modelling of systems using *Alloy*.	**K3**
CO3	Illustrate the process of proving correctness of code using Hoare-Triple based weakest precondition analysis	**K3**
CO4	Demonstrate program verification using VCC.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Software Abstractions	Daniel Jackson	MIT Press	2011

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

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

SEMESTER S7

WEB PROGRAMMING

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

Course Code	PECST742	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Asynchronous JavaScript and XML - AJAX : Making Asynchronous Requests , Complete Control over AJAX , Cross-Origin Resource Sharing **JavaScript library - jQuery** - jQuery Foundations - Including jQuery, jQuery Selectors, Common Element Manipulations in jQuery, Event Handling in jQuery	
3	**JavaScript runtime environment : Node.js -** The Architecture of Node.js, Working with Node.js, Adding Express to Node.js; **Server-side programming language : PHP** - What Is Server-Side Development? Quick tour of PHP, Program Control , Functions , Arrays , Classes and Objects in PHP , Object-Oriented Design ; **Rendering HTML : React -** ReactJS Foundations : The Philosophy of React, What is a component? Built- in components, User- defined components - Types of components, Function Components, Differences between Function and Class Components	**9**
4	**SPA** – Basics, Angular JS; **Working with databases** - Databases and Web Development, SQL, Database APIs, Accessing MySQL in PHP; **Web Application Design** - Real World Web Software Design, Principle of Layering , Software Design Patterns in the Web Context, Testing; **Web services** - Overview of Web Services - SOAP Services, REST Services, An Example Web Service, Web server - hosting options	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop structured web pages with HTML5 and style them using CSS techniques, including positioning, media queries, and the box model.	**K3**
CO2	Write client-side scripts using JavaScript and utilize jQuery for DOM manipulation, event handling, and AJAX requests to create responsive and interactive user interfaces.	**K3**
CO3	Build and deploy server-side applications using Node.js, Express, and PHP, and integrate databases using SQL to store and retrieve data for dynamic content generation.	**K3**
CO4	Utilize React for building component-based single-page applications (SPAs), understanding the fundamental principles of component architecture, and leveraging AngularJS for web application development.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Web Development	Randy Connolly, Ricardo Hoar	Pearson	1/e, 2017
2	Building User Interfaces with ReactJS - An Approachable Guide	Chris Minnick	Wiley	1/e, 2022
3	Internet & World Wide Web - How to Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson	1/e, 2011
4	SPA Design and Architecture: Understanding Single Page Web Applications	Emmit Scott	Manning Publications	1/e, 2015

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

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

SEMESTER S7

BIOINFORMATICS

Course Code	PECST743	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	**R FOR BIOINFORMATICS** Variables, Data types, control flow constructs, String manipulation, Pattern Matching, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation, packages for sequence alignment, FASTA, BLAST (Bioconductor, msa, Biostrings etc.) **Indicative Laboratory/Microproject Tasks** Biological Databases, Sequence alignment: BLAST family of programs, FASTA, ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Related Programs in R.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the Basics of Bioinformatics	**K2**
CO2	Use various biological databases and apply sequence alignment techniques	**K3**
CO3	Use molecular phylogenetics to identify evolutionary relationships among various biological species	**K3**
CO4	Apply the concept of combinatorial pattern matching in bioinformatics	**K3**
CO5	Use R language and packages to solve bioinformatics problems	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	An Introduction to Bioinformatics Algorithms,	N. C. Jones and P. A. Pevzner,	MIT Press, 2004	1/e, 2004
2	Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools	Supratim Choudhuri	Academic Press	1/e, 2014
3	R Programming for Bioinformatics	Robert Gentleman	CRC Press	1/e, 2009

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

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

SEMESTER S7

INFORMATION SECURITY

(Common to CS/CM/CA/AM)

Course Code	PECST744	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PECST637	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	Security in Networks - Threats in networks, Network Security Controls - Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP, S/MIME.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the goals, services and mechanisms related to information security.	**K2**
CO2	Identify the different types of threats and attacks and the design strategies to mitigate the attacks	**K2**
CO3	Describe the information security practices within an organization, ensuring data protection and compliance with industry standards and legal requirements.	**K2**
CO4	Discuss the skills to enhance network security, protect data in transit, and respond to potential threats effectively	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Network security and Cryptography	B. Menezes	Cengage	1/e, 2010
2	Cryptography And Network Security Principles And Practice	William Stallings	Pearson	5/e, 2011

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

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

SEMESTER S7

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**	10

	Bitcoin: Components, Nodes in Bitcoin network, Transactions and memory 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)	**9**

	Approximation Schemes - Polynomial-time approximation schemes (PTAS), 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 S6

REINFORCEMENT LEARNING

Course Code	**PECMT745**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	40
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the concepts and components of reinforcement learning.
2. To enable the learners to develop real life solutions using reinforcement learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:**Deep Reinforcement Learning, Suitability of Reinforcement Learning, Components of Reinforcement Learning - Agent, Environment, Observations, Actions.Examples - The Bandit Walk Environment, Agent-Environment interaction cycle. **Markov Decision Process (MDP):**The Engine of the Environment - States, Actions, Transition Function, Reward Signal.	**8**
2	**Planning:**Objective of a decision making agent-environment, Plan, Optimal policy, Comparison of Policies, Bellman Equation/State-Value Function, Action-Value Function, Action-Advantage Function, Optimality. **Exploitation and Exploration of Reinforcement Learning:**Bandits- Single State Decision Problem (Multi-Armed Bandit(MAB) problem), The cost of exploration, Approaches to solve MAB environments, Greedy Strategy, Random Strategy, Epsilon-Greedy Strategy, Decaying Epsilon-Greedy Strategy, Optimistic Initialization Strategy, Strategic Exploration, Softmax Exploration Strategy, Upper Confidence Bound (UCB) Equation Strategy, Thompson Sampling Strategy.	**10**

3	**Model Free Reinforcement Learning:**Monte Carlo Prediction (MC), First-Visit MC (FVMC), Every-Visit MC (EVMC), Temporal Difference Learning (TD), Learning to Estimate from Multiple Steps, N-step TD Learning, Forward-View TD(λ), Backward-View TD(λ), Generalized Policy Iteration(GPI), Monte Carlo Control, SARSA: On-Policy TD control, Q-learning: Off-Policy TD control, Double Q-learning, SARSA(λ), Watkins's Q(λ). **Model Based Reinforcement Learning:**Dyna-Q, Trajectory sampling	**10**
4	**Value Based Reinforcement Learning:**Deep Reinforcement Learning Agents with Sequential Feedback, Evaluative Feedback, Sampled Feedback, Function Approximation for Reinforcement Learning - High-Dimensional State and Action Spaces, Continuous State and Action Spaces, State-Value Function and Action-Value Function with and without Function Approximation, Neural Fitted Q (NFQ), Deep Q-Network (DQN), Double Deep-Q Networks (DDQN), Duelling DDQN, Prioritized Experience Replay (PER).	**8**

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. Develop a reinforcement learning-based model to autonomously navigate a drone through an environment with obstacles. The drone will learn to reach a designated target location while avoiding collisions and optimizing its path. The environment can be simulated in a 2D or 3D space, using a platform like OpenAI Gym, ROS (Robot Operating System), or a custom simulation environment.
2. Develop a model-free reinforcement learning agent that can autonomously park a car in various parking scenarios. The agent will learn to maneuver a car into a parking spot by taking actions like steering, accelerating, and braking, without prior knowledge of the environment's dynamics. Use a platform like OpenAI Gym for simulation.

End Semester Examination Marks (ESE):

In Part A, all questions need 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	Demonstrate various Components of Reinforcement Learning	**K2**
CO2	Make use of various exploration and exploitation strategies.	**K3**
CO3	Apply Model based and Model Free Prediction techniques	**K3**
CO4	Evaluate different value based Reinforcement Learning Algorithms.	**K5**

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										
CO2	3	3	3		3				3			2
CO3	3	3	3		3				3			2
CO4	3	3	3		3				3			2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Grokking Deep Reinforcement Learning	Miguel Morales	Manning Publications	1/e, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Reinforcement learning: An Introduction	Richard S. Sutton and Andrew G. Barto	MIT Press	2/e, 2019
2	Reinforcement Learning, State-of-the-Art, Adaptation	Marco Wiering and Martijn van Otterlo(Eds.)	Springer	1/e, 2012
3	Foundations of Deep Reinforcement Learning: Theory and Practice in Python	Laura Graesser and Wah Loon Keng	Pearson India	1/e, 2022

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc19_cs55/preview

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 theoretical bounds.	9

	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 added noise and measure the performance of the expander code in correcting errors. Evaluate the BER, code rate, and error correction	**9**

	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 Engineering,	9

	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.	**10**

	Privacy preservation - Attack models, Privacy-preserving Learning, Differential privacy- Working, The Laplace Mechanism, Introduction to 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 7

COMPUTATIONAL LINGUISTICS

Course Code	PECMT753	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 foundational principles and history of computational linguistics and key linguistic subfields.
2. To enable the learners to develop skills to create and analyse models for syntactic and semantic tasks, focusing on ambiguity resolution.
3. To provide the learners an experience in designing and implementing NLP applications using modern computational techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Computational Linguistics**:- Definition, scope, and history ,Overview of linguistic subfields- Phonetics, Phonology, Morphology, Syntax, Semantics, and Pragmatics. **Linguistic Theories and Models**:- Structural linguistics and its influence on computational methods. **Chomsky's Hierarchy**:- Regular languages, context-free grammars, and their computational relevance.	9
2	**Goals and Methods of Computational Linguistics:-** Syntax and Parsing,Structural Hierarchy and Coping with Syntactic Ambiguity.Semantic Representation - Logicist Approaches and Statistical Semantics, Mapping Syntactic Trees to Logical Forms, Handling Semantic Ambiguity and Under-specification.	9
3	**Word Sense Disambiguation (WSD):-** Techniques for resolving word meaning ambiguities. Distributional Semantics-Vector space models and word embeddings for capturing semantic meaning.Coreference Resolution - Linking expressions referring to the same entity.Discourse Analysis - Analysing text structure and coherence, including	9

	anaphora and discourse relations.Pragmatic Enrichment - Integrating context and world knowledge into computational models.	
4	**Natural Language Applications:-** Machine Translation, Sentiment analysis, Chatbots and dialogue systems, Text extraction and summarization. Natural language user interfaces - Text-based question answering, knowledge-based question answering, Voice-based web services and assistants.	**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	Grasp the foundational concepts, scope, and linguistic subfields essential to computational linguistics.	**K2**
CO2	Examine and utilize linguistic theories and Chomsky's Hierarchy in computational language processing.	**K3**
CO3	Construct and assess models for syntactic and semantic tasks, addressing linguistic ambiguities.	**K3**
CO4	Design and develop NLP applications like machine translation, sentiment analysis, and chatbots using advanced techniques.	**K3**

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

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

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

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Speech and Language Processing	Daniel Jurafsky, James H. Martin	Pearson	2/e, 2013
2	Introduction to Natural Language Processing	Jacob Eisenstein	MIT Press	1/e, 2019
3	Computational Linguistics : An Introduction	Ralph Grishman	Cambridge University Press	1/e, 1986

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Handbook of Computational Linguistics and Natural Language Processing	Alexander Clark, Chris Fox and Shalom Lappin	Wiley-Blackwell	1/e, 2012
2	Deep Learning for Natural Language Processing	Stephan Raaijmakers	Manning Publications	1/e, 2020

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_cs45/preview

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	**PECST756**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To equip students with a general purpose tool to analyze strategic behavior in multi-agent interaction
2. To discuss the mathematical details of analyzing and designing strategic interactions.

SYLLABUS

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

4	Introduction to VCG mechanism, VCG in Combinatorial allocations, 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/

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 Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

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

End Semester Examination Marks (ESE):

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. • Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand IoT trends, architecture layers, and key technologies, including Device-to-Device, Device-to-Cloud, and Cloud-to-Cloud integration.	**K2**
CO2	Identify and differentiate between various IoT infrastructure, service discovery, and integration protocols, as well as their roles in IoT ecosystems.	**K3**
CO3	Develop simple IoT projects using Raspberry Pi, integrating sensors, actuators, and protocols such as MQTT and HTTP to create interactive systems.	**K3**
CO4	Evaluate cloud and edge computing models, including hybrid and federated environments, and apply these concepts to build scalable and efficient IoT applications.	**K5**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Internet of Things	Pethuru Raj, Anupama C. Raman	CRC Press	1/e, 2017
2	Mastering Internet of Things	Peter Waher	Pact	1/e, 2018

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

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

SEMESTER S7

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	11

	Tasks: Handle missing values, outliers, and noisy data. Apply 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.	**11**
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.	**11**
4	**Algorithms for Big Data and Scalability :-**	**11**

	Introduction to Big Data Algorithms - Overview of big data challenges and 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/
2	https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044
3	https://www.coursera.org/learn/data-security-privacy#modules
4	https://nptel.ac.in/courses/106105217
	https://archive.nptel.ac.in/courses/106/106/106106156/

SEMESTER S7

CLOUD COMPUTING

Course Code	**OECST722**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Cloud Computing, Types of Cloud, Working of Cloud Computing, Cloud Computing Architecture - Cloud Computing Technology, Cloud Architecture, Cloud Modelling and Design.	**8**
2	Virtualization - Foundations, Grid, Cloud And Virtualization, Virtualization And Cloud Computing; Data Storage And Cloud Computing - Data Storage, Cloud Storage, Cloud Storage from LANs to WANs.	**9**
3	Cloud Computing Services - Cloud Computing Elements, Understanding Services and Applications by Type, Cloud Services; Cloud Computing and Security - Risks in Cloud Computing, Data Security in Cloud, Cloud Security Services.	**10**
4	Cloud Computing Tools - Tools and Technologies for Cloud, Apache Hadoop, Cloud Tools; Cloud Applications - Moving Applications to the Cloud, Microsoft Cloud Services, Google Cloud Applications, Amazon Cloud Services.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Articulate the fundamental concepts of cloud computing, its types, and how cloud computing architecture operates.	**K2**
CO2	Understand and describe the foundations of virtualization, its relationship with cloud computing.	**K2**
CO3	Describe various cloud computing services, understand the different service models, and identify potential risks.	**K3**
CO4	Demonstrate proficiency in using cloud computing tools such as Apache Hadoop, and deploy applications using popular cloud platforms.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Computing: A Practical Approach for Learning and Implementation	A.Srinivasan, J.Suresh	Pearson	1/e, 2014

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

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

SEMESTER S7

SOFTWARE ENGINEERING

Course Code	OECST723	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Engineering and Process Models -** Software engineering, Software characteristics and types, Layers of Software Engineering-Process, Methods, Tools and Quality focus. Software Process models – Waterfall, Prototype, Spiral, Incremental, Agile model – Values and Principles. **Requirement engineering -** Functional, Non-functional, System and User requirements. Requirement elicitation techniques, Requirement validation, Feasibility analysis and its types, SRS document characteristics and its structure. *Case study:* SRS for College Library Management Software	9
2	**Software design -** Software architecture and its importance, Software architecture patterns: Component and Connector, Layered, Repository, Client-Server, Publish-Subscribe, Functional independence – Coupling and Cohesion *Case study:* Ariane launch failure **Object Oriented Software Design -** UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram, Sequence diagram *Case Studies*: Voice mail system, ATM Example	10

	Software pattern - Model View Controller, Creational Design Pattern types – Factory method, Abstract Factory method, Singleton method, Prototype method, Builder method. Structural Design Pattern and its types – Adapter, Bridge, Proxy, Composite, Decorator, Façade, Flyweight. Behavioral Design Pattern	
3	**Coding, Testing and Maintenance:** **Coding guidelines** - Code review, Code walkthrough and Code inspection, Code debugging and its methods. **Testing -** Unit testing , Integration testing, System testing and its types, Black box testing and White box testing, Regression testing **Overview of DevOps and Code Management** - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD), *Case study* – Netflix. **Software maintenance and its types-** Adaptive, Preventive, Corrective and Perfective maintenance. Boehm's maintenance models (both legacy and non-legacy)	**10**
4	**Software Project Management -** Project size metrics – LOC, Function points and Object points. Cost estimation using Basic COCOMO. Risk management: Risk and its types, Risk monitoring and management model **Software Project Management -** Planning, Staffing, Organisational structures, Scheduling using Gantt chart. Software Configuration Management and its phases, Software Quality Management – ISO 9000, CMM, Six Sigma for software engineering.	**7**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	60

Course Outcomes (COs)

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

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

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

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

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

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

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

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

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/watch?v=Z6f9ckEElsU
2	https://www.youtube.com/watch?v=1xUz1fp23TQ
3	http://digimat.in/nptel/courses/video/106105150/L01.html
4	https://www.youtube.com/watch?v=v7KtPLhSMkU
2	https://archive.nptel.ac.in/courses/106/105/106105182/

SEMESTER S7

COMPUTER NETWORKS

Course Code	**OECST724**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To Introduce the core concepts of computer networking.
2. To Explore routing protocols and their role in network communication

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Comprehend the OSI and TCP/IP models, the functioning of different network layers, and the protocol stack used in computer networks.	**K2**
CO2	Evaluate various transmission media (copper, fiber, wireless), error detection/correction methods, and medium access control mechanisms in both wired and wireless LANs.	**K2**
CO3	Demonstrate a working knowledge of IPv4 and IPv6 addressing schemes, routing protocols (unicast and multicast), and apply them to network scenarios.	**K3**
CO4	Summarize UDP and TCP protocols, explain congestion control mechanisms, and understand client-server and peer-to-peer applications like HTTP, FTP, DNS, and P2P networks.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017

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

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

SEMESTER S7

MOBILE APPLICATION DEVELOPMENT

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

Course Code	**OECST725**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST204 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

(Artificial Intelligence and Machine Learning)

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

LARGE LANGUAGE MODELS

Course Code	**PECMT862**	**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)	PCCMT503, PCCMT602	**Course Type**	Theory

Course Objectives:

1. To introduce the learners to a foundation of Large Language Models.
2. To familiarize the students with various learning, tuning and generation mechanisms in LLM.
3. To give an idea how LLMs are used in production.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Large Language Models: An Introduction :-** Introduction, Natural Language, NLP and Language Models Evolution, The Era of Large Language Models, Large Language Models in Practice. **Language Models Pre-training :–** Encoder-Decoder Architecture, Attention Mechanism, Transformers, Data, Pre-trained LLM Design Choices, Commonly Used Pre-trained LLMs (*BERT, T5, GPT, Mixtral 8x7B*).	**9**
2	**Prompt-Based Learning :–** Introduction, Basics of Prompt-based Learning, Prompt Engineering, Answer Engineering, Multi-Prompt Inference. **LLM Adaptation and Utilization :–** Introduction, Instruction Tuning, Parameter-Efficient Fine-Tuning, Compute-Efficient Fine-Tuning, End-User Prompting.	**9**
3	**Tuning for LLM Alignment :–** Alignment Tuning, The Reinforcement Learning Framework, Mapping the RL Framework to LLMs with Human Feedback, Evolution of RLHF, Overcoming RLHF Challenges.	**9**

	LLM Challenges and Solutions :– Hallucination, Bias and Fairness, Toxicity, Privacy.	
4	**Retrieval-Augmented Generation :–** Introduction, Basics of RAG, Optimizing RAG, Enhancing RAG, Evaluating RAG Applications. **LLMs in Production :–** Introduction, LLM Applications, LLM Evaluation Metrics, LLM Benchmark Datasets, LLM Selection, Tooling for Application Development, Inference, LLMOps.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the concepts and need of Large Language Models.	**K2**
CO2	Illustrate various training, learning and generation methods in LLMs.	**K3**
CO3	Demonstrate various tuning mechanisms in LLMs, their challenges and solutions.	**K3**
CO4	Illustrate how LLM experimental models are prepared for production deployment.	**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*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Large Language Models: A Deep Dive	Uday kamath, Kevin Keenan, Garret Somers, and Sarah Sorenson	Springer	1/e, 2024

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Hands-On Large language Models	Jay Alammar and Maarten Grootendorst	O'Reilly	1/e, 2024
2	Build a Large Language Model (From Scratch)	Sebastian Raschka	Manning	1/e, 2024
3	Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs	Sinan Ozdemir	Addison-Wesley Professional	1/e, 2023
4	GPT-3 - Building Innovative NLP Products Using Large Language Models	Sandra Kublik and Shubham Saboo	O'Reilly	1/e, 2022
5	Introduction to Large Language Models	Tanmoy Chakraborty	Wiley	1/e, 2024

Video Links (NPTEL, SWAYAM…)	
Sl. No.	**Link ID**
1	https://youtu.be/W0c7jQezTDw?si=yw4j5Y4aoJ82mx55

SEMESTER 8

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 = 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)	**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 , Synthetic Full Backups, Application-Aware Backups	9

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.	9

	Handson : Crafting and optimizing prompts for specific tasks (e.g., text generation, summarization, Q&A); Using prompt engineering to fine-tune pre-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	9

	curves, Elliptic curve cryptosystems; Cryptographic Protocols - Key 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 Type**	Theory

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.	10
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.	10
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;	13

	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.	**11**

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

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

End Semester Examination Marks (ESE):

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. • Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply fundamental interaction design principles and human-computer interaction (HCI) concepts to create effective and intuitive user experiences in AR/VR applications.	**K3**
CO2	Demonstrate proficiency in using AR/VR hardware and software tools for the development and prototyping of immersive environments.	**K3**
CO3	Conduct user research and apply user-centered design methodologies to tailor AR/VR experiences that meet specific user needs and contexts.	**K4**
CO4	Implement advanced interaction techniques such as gesture controls, voice commands, haptic feedback, and eye gaze in AR/VR applications to enhance user engagement and immersion.	**K3**
CO5	Evaluate AR/VR projects, utilizing appropriate evaluation methods and metrics, and propose improvements based on user feedback and emerging trends in the field.	**K5**

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

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

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

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Augmented Reality - Theory, Design and Development	Chetankumar G Shetty	McGraw Hill	1/e, 2023
2	Virtual Reality and Augmented Reality: Myths and Realities	Ralf Doerner, Wolfgang Broll, Paul Grimm, and Bernhard Jung	Wiley	1/e, 2018
3	Augmented Reality: Principles and Practice	Dieter Schmalstieg and Tobias Hollerer	Pearson	1/e, 2016
4	Human–Computer Interaction	Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale	Pearson	3/e, 2004
5	Evaluating User Experience in Games: Concepts and Methods	Regina Bernhaupt	Springer	1/e, 2010
6	Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics	Bill Albert, Tom Tullis	Morgan Kaufman	2/e, 2013
7	The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything	Robert Scoble and Shel Israel	Patrick Brewster	1/e, 2016
8	Augmented Reality and Virtual Reality: The Power of AR and VR for Business	M. Claudia tom Dieck and Timothy Jung	Springer	1/e, 2019

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

SEMESTER S8

INTRODUCTION TO ALGORITHM

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

Course Code	OECST831	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Identify algorithm efficiency using asymptotic notation, compute complexities, and solve recurrence equations	**K3**
CO2	Use binary trees and search trees, and apply graph representations, BFS, DFS, and topological sorting	**K3**
CO3	Use divide and conquer to solve problems like finding maximum/minimum, binary search, quick sort, and merge sort	**K3**
CO4	Apply greedy strategies to solve the fractional knapsack problem, minimum cost spanning trees using Prim's and Kruskal's algorithms, and shortest paths with Dijkstra's algorithm.	**K3**
CO5	Understand the concepts of Dynamic Programming, Backtracking and Branch & Bound	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Algorithms	T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein	Prentice-Hall India	4/e, 2022
2	Fundamentals of Computer Algorithms	Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran	Universities Press	2/e, 2008

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

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

SEMESTER S8

WEB PROGRAMMING

Course Code	OECST832	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST203	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	JavaScript library - jQuery - jQuery Foundations - Including jQuery, jQuery Selectors, Common Element Manipulations in jQuery, Event Handling in jQuery	
3	**JavaScript runtime environment : Node.js -** The Architecture of Node.js, Working with Node.js, Adding Express to Node.js; **Server-side programming language : PHP** - What Is Server-Side Development? Quick tour of PHP, Program Control , Functions , Arrays , Classes and Objects in PHP , Object-Oriented Design ; **Rendering HTML : React -** ReactJS Foundations : The Philosophy of React, What is a component? Built- in components, User- defined components - Types of components, Function Components, Differences between Function and Class Components	**9**
4	**SPA** – Basics, Angular JS; **Working with databases -** Databases and Web Development, SQL, Database APIs, Accessing MySQL in PHP; **Web Application Design -** Real World Web Software Design, Principle of Layering , Software Design Patterns in the Web Context, Testing; **Web services** - Overview of Web Services - SOAP Services, REST Services, An Example Web Service, Web server - hosting options	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop structured web pages with HTML5 and style them using CSS techniques, including positioning, media queries, and the box model.	**K3**
CO2	Write client-side scripts using JavaScript and utilize jQuery for DOM manipulation, event handling, and AJAX requests to create responsive and interactive user interfaces.	**K3**
CO3	Build and deploy server-side applications using Node.js, Express, and PHP, and integrate databases using SQL to store and retrieve data for dynamic content generation.	**K3**
CO4	Utilize React for building component-based single-page applications (SPAs), understanding the fundamental principles of component architecture, and leveraging AngularJS for web application development.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Web Development	Randy Connolly, Ricardo Hoar	Pearson	1/e, 2017
2	Building User Interfaces with ReactJS - An Approachable Guide	Chris Minnick	Wiley	1/e, 2022
3	Internet & World Wide Web - How to Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson	1/e, 2011
4	SPA Design and Architecture: Understanding Single Page Web Applications	Emmit Scott	Manning Publications	1/e, 2015

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

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

SEMESTER S8

SOFTWARE TESTING

Course Code	OECST833	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To Cultivate proficiency in software testing methodologies and techniques.
2. To Foster expertise in software testing tools and technologies.

SYLLABUS

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

3	**Advanced White Box Testing & Security Testing:-** Graph Coverage Criteria - Node, edge, and path coverage; prime path and round trip coverage; Data Flow Criteria - du paths, du pairs, subsumption relationships; Graph Coverage for Code - Control flow graphs (CFGs) for complex structures (e.g., loops, exceptions); Graph Coverage for Design Elements - Call graphs, class inheritance testing, and coupling data-flow pairs; Security Testing - Fundamentals, tools (OWASP, Burp Suite), and their role in protecting modern applications; Case Study - Application of graph based testing and security testing using industry standard tools.	**10**
4	**Black Box Testing, Grey Box Testing, and Responsive Testing:-** Black Box Testing - Input space partitioning, domain testing, functional testing (equivalence class partitioning, boundary value analysis, decision tables, random testing); Grey Box Testing - Introduction, advantages, and methodologies (matrix testing, regression testing, orthogonal array testing); Performance Testing - Network latency testing, browser compatibility, responsive testing across multiple devices (e.g., BrowserStack, LambdaTest); Introduction to PEX - Symbolic execution, parameterized unit testing, symbolic execution trees, and their application; GenAI in Testing - Advanced use cases for predictive and responsive testing across devices and environments; Case Study- Implementation of black-box, grey-box, and responsive testing using PEX and AI-driven tools.	**10**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the ability to apply a range of software testing techniques, including unit testing using JUnit and automation tools.	**K2**
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	**K3**
CO3	Explain and apply graph coverage criteria in terms of control flow and data flow graphs to improve code quality.	**K2**
CO4	Demonstrate the importance of black-box approaches in terms of Domain and Functional Testing	**K3**
CO5	Illustrate the importance of security, compatibility, and performance testing across devices.	**K3**
CO6	Use advanced tools like PEX to perform symbolic execution and optimize test case generation and also leverage AI tools for automated test case prediction and symbolic execution with PEX.	**K3**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3	3	3							3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3		3							3
CO6	3	3	3	3	3							3

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Software Testing.	Paul Ammann, Jeff Offutt	Cambridge University Press	2/e, 2016
2	Software Testing and Quality Assurance: Theory and Practice	Kshirasagar Naik, Priyadarshi Tripathy	Wiley	1/e, 2008

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

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

SEMESTER S8

INTERNET OF THINGS

Course Code	OECST834	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to IoT - Physical Design of IoT, Logical Design of IoT, IoT levels and Deployment templates, Domain Specific IoT- Home automation, Energy, Agriculture, Health and lifestyle.	9
2	IoT and M2M-M2M, Difference between IoT and M2M, Software Defined Networking, Network Function virtualization, Need for IoT System Management, Simple Network Management Protocol (SNMP), NETCONF, YANG; LPWAN - LPWAN applications, LPWAN technologies, Cellular (3GPP) and Non 3GPP standards, Comparison of various protocols like Sigfox, LoRA, LoRAWAN, Weightless, NB-IoT, LTE-M.	9
3	Developing IoT - IoT design methodology, Case study on IoT system for weather monitoring, Motivations for using python, IoT-system Logical design using python, Python Packages of Interest for IoT - JSON, XML, HTTPlib & URLLib, SMTPLib	9
4	Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi, Interfacing an LED and switch with Raspberry Pi, Other IoT devices- PcDino, Beagle bone Black, Cubieboard, Data Analytics for IoT	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand domain-specific applications and apply the principles of IoT, including physical and logical design and deployment templates	**K2**
CO2	Use the principles of IoT and M2M, their differences, and key concepts like SDN, NFV, and essential management protocols.	**K3**
CO3	Develop and apply IoT design methodology, utilize Python for logical system design, and leverage key Python packages through practical case studies.	**K3**
CO4	Experiment using Raspberry Pi with Python to control LEDs and switches, interface with other IoT devices.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internet of Things - a Hands On Approach.	Arshdeep Bahga, Vijay Madisetti	Universities Press	1/e, 2016

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

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

SEMESTER S8

COMPUTER GRAPHICS

Course Code	OECST835	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objective:

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

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the principles of computer graphics and displays	**K2**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	**K3**
CO3	Illustrate 2D and 3D basic transformations and matrix representation	**K3**
CO4	Demonstrate different clipping algorithms and 3D viewing pipeline.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Graphics : Algorithms and Implementations	D. P. Mukherjee, Debasish Jana	PHI	1/e, 2010
2	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4/e, 2013

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

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