SEMESTER 3

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

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 1: Relevant topics from sections 2.7, 2.8, 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 1: 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 Outcomes		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- Analyze, 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 Authors	Name of the Publisher	Edition and Year
1	Probability and Statistics for Engineering and the Sciences	Devore J. L.	Cengage Learning	9th edition, 2016
2	Introduction to Probability Models	Sheldon M. Ross	Academic Press	13th edition, 2024

Reference Books

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

Video Links (NPTEL, SWAYAM...)

Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_mg[illegible]/preview
2	https://onlinecourses.nptel.ac.in/noc22_mg[illegible]/preview
3	https://archive.nptel.ac.in/courses/108/[illegible]/108[illegible]112
4	https://archive.nptel.ac.in/courses/108/[illegible]/108[illegible]112

SEMESTER S3

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

Course Code	PCAIT302	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. Introduce the fundamental principles of intelligent systems.
2. Impart a good insight into the characteristics of intelligent systems, knowledge representation schemes, logic and inference mechanisms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Artificial Intelligence:-** AI definition - Foundations of AI, History and applications of AI; Intelligent agents - Agents and Environments, The concept of rationality, The nature of environments, Structure of agents	7
2	**Problem Solving by Searching:-** Problem Solving Agents and examples - Searching for Solutions, Uninformed Search strategies - Breadth First Search, Uniform Cost Search, Depth First Search, Depth Limited Search, Iterative deepening DFS, Heuristic functions, Informed Search Strategies - Greedy Search, A* Search, AO* Search	13
3	**Advanced Search and Game Playing:-** Adversarial Search - Games, Optimal decisions in Games, MiniMax algorithm, Alpha_Beta pruning, Constraint Satisfaction Problems: Constraint Propagation, Inference in CSP's, Backtracking Search for CSP's	10
4	**Knowledge, Logic, and Reasoning Patterns:-** Knowledge Based Agents - The Wumpus World, Logic - Propositional Logic; First order logic - Syntax and Semantics, Using First Order Logic, Knowledge Engineering in First order logic; Inference in first order logic: Propositional vs. first order inference; Unification & Lifting, Forward chaining, Backward chaining	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	Explain the fundamental concepts of intelligent systems.	K2
CO2	Apply searching strategies for real time scenarios.	K3
CO3	Apply Constraint satisfaction problems for real time scenarios	K3
CO4	Apply methods of knowledge representation and processing within expert systems.	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	3	3	3	3								2
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	Artificial Intelligence – A Modern Approach	Stuart Russell, Peter Norvig	Pearson Education	4th, 2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence: A new Synthesis	J. Nilsson	Elsevier Publishers	1st, 1998
2	Computational Intelligence - A logical approach	David Poole, Alan Mackworth, Randy Goebel	Oxford University Press	1st, 2004
3	Artificial Intelligence: Structures and Strategies for Complex Problem Solving	George F. Luger	Pearson Education	6th, 2009

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_ge20/preview
2	https://onlinecourses.swayam2.ac.in/cec21_cs08/preview

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 Breadth First Search; Applications of Graphs - Single Source All Destination.	11

4	**Sorting and Searching** Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort. Searching Techniques – Linear Search, Binary Search, Hashing - Hashing functions : Mid square, Division, Folding, Digit Analysis; Collision Resolution : Linear probing, Quadratic Probing, Double hashing, Open hashing.	11

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 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 Outcomes		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- Analyze, K5- Evaluate, K6- Create

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,	2nd, 2007
2.	Introduction to Algorithms	Thomas H Cormen, Charles Leiserson, Ronald L Rivest, Clifford Stein	PHI	3rd, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Authors	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	Lipschutz 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

INTRODUCTION TO DATA SCIENCE

Course Code	PBADT304	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the basic concepts of data science.
2. To understand data representation, data pre-processing, data classification and model evaluation techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to data – Structured, Unstructured, Semi-structured, Data sets & Patterns; Brief history of Data Science; Introduction to Data Science; Importance of Data Science; Differences between AI, ML, DL, Data Science & Data Analytics, Real-world applications of data science; Steps in data science process. Ethical and privacy implications of Data Science; Tools and Skills Needed – Introduction of platforms, Tools, Frameworks, Languages, Databases and Libraries, Current trends & Major research challenges in data science.	8
2	Matrices to represent relations between data, and necessary linear algebraic operations on matrices -Approximately representing matrices by decompositions (SVD and PCA); Statistics: Descriptive Statistics: distributions and probability – Statistical Inference: Populations and samples – Statistical modeling – probability distributions – fitting a model – Hypothesis Testing	10
3	Data pre-processing: Data cleaning – data integration – Data Reduction Data Transformation and Data Discretization. Evaluation of classification	13

	methods – Confusion matrix, Students T-tests and ROC curves-Exploratory Data Analysis – Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA.	
4	Basic Machine Learning Algorithms- Linear Regression- Logistic Regression – Classifiers – Feature Generation and Feature Selection – Feature Selection algorithms – Filters; Wrappers-Decision Trees-Random Forests	11

Suggestion on Project Topics

- Students can implement various data related projects from any domain, using the techniques studied in the syllabus. It may contain sections for data storage, data pre-processing and small levels of data mining to recognize patterns in the data. Socially relevant project domains are highly appreciated. Check the datasets available at https://www.kaggle.com/datasets and perform data pre-processing operations such as data cleaning, missing value management and mine useful information from the dataset.

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 Outcomes		Bloom's Knowledge Level (KL)
CO1	Recall the fundamental concepts and applications of data science, and make inferences on key important points	K1
CO2	Comprehend the various methods of data representation	K2
CO3	Analyse the different steps in data pre-processing and model evaluation	K3
CO4	Perform feature generation and feature selection for classification	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, 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	2	2								3
CO3	3	3	3	2								3
CO4	3	3	3	3								3

Text Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Data mining Concepts and Techniques	Jiawei Han, Micheline Kamber, Jian Pei	Morgan Kaufmann Publishers	3rd, 2011
2	Fundamentals of Data Science	Sanjeev J. Wagh, Manisha S. Bhende, and Anuradha D. Thakare	CRC Press	1st, 2021
3	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki and Wagner Meira Jr	Cambridge University Press	1st 2014
4	Doing Data Science, Straight Talk From The Frontline	Cathy O'Neil and Rachel Schutt	O'Reilly	1st 2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Year
1	Data Science for Business	Foster Provost, Tom Fawcett	O'Reilly Media	1st, 2013
2	Data Science from Scratch: First Principles with Python",	Joel Grus,	O'Reilly Media	1st, 2015
3	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython",	Wes McKinney,	O'Reilly Media	1st,2012

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106106179
2	https://onlinecourses.swayam2.ac.in/cec22_mg64/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/ Seminar/ 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 (5 Marks)

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

SEMESTER S3

DIGITAL ELECTRONICS AND LOGIC DESIGN

(Common to Group A)

Course Code	GAEST305	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to digital Systems :- Digital abstraction Number Systems – Binary, Hexadecimal, grouping bits, Base conversion; Binary Arithmetic – Addition and subtraction, Unsigned and Signed numbers; Fixed-Point Number Systems, Floating-Point Number Systems Basic gates- Operation of a Logic circuit; Buffer; Gates - Inverter, AND gate, OR gate, NOR gate, NAND gate, XOR gate, XNOR gate; Digital circuit operation - logic levels, output dc specifications, input dc specifications, noise margins, power supplies; Driving loads - driving other gates, resistive loads and LEDs. Verilog (Part 1) :- HDL Abstraction, Modern digital design flow - Verilog constructs: data types, the module, Verilog operators.	11

2	**Combinational Logic Design: -** Boolean Algebra - Operations, Axioms, Theorems. Combinational logic analysis - Canonical SOP and POS, Minterm and Maxterm equivalence; Logic minimization - Algebraic minimization, K-map minimization, Don't cares, Code converters. **Modeling concurrent functionality in Verilog:** Continuous assignment - Continuous Assignment with logical operators, Continuous assignment with conditional operators, Continuous assignment with delay.	11
3	**MSI Logic and Digital Building Blocks** MSI logic - Decoders (One-Hot decoder, 7 segment display decoder), Encoders, Multiplexers, Demultiplexers. Digital Building Blocks - Arithmetic Circuits - Half adder, Full adder, half subtractor, full subtractor, Comparators. Structural design and hierarchy - lower level module instantiation, gate level primitives, user defined primitives, adding delay to primitives.	8
4	**Sequential Logic Design** - Latches and Flip-Flops- SR latch, SR latch with enable, JK flipflop, D flipflop, Register Enabled Flip-Flop, Resettable Flip-Flop. Sequential logic timing considerations, Common circuits based on sequential storage devices - toggle flop clock divider, asynchronous ripple counter, shift register. Finite State Machines :- Finite State Machines - logic synthesis for an FSM, FSM design process and design examples, Synchronous Sequential Circuits - Counters. Verilog (Part I): - 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 concepts 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 counters, 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	1	1	2									1
CO2	1	1	1	1								1
CO3	1	1	1	1	1							1
CO4	2	2	2	2	2							2
CO5	2	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	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	McGraw-Hill	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_ee01

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 -	6

	Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering – Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	8

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks (6x3 =18marks)	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 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 Authors	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 spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education, employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, Ethical values and practices in	6

	intersection with gender - equity, diversity & gender justice, Gender policy and women/transgender empowerment initiatives.	
2	**Introduction to Environmental Ethics:** Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). **Sustainable Engineering Principles:** Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. **Ecosystems and Biodiversity:** Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. **Landscape and Urban Ecology:** Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	6
3	**Hydrology and Water Management:** Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. **Zero Waste Concepts and Practices:** Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. **Circular Economy and Degrowth:** Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. **Mobility and Sustainable Transportation:** Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	6
4	**Renewable Energy and Sustainable Technologies:** Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. **Climate Change and Engineering Solutions:** Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. **Environmental Policies and Regulations:** Overview of key environmental policies and regulations (national and international), Role of engineers in policy	6

	implementation and compliance, Ethical considerations in environmental policy-making. **Case Studies and Future Directions:** Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	

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

Continuous Internal Evaluation Marks (CIE):

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

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

Sl. No.	Item	Particulars	Group/ Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarizing 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 Outcomes		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	3	3	2		2
CO4		1				3	3	3	3	2		2
CO5						3	3	3	3	2		2

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

- Analyse 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 expressions 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	Results 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 Outcomes		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.	K2

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	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 Authors	Name of the Publisher	Edition and Year
1	Fundamentals of Data Structures in C	Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed,	Universities Press,	2/e, 2007
2	Introduction to Algorithms	Thomas H Cormen, Charles Leiserson, Ronald L Rivest, Clifford Stein	PHI	3/e, 2009

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Classic Data Structures	Samanta D.	Prentice Hall India.	2/e, 2012
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.
   - Team work: 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. Results with Valid Inference/Quality of Output (10 Marks)

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER S3

PYTHON AND STATISTICAL MODELING LAB

(Common to AD/CD/CR)

Course Code	PCCBL308	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. The course aims to familiarize students with basic Python concepts and data structures, model graphical representation of data, measures of central tendency and measures of dispersion. The course will also introduce students to use python in solving problems based on statistical distributions, regression analysis and correlation tests.

Expt. No.	Experiments
1	Write a program to find the largest of three numbers.
2	Write a program to print the multiplication table of a number n.
3	Write a program to find Surface area and volume of a cylinder using function.
4	Write a program to replace a word by another word in a sentence.
5	Write a program to confirm the validity of an email id by verifying its format.
6	Write a program to remove every occurrence of a number from a list.
7	Write a program to add two matrices.
8	Write a program to read a tuple of numbers and print even tuple and odd tuple.
9	Create a dictionary with a set of book title and corresponding stock. Write a program to update the stock and to add or delete books.
10	A set of numbers are stored in a file. Write a program to print the prime numbers among them.
11	Write a program to count the number of words, sentences, upper case letters, lowercase letters and special symbols in a text stored in file.
12	Plot a graph $y = f(x)$
13	The areas of the various continents of the world (in millions of square miles) are as follows: 11.7 for Africa; 10.4 for Asia; 1.9 for Europe; 9.4 for North America; 3.3 Oceania; 6.9 South America; 7.9 Soviet Union. Draw a bar chart representing the given data.
14	Draw the histogram of the following data.

Height of students(cm)	135 - 140	140 - 145	145-150	150-155
No. of students	4	12	16	8

15 Table contains population and murder rates (in units of murders per 100,000 people per year) for different states. Compute the mean, median and variance for the population.

State	Population	Murder
Alabama	4,779,736	5.7
Alaska	710231	5.6
Arizona	6,392,017	4.7
Arkansas	2,915,918	5.6
California	37,253,956	4.4
Colorado	5,029,196	2.8
Connecticut	3,574,097	2.4
Delaware	89,934	5.8

16 Calculate the S.D. and coefficient of variation (C.V.) for the following table:

Class:	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Frequency:	2	18	20	40	30	20	10	2

17 If X is binomially distributed with 6 trials and a probability of success equal to 0.25 at each attempt, what is the probability of

a) exactly 4 successes b) at least one success

18

19 If the random variable X follows a Poisson distribution with mean 3.4, find P(X=6).

20 A random sample of 395 people were surveyed and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table. Are gender and education level dependent at 5% level of significance?

	High School	Bachelors	Masters	Ph.D	Total

Female	60	54	46	41	201
Male	40	44	53	57	194
Total	100	98	99	98	395

30 Calculate the correlation coefficient of the two variables shown in the table below.

Person	Hand	Height
A	17	150
B	15	154
C	19	169
D	17	172
E	21	175

31 Suppose a sample of 16 light trucks is randomly selected off the assembly line. The trucks are driven 1000 miles and the fuel mileage (MPG) of each truck is recorded. It is found that the mean MPG is 22 with a SD equal to 3. The previous model of the light truck got 20 MPG. Conduct a t- test of the null hypothesis at p = 0.05.

32 The mean productivity rating for all employees at a company was 3.5 on a five- point scale last year. This year you get ratings from a representative sample of fifteen employees from the Human Resource Management. Do the data from this sample provide evidence that employee productivity in the department of Human Resource Management is significantly higher than in the company as a whole? Write the null and alternative hypotheses for this problem. Use statistical analysis software to test the null hypothesis stated above.

33 Obtain the regression equation for predicting systolic blood pressure from job statistical analysis software. If one knows that a subject in the future has a score on job satisfaction of 15, what is their systolic blood pressure predicted to be? What is the standard error of estimate?

Job Satisfaction	Systolic BP
34	124
23	126
19	127
43	133
56	116
47	122
32	147
16	167

33	118
15	156

13

a) If the random variable X follows a Poisson distribution with mean 3.4, find P(X=6).

b) A random sample of 395 people were surveyed and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table. Are gender and education level dependent at 5% level of significance?

	High School	Bachelors	Masters	Ph.D	Total
Female	60	54	46	41	201
Male	40	44	53	57	194
Total	100	98	99	98	395

c) Calculate the correlation coefficient of the two variables shown in the table belo

Person	Hand	Height
A	17	150
B	15	154
C	19	169
D	17	172
E	21	175

d) Suppose a sample of 16 light trucks is randomly selected off the assembly line. The trucks are driven 1000 miles and the fuel mileage (MPG) of each truck is recorded. It is found that the mean MPG is 22 with a SD equal to 3. The previous model of the light truck got 20 MPG. Conduct a t-test of the null hypothesis at p = 0.05.

e) The mean productivity rating for all employees at a company was 3.5 on a five point scale last year. This year you got ratings from a representative sample of fifteen employees from the Human Research Management. Do the data from this sample provide evidence that employee productivity in the department of Human Resource Management is significantly higher than in the company as a whole? Write the null and alternative hypotheses for this problem. Use statistical analysis software to test the null hypothesis stated above.

b) Obtain the regression equation for predicting systolic blood pressure from job satisfaction using statistical analysis software. If one knows that a subject in the future has a score on job satisfaction of 15, what is their systolic blood pressure predicted to be? What is the standard error of estimate?

Job Satisfaction	Systolic BP
34	124
23	128
19	157
43	133
56	116
47	125
32	147
16	167
55	110
38	156

20

a) If the random variable X follows a Poisson distribution with mean 3.4, find P(X=6).

b) A random sample of 395 people were surveyed and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table. Are gender and education level dependent at 5% level of significance?

	High School	Bachelors	Masters	Ph.D	Total
Female	60	54	46	41	201
Male	40	44	53	57	194
Total	100	98	99	98	395

c) Calculate the correlation coefficient of the two variables shown in the table below.

Person	[illegible]	Height

	d	
A	[illegible]	160
B	[illegible]	158
C	[illegible]	165
D	[illegible]	172
E	[illegible]	175

[illegible] Suppose a sample of 16 light trucks is randomly selected off the assembly line. The trucks are driven 1000 miles and the fuel mileage (MPG) of each truck is recorded. It is found that the mean MPG is 22 with a SD equal to 3. The previous model of the light truck got 20 MPG. Conduct a t-test of the null hypothesis at p = 0.05.

[illegible] The mean productivity rating for all employees at a company was 3.5 on a five-point scale last year. This year you get ratings from a representative sample of fifteen employees from the Human Research Management. Do the data from this sample provide evidence that employee productivity in the department of Human Resource Management is significantly higher than in the company as a whole? Write the null and alternative hypotheses for this problem. Use statistical analysis software to test the null hypothesis stated above.

[illegible] Obtain the regression equation for predicting systolic blood pressure from job statistical analysis software. If we know that a subject in the future has a score on job satisfaction of 15, what is their systolic blood pressure predicted to be? What is the standard error of estimate?

Job Satisfaction	Systolic BP
34	124
23	128
19	157
43	133
56	116
47	122
32	147
16	167
55	119
25	186

[illegible]

[illegible] If the random variable X follows a Poisson distribution with mean 3.4, find $P(X=6)$.

[illegible] A random sample of 200 people were surveyed and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table. Are gender and education level dependent at 5% level of significance?

	High School	Bachelors	Masters	Ph.D	Total
Female	60	54	46	41	201
Male	40	44	53	57	194
Total	100	98	99	98	395

20 Calculate the correlation coefficient of the two variables shown in the table below:

Person	Hand	Height
A	17	150
B	15	154
C	19	169
D	17	172
E	21	175

21 Suppose a sample of 10 light trucks is randomly selected off the assembly line. The trucks are driven 1000 miles and the fuel mileage (MPG) of each truck is recorded. It is found that the mean MPG is 22 with a SD equal to 3. The previous model of the light truck got 20 MPG. Conduct a t-test of the null hypothesis at p = 0.05.

22 The mean productivity rating for all employees at a company was 3.4 on a five-point scale last year. This year you get ratings from a representative sample of fifteen employees from the Human Resource Management. Do the data from this sample provide evidence that employee productivity in the department of Human Resource Management is significantly higher than in the company as a whole? Write the null and alternative hypotheses for this problem. Use statistical analysis software to test the null hypothesis stated above.

23 Obtain the regression equation for predicting systolic blood pressure from job statistical analysis software. If one knows that a subject in the future has a score on job

satisfaction of 25, what is their systolic blood pressure predicted to be? What is the standard error of estimate?

Job Satisfaction	Systolic BP
34	124
23	128
19	157
43	133
56	116
47	125
32	147
16	167
55	110
25	156

22

[illegible] If the random variable X follows a Poisson distribution with mean 3.4, find P(X=6).

[illegible] A random sample of 395 people were surveyed and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table. Are gender and education level dependent at 5% level of significance?

	High School	Bachelors	Masters	Ph.D.	Total
Female	60	54	46	41	201
Male	40	44	53	57	194
Total	100	98	99	98	395

[illegible] Calculate the correlation coefficient of the two variables shown in the table below

Person	Hand	Height
A	17	150
B	15	154
C	19	169
D	17	172
E	21	175

[illegible] Suppose a sample of 16 light trucks is randomly selected off the assembly line. The trucks are driven 1000 miles and the fuel mileage (MPG) of each truck is recorded. It is found that the mean MPG is 22 with a SD equal to 3. The previous model of the light truck got 20 MPG. Conduct a t-test of the null hypothesis at α = 0.05

21 The mean productivity rating for all employees at a company was 3.5 on a five point scale last year. This year you get ratings from a representative sample of fifteen employees from the Human Research Management. Do the data from this sample provide evidence that employee productivity in the department of Human Resource Management is significantly higher than in the company as a whole? Write the null and alternative hypotheses for this problem. Use statistical analysis software to test the null hypothesis stated above.

25 Obtain the regression equation for predicting systolic blood pressure from job statistical analysis software. If one knows that a subject in the future has a score on job satisfaction of 11, what is their systolic blood pressure predicted to be? What is the standard error of estimate?

Job Satisfaction	Systolic BP
34	124
33	128
19	157
40	108
36	116
47	125
30	147
18	127
50	119
28	138

13

28 If the random variable X follows a Poisson distribution with mean 3.4, find P(X=6).

29 A random sample of 395 people were surveyed and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table. Are gender and education level dependent at 5% level of significance?

	High School	Bachelors	Masters	Ph.D	Total
Female	60	54	46	41	201
Male	40	44	53	57	194
Total	100	98	99	98	395

30 Calculate the correlation coefficient of the two variables shown in the table below.

Person	Hand	Height
A	17	150
B	15	154
C	19	169
D	17	172
E	21	175

		22	Suppose a sample of 16 light trucks is randomly selected off the assembly line. The trucks are driven 1000 miles and the fuel mileage (MPG) of each truck is recorded. It is found that the mean MPG is 22 with a SD equal to 3. The previous model of the light truck got 20 MPG. Conduct a t-test of the null hypothesis at p = 0.05.
		23	The mean productivity rating for all employees in a company was 3.5 on a five-point scale last year. This year you got ratings from a representative sample of fifteen employees from the Human Resource Management. Do the data from this sample provide evidence that employee productivity in the department of Human Resource Management is significantly higher than in the company as a whole? Write the null and alternative hypotheses for this problem. Use statistical analysis software to test the null hypothesis stated above.
		24	Obtain the regression equation for predicting systolic blood pressure from job statistical analysis software. If you knew that a subject in the future has a score on job satisfaction of 15, what is their systolic blood pressure predicted to be? What is the standard error of estimate?

Job Satisfaction	Systolic BP
34	124
23	128
12	157
40	133
26	136
47	122
30	147
18	167
55	110
20	156

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 Outcomes	Bloom's Knowledge Level (KL)
CO1	Experiment with concepts of iteration, function, string and list	K3
CO2	Identify the importance of tuples, dictionary traversal, dictionary methods, files and operations	K3
CO3	Model graphical representation of data, measures of central tendency and measures of dispersion	K3
CO4	Solve problems based on Binomial distribution, Poisson distribution, sampling and regression analysis	K3
CO5	Make use of various correlation tests and utilize statistical analysis software	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, 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	√	√	√					√				√
CO2	√	√	√	√				√				√
CO3	√	√	√	√				√				√
CO4	√	√	√	√				√				√
CO5	√	√	√	√	√			√				√

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Authors**	**Name of the Publisher**	**Edition and Year**
1	Probability and Statistics for Engineering and the Sciences	Jay L Devore	Cengage Learning India	9/e, 2020

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. Results 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

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

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 and properties, Pendant vertices, Distance and centres in a tree, Rooted and binary trees, Counting trees, Spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm, Floyd-Warshall	9

	shortest path algorithm. [Text 1: Relevant topics from sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.10, 11.5. Proofs of theorems 3.10, 3.16 are excluded.]	
4	Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix. Coloring- Chromatic number, Chromatic polynomial, Greedy colouring algorithm. [Text 1: Relevant topics from sections 7.2, 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 Outcomes		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- Analyze; 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	1	-	-	-	-	-	-	-	-	2
CO3	3	3	2	1	-	-	-	-	-	-	-	2
CO4	3	3	2	1	-	-	-	-	-	-	-	2

Text Books				
Sl. No.	Title of the Book	Name of the Authors	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 Authors	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_ma13/preview
2	https://onlinecourses.nptel.ac.in/noc22_ma13/preview
3	https://onlinecourses.nptel.ac.in/noc21_cs46/preview
4	https://onlinecourses.nptel.ac.in/noc21_cs48/preview

SEMESTER S4

DATABASE MANAGEMENT SYSTEMS

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

Course Code	PCCST402	CIE Marks	40
Teaching Hours/Week (L: T: P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST303	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Databases** :- Database System Concepts and Architecture-Data Models, Schemas and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, Centralized and Client/Server Architectures for DBMSs. **Conceptual Data Modelling and Database Design**:- Data Modelling Using the Entity- Relationship (ER) Model - Entity Types, Entity Sets, Attributes, and Keys, Relationship Types, Relationship Sets, Roles, and Structural Constraints, Weak Entity Types, Refining the ER Design for the COMPANY Database.	12
2	**The Relational Data Model and SQL** - The Relational Data Model and Relational Database Constraints-Relational Algebra and Relational Calculus - Structured Query Language (SQL)-Data Definition Language, Data Manipulation Language, Assertions, Triggers, views, Relational Database Design Using ER-to-Relational Mapping.	11
3	**Database Design Theory & Normalization** - Functional Dependencies - Basic definitions; Normalization- First, Second, and Third normal forms. **Transaction Management** - Transaction Processing : Introduction, problems and failures in transaction, Desirable properties of transaction, Characterizing schedules based on recoverability and serializability; Concurrency Control	12

	rule, Two-Phase Locking Techniques: Database Recovery management: Deferred update-immediate update- shadow paging.	
4	Introduction To NoSQL Concepts - types of NoSQL databases- CAP Theorem- BASE properties- Use Cases and limitations of NoSQL. SQL architectural Patterns - Key-value Stores, Graph Stores, Column Family stores and Document Stores.	11

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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	2	3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3	3								3

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

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

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_cs04/preview
2	https://onlinecourses.nptel.ac.in/noc22_cs04/preview
3	https://onlinecourses.nptel.ac.in/noc22_cs04/preview
4	https://archive.nptel.ac.in/courses/106/104/106104135/

SEMESTER S4

OPERATING SYSTEMS

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

Course Code	PCCST403	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Preemption and Context Switching (Book 2 Ch 4)	
2	**Concurrency and Synchronization** - Basic principles (Book 3 Sections 6.1, 6.2), Mechanisms - Locks: The Basic Idea, Building Spin Locks with Test-And-Set, Compare and Swap, Using Queues: Sleeping Instead Of Spinning (Book 1 Ch 28), Semaphores - Definition, Binary Semaphores, The Producer-Consumer (Bounded Buffer) Problem and its solution using semaphores, Reader-Writer Locks (Book 1 Ch 31) **Case study**: *Linux Kernel Synchronization Methods* - Spin Locks, Semaphores, Mutexes (Book 2 Ch 10) **Concurrency**: Deadlock and Starvation - Deadlock Characterization, Deadlock Prevention and Avoidance, Deadlock Detection and recovery (Book 3 Ch 8), Dining Philosophers Problem and its solution (Book 1 Ch 31)	12
3	**Memory management** - Address Space, Memory API, Address Translation - An Example, Dynamic (Hardware-based) Relocation, Segmentation: Generalized Base/Bounds, Address translation in segmentation, Support for Sharing (Book 1 Ch 13 to 16) **Virtual memory** - Paging: Introduction, page tables and hardware support, TLBs, Example: Accessing An Array, - TLB hits and misses, Handling TLB misses, TLB structure, Reducing the page table size (Book 1 Ch 18 to 20) **Going beyond physical memory** - Swap space, page fault and its control flow, page replacement policies, Thrashing (Book 1 Ch 21, 22)	11
4	**I/O system**: Modern System architecture, Programmed I/O, Interrupts, DMA, Device interaction methods, The Device Driver (Book 1 Ch 36) **Hard disk**: - Geometry (Book 1 Ch 37), disk scheduling (Book 3 Section 11.2) **Case study**: *Linux I/O schedulers - Elevator, Complete Fair Queuing* (Book 2 Ch 14) **Files and Directories**: The File System Interface - File descriptors, 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)	18

	File Organization: The Index, The Multi-Level Index (Book 1 Ch 40) *Case study: STL Objects and Their Data Structures : The Index Object, Index Operations (Book 2 Ch 14)*	

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 Outcomes		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- Analyze, K5- Evaluate, K6- Create

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									2
CO2	1	1	1									1
CO3	2	2	2									2
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	1st, 2018
2	Linux Kernel Development	Robert Love	Pearson	3rd, 2018
3	Operating System Concepts	Abraham Silberschatz, Peter B. Galvin, Greg Gagne	Wiley	10th, 2018

Reference Books				
S. 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, 2022
2	The Design of the UNIX Operating System	Maurice J. Bach	Prentice Hall of India	1/e, 1988
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/106/102/106102132/
2	https://www.youtube.com/playlist?list=[illegible]

SEMESTER S4

COMPUTER ORGANIZATION AND ARCHITECTURE

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

Course Code	PBCST404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GAEST305	Course Type	Theory

Course Objectives:

1. Introduce principles of computer organization and the basic architectural concepts using RISC.
2. Introduce the concepts of microarchitecture, memory systems, and I/O systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Structure of computers – Functional units - Basic operational concepts; Memory map; Endianness. CISC vs RISC architectures– RISC Introduction - Assembly Language, Assembler directives, Assembling. Programming concepts - Program flow, Branching, Conditional statements, Loops, Arrays, Function calls; Instruction execution cycle. Machine language - Instructions, addressing modes, Stored program concept. Evolution of the RISC Architecture.	11
2	Microarchitecture – Introduction; Performance analysis; Single-Cycle Processor - Single Cycle Datapath, Single Cycle Control; Pipelined Processor - Pipelined Data Path, Pipelined Control - Hazards, Solving Data/Control Hazards, Performance Analysis.	11
3	Memory Systems: Introduction; performance analysis; Caches - basic concepts, Cache mapping, Cache replacement, Multiple-Level Caches, Reducing Miss Rate, Write Policy; Virtual Memory - Address Translation; Page Table; Translation Lookaside Buffer; Memory Protection.	11

4	Input / Output - External Devices; I/O Modules; Programmed I/O, Interrupt Driven I/O, Direct Memory Access. Embedded I/O Systems - Embedded I/O, General Purpose I/O, Serial I/O, Other Peripherals.	11

Suggestion on Project Topics

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 subdivisions. • Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Identify the basic structure and functional units of a digital computer and the features of RISC architecture.	K2
CO2	Experiment with the single cycle processor, pipelining, and the associated problems.	K3
CO3	Utilize the memory organization in modern computer systems.	K3
CO4	Experiment with the I/O organization of a digital computer.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, 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	1st, 2022
2	Computer Organization and Architecture Designing for Performance	William Stallings	Pearson	9th, 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 Kaufmann	1 st,2018
2.	Computer Organization and Embedded Systems	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian	McGraw Hill	6th, 2012
3.	Modern Computer Architecture and Organization	Jim Ledin	Packt Publishing	1 st,2020

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

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 3 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	9

	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)	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, Microservice 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 Outcomes		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	Yingxu 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=[illegible]
2	https://www.youtube.com/watch?v=[illegible]
3	http://digimat.in/nptel/courses/video/[illegible].html
4	https://www.youtube.com/watch?v=[illegible]

SEMESTER S4

DATA SCIENCE PRIVACY & ETHICS

(Common to AD/CR)

Course Code	PEADT482	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 principles of data ethics and privacy.
2. To analyze real-world cases involving data privacy and ethical issues.
3. To develop skills to implement ethical practices in data science projects.
4. To learn about legal frameworks governing data privacy.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Data & Risks - Data access and analysis – Risk mitigation – Risks, Harms and Benefit assessment – Sensitive data – Sensitive contexts – Data security – Data Retention. Data Ethics – the importance of data ethics –Privacy, transparency, fairness and bias, accountability, security, data quality, Data collection – The ethical use of data.	8
2	Data Privacy: Introduction to Data privacy – History of privacy, Degrees of privacy, Modern privacy risks, Anonymity, Data validity – Choice of Attributes and Measures, Errors in Data Processing – Errors in Model Design, Algorithmic Fairness. Data ownership, Data Integrity – Biased and Unbiased data, Fairness, Five C's of data, Anonymization, Key issues in Data ethics, Open data usage – Features and characteristics.	9
3	**Database Security and Analytics –** Relational databases, Database features, Metadata - Importance, Descriptive	8

	and structured metadata, Lifecycle, Metadata management; Common security challenges- Human error, SQL injection attacks, DDoS, Malware attacks; Prevention methods- Access control, Auditing, Authentication, Encryption, Integrity controls, Backups.	
4	**Ethics and Data Protection –** Government regulatory frameworks – Data Protection laws- GDPR, CCPA, Security standards; Data retention policies - GDPR retention policy, 7 year retention policy, Compliance and audits, International standards - ISO/IEC standard; Real world case studies.	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 Ethical Data Collection and Usage.	K2
CO2	Understand Ethical Principles in Data Science.	K2
CO3	Identify Data Privacy Issues.	K3
CO4	Illustrate Legal and Regulatory Frameworks.	K3
CO5	Identify Real-World privacy and ethics violation Cases.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics and Data Science	Mike Loukides, Hilary Mason, and DJ Patil	O'Reilly Media	1st, 2018
2	Data Privacy: Principles and Practice	Nataraj Venkataramanan and Ashwin Shriram	CRC Press	1st, 2017
3	The Ethical Algorithm: The Science of Socially Aware Algorithm Design	Michael Kearns and Aaron Roth	Oxford University Press	1st, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Data Privacy Law: A Practical Guide to the GDPR	G.E. Kennedy , L.S.P. Prabhu,	G.E. Kennedy & L.S.P. Prabhu	1st, 2020

Video Links (NPTEL, SWAYAM…)	
No.	Link ID
1	Online Privacy https://onlinecourses.nptel.ac.in/noc22_cs57/preview
2	Towards an Ethical Digital Society: From Theory to Practice. https://onlinecourses.nptel.ac.in/noc22_hs63/preview

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)	GYEST104	**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 2 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.	K3
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							2
CO2	[illegible]	[illegible]	[illegible]		[illegible]							[illegible]
CO3	[illegible]	[illegible]	[illegible]		[illegible]							[illegible]
CO4	[illegible]	[illegible]	[illegible]		[illegible]							[illegible]

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (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

FUNDAMENTALS OF BIOINFORMATICS

(Common to AD/CR)

Course Code	PEADT414	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 (5 hours)** Global and local sequence alignment-dynamic programming algorithm, edit distance, similarity, Needleman Wunsch Algorithm, Smith Waterman Algorithm.	8
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 (5 hours)** Phylogenetic Tree basics and Construction Methods, UPGMA, Neighbour joining, Parsimonious trees, Additive trees, Bootstrapping.	8
3	**Combinatorial Pattern Matching (8 hours)** Combinatorial Pattern Matching, Repeat finding, Keyword Trees, Suffix	8

	Trees, Heuristic similarity search algorithms, Approximate Pattern Matching.	
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.)	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 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 concepts of combinatorial pattern matching in bioinformatics	K3

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

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	2	2	2									2
CO3	3	3	3									2
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 Authors	Name of the Publisher	Edition and Year
1	An Introduction to Bioinformatics Algorithms,	N. C. Jones and P. A. Pevzner,	MIT Press, 2004	1st, 2004
2	Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools	Supratim Choudhuri	Academic Press	1st, 2014

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

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

SEMESTER S4

NUMBER THEORY

(Common to AD/CS)

Course Code	PEADT414	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 of divisibility and prime numbers.
2. To enable the learners develop problem solving skills in the context of number theory.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals - Polygonal numbers, Pyramidal numbers, Catalan numbers; Divisibility-Division algorithm, Number patterns, Prime and composite numbers, Fibonacci and Lucas numbers, Fermat numbers, Greatest common divisors - Greatest common divisor, Euclidean algorithm, Least Common Multiple, Linear Diophantine Equations	9
2	Congruences - Congruences (Basics only), Linear congruences, Congruence Applications - divisibility tests, Modular designs, Check digits; Systems of Linear Congruences- Chinese remainder theorem, General Linear systems, 2x2 Linear systems; Wilson's theorem, Fermat's little theorem (Theorem and proof of theorem only)	9
3	Multiplicative Functions – Euler's Phi Function, Euler's Theorem, Tau and sigma function, Perfect numbers, Mersenne Primes; Primitive Roots- Order of a positive integer, Primality tests, Primitive roots of primes, Congruences with primitive roots	9
4	Cryptology - Affine ciphers, Hill ciphers, Exponentiation ciphers, RSA Cryptosystem, Knapsack Ciphers	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 operations and properties of integer arithmetic	K2
CO2	Use the concepts of prime numbers and factorization	K3
CO3	Solve Diophantine equations and congruences	K3
CO4	Use the concepts of the order of a positive integer, primality tests, and primitive roots of primes for ensuring security in computing systems.	K3
CO5	Illustrate classical theorems of Number theory and Apply number theory to algebra	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	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-	-	[illegible]
CO2	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	-	-	-	-	[illegible]
CO3	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	-	-	-	-	[illegible]
CO4	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-	-	[illegible]
CO5	[illegible]	[illegible]	-	[illegible]	[illegible]	-	-	-	-	-	-	[illegible]

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Elementary Number Theory with Applications	Thomas Koshy	Elsevier Academic Press	2/e, 2007

Reference Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Elementary Number Theory	David M Burton	McGraw Hill	7/e, 2011
2	Elementary Number Theory	Gareth A Jones, J Mary Jones	Springer	1/e, 1998
3	Elementary Number Theory	Kenneth H Rosen	Pearson Education	6/e, 2011

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://archive.nptel.ac.in/course.html
2	https://archive.nptel.ac.in/courses/111/101/111101137

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, Fuzzy If-Then Rules, Fuzzification, Defuzzification– Lambda 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- Analyze, K5- Evaluate, K6- Create

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	3	2								3
CO4	3	3	3	2								3
CO5	3	3	3									3

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Soft Computing	S.N. Sivanandam, S.N. Deepa	John Wiley & Sons	3/e, 2011
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, 2021

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,	3rd, 2011
2	Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis and Applications	S.Rajasekaran, G.A.Vijayalakshmi Pai	Prentice Hall India	1st, 2005
3	Neural Networks- A Comprehensive Foundation	Simon Haykin	Pearson Education	2nd, 1997
4	Fuzzy Set Theory & its Applications	Zimmermann H. J.	Allied Publishers Ltd.	4th, 2001

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

SEMESTER S4

MICROCONTROLLERS

(Common to AD/CD/CR)

Course Code	PEADT415	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 ARM architecture and ARM based microcontroller architecture.
2. To impart knowledge on the hardware and software components to develop embedded systems using STM32 microcontrollers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Embedded Systems and ARM Cortex-M Architecture:** Overview of embedded systems including definition, applications, and characteristics. Embedded C Programming Basics and Key Concepts. Differences and use cases of microcontrollers versus microprocessors. Classification of processors including RISC, CISC, and other architectures. Overview of ARM Cortex-M Series features and applications. Introduction to Cortex-M33 and Cortex-M23 Processors. Armv8-M Architecture: Core Features (Registers, Memory, Bus Architecture)/Comparison with Previous Cortex-M Generations.	8
2	**STM32 Microcontroller Overview and Development Environment Setup:** Overview of the STM32 Family and Features of the STM32U575, Development Environment and HAL- Introduction, Writing, and Debugging Your First Program (LED Interfacing). Interfacing – Seven-Segment Display, LCD Display, Matrix Keypad, Relay, Analog to Digital Conversion- Potentiometer, Temperature Sensor, LDR, Microphone. Digital to Analog Conversion - Simple DAC Output, Sine Wave Generation, Audio Signal	10

	Generation, Interrupt Handling Basics and Applications, Timers and PWM Configuration, Real-Time Clock (RTC), LED Brightness Control, Motor Speed Control.	
3	Communication Protocols :- Overview of Serial Communication Protocols- USART, I2C, and SPI. Interfacing an I2C Temperature Sensor and Displaying Data on an LCD, writing to and Reading from an SPI-based EEPROM, Implementing CAN Communication Between STM32 Microcontrollers, Creating a USB HID Device for Keyboard and Mouse Emulation.	9
4	IoT and RTOS:- Introduction to IoT and its Layers of Architecture, Introduction to IoT Communication Protocols including MQTT, CoAP, and HTTP, Securing IoT Data Using Encryption Techniques, Wireless Communication Basics- GSM, Interfacing GSM (Sending SMS, Making Calls, Internet Connectivity Using AT Commands), Bluetooth(Data Transfer between STM32F373 and Mobile Devices), RTOS Concepts: FreeRTOS Overview: Task Creation, Scheduling, Timers, Inter-task Communication (Queues, Semaphores), Designing an IoT-Based Home Automation System.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
- 2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =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 architectural features and instructions of the ARM microcontroller.	K2
CO2	Develop applications involving interfacing of external devices and I/O with ARM microcontroller.	K3
CO3	Use various communication protocols for interaction with peer devices and peripherals	K3
CO4	Demonstrate the use of a real time operating system in embedded system applications	K3

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

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	3	3	3									3
CO3	3	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	The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors	Joseph Yiu	Newnes - Elsevier	3rd, 2014
2	Mastering STM32	Carmine Noviello	Leanpub	2nd, 2022

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

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/108/105/108105102/
2	https://www.st.com/resource/en/datasheet/

SEMESTER S4

FOUNDATIONS OF PATTERN RECOGNITION

Course Code	PEADT415	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)	GCCST100		

Course Objectives:

1. To provide a comprehensive understanding of the fundamental concepts and techniques of pattern recognition.
2. To develop the ability to apply pattern recognition methods to solve practical problems.
3. To enhance skills in using modern tools and techniques for feature extraction, dimensionality reduction, and machine learning algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Pattern Recognition - Basics of pattern recognition, Applications and examples, Statistical pattern recognition, Introduction to classifiers: k-NN, Naive Bayes. Project 1: Image Classification using k-NN and Naive Bayes - Classify images from the CIFAR-10 dataset using k-NN and Naive Bayes classifiers, and the deliverables are code implementation, project report, and presentation. Assignments : Assignment on k-NN and Naive Bayes classifiers Mini-project proposal submission.	9
2	Feature Extraction and Dimensionality Reduction - Feature selection techniques, Principal Component Analysis (PCA), Non-linear dimensionality reduction methods (t-SNE, LLE) Project 2: Dimensionality Reduction for Handwritten Digit Recognition - Use PCA and LDA to reduce the dimensionality of the MNIST dataset and apply a classifier, and the deliverables are code implementation, project report, and presentation. Assignments: Assignment on PCA and LDA theory. Mid-term project: Detailed report on feature extraction project	9

5	Machine Learning Algorithms for Pattern Recognition - Support Vector Machines (SVM), Neural Networks and Deep Learning, Ensemble methods (Random Forests, Gradient Boosting), Clustering techniques (k-means, hierarchical clustering) Project 5: Text Classification using SVM and Neural Networks - Classify text documents from the 20 Newsgroups dataset using SVM and a simple neural network, and the deliverables are code implementation, project report, and presentation. Assignments : Assignment on SVM and neural network theory Group project on Ensemble methods applied to a complex dataset	9
6	Advanced Topics and Applications - Hidden Markov Models (HMM), Bayesian Networks, Pattern recognition in speech and handwriting Project 6 : Speech Recognition using Hidden Markov Models : Develop a speech recognition system using Hidden Markov Models using the dataset - TIMIT Acoustic-Phonetic Continuous Speech Corpus. The deliverables are code implementation, project report, and presentation. Tools: Python, HTK (Hidden Markov Model Toolkit) Project 7: Handwriting Recognition using Deep Learning - Develop a handwriting recognition system using deep learning techniques using the datasets - MNIST Handwritten Digits Dataset, IAM Handwriting Database. The deliverables are code implementation, project report, and presentation. Tools: Python, TensorFlow/Keras, OpenCV Project 8: Bayesian Networks for Medical Diagnosis - Use Bayesian Networks to develop a system for medical diagnosis using the datasets - UCI Machine Learning Repository, Hepatitis Dataset. The deliverables are code implementation, project report, and presentation. Tools: Python, PyMC3, Netica Assignments: Assignment on HMM and Bayesian networks Final project: Comprehensive pattern recognition application	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

1. **Code Implementation (40%) – 8 Marks**

- Correctness (4 Marks): Code accurately implements the required algorithms (e.g., k-NN, Naive Bayes, PCA, LDA, SVM, Neural Networks, HMM) and processes the dataset as required. Code runs without errors and produces the expected output for different scenarios or edge cases.
- Efficiency and Robustness (4 Marks): Code is optimized for efficiency, handling large datasets or complex computations effectively, and includes error handling and can manage diverse data.

2. **Results Analysis (60%) – 12 Marks**

- Validation Metrics (6 Marks): Proper use of evaluation metrics (e.g., accuracy, precision, recall, F1 score) to assess the performance of classifiers and dimensionality reduction techniques. Comparison of different methods or classifiers and discussion on their effectiveness, including strengths and limitations.
- Insightful Analysis (6 Marks): Interpretation of the results, including any anomalies or unexpected findings. Based on results, provides thoughtful recommendations or insights for potential improvements or alternative approaches.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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 2 sub divisions. • Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and explain the fundamental concepts of pattern recognition and its applications.	K2
CO2	Apply statistical and machine learning techniques to solve pattern recognition problems.	K3
CO3	Implement feature extraction and dimensionality reduction techniques for various datasets.	K4
CO4	Develop and evaluate different machine learning models for pattern recognition tasks.	K5
CO5	Work on real-world pattern recognition projects, demonstrating problem-solving and project management skills.	K6

Note: K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create

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	2	2	2	2								2
CO4	3	3	3	3								3
CO5	3	3	3				3		3	3		3

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer	1st, 2006
2	Mastering Machine Learning Algorithms	Giuseppe Bonaccorso	Packt Publishing	2nd, 2020
3	Pattern Classification	Richard Duda, Peter Hart, David Stork	Wiley	2nd, 2007
4	Deep Learning	Ian Goodfellow, Yoshua Bengio, and Aaron Courville	McGraw-Hill	1st, 2017
5	Feature Extraction and Image Processing for Computer Vision	Mark Nixon and Alberto Aguado	Academic Press	3rd, 2012

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.	2nd, 2010
2	The Elements of Statistical Learning	Jerome Friedman, Robert Tibshirani, Trevor Hastie	Springer-Verlag New York Inc.	9th, 2017
3	Pattern Recognition	S.Theodoridis and K.Koutroumbas	Academic Press	4th, 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

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	8
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	5

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks (8x2 =16marks)	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. • Each question carries 8 marks. (4x8 = 32 marks)	48

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	2	-	-	-	-	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**	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.	8
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.	8

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.	5

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 concept 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.	K2
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						2	2	3	3	2		2
CO2		1				2	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

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

FOUNDATIONS OF AI AND DATA SCIENCE LAB

Course Code	PCADL407	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	1 0 2 0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	[illegible]	Course Type	Lab

Course Objectives

1. To get hands-on experience in AI and data science using Python programming.
2. To develop an expert system for knowledge representation and reasoning.

Expt. No.	Experiments
1	Implement basic search strategies (BFS, DFS) for selected AI applications
2	Implement informed search (A*) algorithms for routing problem.
3	Implement backtracking algorithms for Constraint Satisfaction Problem.
4	Implementation of Alpha-Beta pruning to find optimal solution for a given problem.
5	Implement a program to find a solution by using the local optima(Hill Climbing) algorithm.
6	Implement propositional logic inferences for AI tasks
7	Implementation of Knowledge representation schemes
8	Write a program to find Correlation between different features of a dataset in csv format
9	Write a program to implement feature reduction using PCA. Calculate the covariance between features to find the optimal number of PCA components.
10	Implement Apriori algorithm in python to find relationships among numerical items in a dataset.
11	Implement FP-Growth algorithm in python to find frequent patterns in large datasets efficiently.
12	Implement Clustering algorithm to categorize the data.

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	Results 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 basic searching strategies, mathematical optimization methods and constraint satisfaction problems.	K3
CO2	Develop an expert system by using appropriate tools and techniques.	K3
CO3	Apply different methods (like Correlation and Covariance) to determine the dependence between features in the dataset and apply dimensionality reduction techniques.	K3
CO4	Apply various association rule mining and clustering techniques.	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2							2
CO2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]
CO3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]
CO4	2	3	3	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	Aurélien Géron	O'Reilly	2/e, 2019
2	Data science and big data analytics: discovering, analyzing, visualizing, and presenting data	David dietrich	John Wiley and sons	1/e, 2015
3	Artificial Intelligence and Intelligent Systems	Padhy, N.P.	Oxford University Press	1/e, 2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence: A Modern Approach	Stuart J. Russell, Peter Norvig	Pearson Education	2/e,2002
2	Knowledge Representation and Reasoning	Brachman, R. and Levesque, H.	Morgan Kaufmann	1/e, 2004

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_[illegible]/preview
2	https://onlinecourses.nptel.ac.in/noc21_[illegible]/preview
3	https://www.coursera.org/learn/data-analysis-with-python

Continuous Assessment (25 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER S4

DBMS LAB

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

Course Code	PCCSL408	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

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

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

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

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1						3		3
CO2	3	3	3	1						3		3
CO3	3	3	3	1						3		3
CO4	3	3	3	2	3					3		3
CO5	3	3	3	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 Database Systems	Elmasri, Navathe	Pearson	7th, 2017
2	Professional NoSQL	Shashank Tiwari	Wiley	1st, 2011

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

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

Continuous Assessment (25 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)
    - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
    - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

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

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

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

3. Results 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

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

SEMESTER S5

COMPUTER NETWORKS

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

Course Code	PCCST[illegible]	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: Socket 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)***	12

3	Data Link Layer: Data link control (DLC), Multiple access protocols (MAC), Link-layer addressing, Ethernet protocol, Connecting devices (Book 1 Ch 9) Wireless LANs, Mobile IP (Book 1 Ch 6) ***Hands-on: Datalink Provider Interface, SOCK_PACKET and PF_PACKET* (Book 2 Ch 29)**	11
4	[illegible] (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- Analyze; K5- Evaluate; K6- Create

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

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SE, 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 Authors	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	5/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

ROBOTICS AND INTELLIGENT SYSTEMS

Course Code	[illegible]	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 Understand the concepts of manipulators and mobile robotics
2. To enable the learner to choose the suitable sensors, actuators and control for robot design
3. To equip the learner to develop kinematic model of mobile robot and understand robotic vision intelligence

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to robotics - Degrees of freedom, Robot types- Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots- wheeled, legged, aerial robots, underwater robots, surface water robots. Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.	11
2	Sensors, Actuators and Control: Sensor classification- touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors. External sensors-contact type, non-contact type. Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors - Servo, Hydraulic & pneumatic actuators.	11
3	Robotic Vision: Sensing, Preprocessing, Segmentation, Description,	11

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

Note: K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create

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	-	-	-	-	-	3
CO4	3	-	-	2	3	3	-	-	-	-	-	2
CO5	2	-	-	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 Autonomous Mobile Robots	R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza	MIT Press	2/e, 2011
2	Embedded Robotics, Mobile Robot Design and Applications with Embedded Systems	Thomas Braunl	Springer	3/e, 2008
3	Introduction to Mobile Robot Control	S.G. Tzafestas	Elsevier	1/e, 2014
4	Artificial Intelligence for Robotics	Francis X. Govers	Packt	1/e, 2018
5	Introduction to Robotics - Analysis, Control, Applications	Saeed B. Niku	Wiley	2/e, 2011
6	Industrial Robotics - Technology, Programming and Applications	Mikell P Groover	McGraw Hill	2/e, 2017

Reference Books				
Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Robotics	John J. Craig	Pearson Education	3/e, 2007
2	Introduction to Robotics	S. K. Saha	TATA McGraw Hills	2/e, 2014
3	Robotics, Vision and Control – Fundamental Algorithms in MATLAB	Peter Corke	Springer-Verlag	3/e, 2021

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/107/106/107106090/
2	https://archive.nptel.ac.in/courses/108/108/108108147/
3	https://www.youtube.com/watch?v=[illegible]
4	https://www.youtube.com/watch?v=[illegible]

SEMESTER S5

MACHINE LEARNING

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

Course Code	**PCCST503**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

	regularization, Idea of Training, Testing, Validation Evaluation measures – Classification - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC). Regression - Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination.	
3	SVM – Linear SVM, Idea of Hyperplane, Maximum Margin Hyperplane, Non-Linear SVM, Kernels for learning non-linear functions Neural Networks (NN) - Perceptron, Neural Network - Multilayer feed-forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm.	9
4	Unsupervised Learning: Clustering - Similarity measures, Hierarchical Clustering - Agglomerative Clustering, partitional clustering, K-means clustering Dimensionality reduction - Principal Component Analysis, Multidimensional scaling Ensemble methods - bagging, boosting; Resampling methods - Bootstrapping, Cross Validation. Practical aspects - Bias-Variance tradeoff.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.	K2
CO2	Demonstrate supervised learning concepts (regression, classification).	K3
CO3	Illustrate the concepts of Multilayer neural network and Decision trees	K3
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques.	K3
CO5	Use appropriate performance measures to evaluate machine learning models	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	4e, 2020
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki / Wagner Meira	Cambridge University Press	1e, 2014
3	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1e, 1995

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

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

SEMESTER S8

BIG DATA ANALYTICS

Course Code	PBADT804	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)	UCEST105 PBADT504	Course Type	Practical

Course Objectives:

1. To understand the need of a framework to store and process the big data.
2. To have knowledge on the Big Data Technologies for processing the Different types of Data.
3. To understand the advanced framework for faster accessing and processing of Big Data.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Hadoop Distributed File System** Introduction to Big data, Conventional Data vs Big data, Big data architecture, Big data platform-Hadoop Ecosystem, Core Components, HDFS- Architecture, Using HDFS Files, HDFS Design, Blocks, Namenodes and Data nodes, Basic File system Operations, Hadoop Specific File Types, Anatomy of a file read and file write. Data Processing with MapReduce: Execution Pipeline-Map Reduce; Developing a map-reduce application	11
2	Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.	11

3	Introduction to R : Overview of modern data analytic tools, Introduction to R, R Graphical User Interfaces - Features of R Language, Vectors, Filtering, Creating Matrices , Applying Functions to Matrix Rows and Columns, Lists , Creating List , General List Operations, Data Frames , Creating Data Frames , Matrix like Operations in Frames , Applying Functions to Data Frames ,Reading and Writing Files.	12
4	Overview of Spark – Hadoop Overview of Spark – Hadoop vs. Spark – Cluster Design – Cluster Management – performance, Application Programming Interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD, RDD Operations and Saving RDD - Lazy Operation – Spark Jobs. Writing Spark Application - Spark Programming in Python, R, Java - Application Execution	12

Suggestion on Project Topics

- Search Engine Optimization,Social Media Reputation Monitoring, Equity Research, Detection of Global Suicide rate, Find the Percentage of Pollution in India, Analyze crime rate in India, Health Status Prediction, Anomaly Detection in cloud server, Tourist Behaviour Analysis, [illegible]. Not limited to above topics

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
- 2 Questions from each module. - Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	- 2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 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 Outcomes	Bloom's Knowledge Level (KL)
CO1	Demonstrate the Hadoop framework, focusing on the Hadoop Distributed File System (HDFS) and MapReduce	K3
CO2	Simulate various Big data technologies like Pig, Hive, Hbase	K3
CO3	Resolve problems associated with big data with the features of R programming	K3
CO4	Demonstrate spark programming with different programming languages	K3
CO5	Develop and Implement innovative ideas on big data technologies	K3

Note: K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create

CO-PO Mapping Table

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Hadoop: The Definitive Guide	Tom White	O'reilly Media	4th, 2015
2	Professional Hadoop Solutions	Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich	Wrox Press	1st, 2014
3	The Art of R Programming: A Tour of Statistical Software Design	Norman Matloff	No Starch Press	1st, 2011
4	Spark in Action	Jean-Georges Perrin	O'Reilly Media	1st, 2020
5	Mastering Apache Spark	Mike Frampton	Packt Publishing	1st, 2015
6	Machine Learning with Spark	Nick Pentreath	Packt Publishing	1st, 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Big Data Fundamentals: Concepts, Drivers & Techniques	Thomas Erl, Wajid Khattak, and Paul Buhler	Pearson India Education Service Pvt. Ltd	1st, 2016
2	Programming Pig Dataflow Scripting with Hadoop	Alan Gates	O'Reilly Media, Inc	1st, 2011
3	Programming Hive	Jason Rutherglen, Dean Wampler, Edward Capriolo	O'Reilly Media Inc	1st, 2012
4	Big Data	Black Book TM	DreamTech Press	1st, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	Big Data Computing: https://nptel.ac.in/courses/106104189
2	Advanced R Programming for Data Analytics in Business https://nptel.ac.in/courses/110106213
3	Social Network Analysis: https://nptel.ac.in/courses/106106239

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

S. 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 S8

SOFTWARE PROJECT MANAGEMENT

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

Course Code	PECST821	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PECST411	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Project scheduling and feasibility study :-** Project Overview and Feasibility Studies - Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal, Project Scheduling - Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.	8
2	**Resource Scheduling, Cost Control and Project management Features :-** Cost Control and Scheduling - Project Cost Control (PERT/Cost), Resource Scheduling & Resource Levelling, Project Management Features - Risk Analysis, Project Control, Project Audit and Project Termination.	8
3	**Agile Project Management :-** Agile Project Management - Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL). Other Agile Methodologies - Introduction to 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, scrum retrospective), 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 Outcomes		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- Analyze, 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	1st, 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	1st, 2010
2	Agile Project Management with Scrum	Ken Schwaber	Microsoft Press	1st, 2004

Video Links (NPTEL, SWAYAM…)	
No.	Link ID
1	https://onlinecourses.nptel.ac.in/[illegible]
2	https://www.youtube.com/watch?v=[illegible]
3	https://www.youtube.com/watch?v=[illegible]

SEMESTER S8

BUSINESS ANALYTICS

Course Code	PEADT821	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 assist the student in gaining a basic understanding of Business Analytics and its application in various functional areas.
2. To introduce the concepts in business analytics, Statistical models, Data Modelling with Tableau and Web analytics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Business Analytics-Evolution and scope, resource alignment within organisation. Applications of business analytics – finance, sensitivity analysis, human resource management, market share estimation, inventory management, risk management, portfolio assets tuning, fraud detection and prediction. Decision models, types - descriptive, diagnostic, predictive, and prescriptive. Data Modelling Approach - Data Organisation, Structured Vs Unstructured data, the 5 V's of Business Analytics, Data Analytics framework, Analytics Tools – licensed vs open source. Data cleaning, outliers and outlier's diagnostics.	8
2	Statistical Models- Probability Distributions, Sampling and Sampling Distributions, Statistical Distributions - Normal, Binomial, Poisson. Measures of Central Tendency, Symmetry, and Correlation. Time Series analysis – definition, steps to analyse, importance, components, models and techniques. Forecasting - Forecasting for Management Decisions, Data Patterns and Choice of Forecasting Techniques, Data Collection and Analysis in Forecasting, Forecasting with Smoothing Techniques, Forecasting with Regression.	8

3	**Data Modelling with Tableau:** Extracting data into Tableau – design flow, file types, data types, data sources, data preparations, dimensions, custom data views, extracting and editing data, transformation of variables, joining and blending data, tableau worksheets, tableau calculations, sort and filters, working with sheets, exporting visualizations, formatting and forecasting.	8
4	**Web Analytics**-A/B Testing, Market Basket Analysis, Classification and Regression Tree, Monte Carlo Simulation Click stream analytics, anonymous vs registered user's analysis, Social Media Analytics - User generated content – Page tagging, Server log files, Data dimensions. Sentiment Analysis, Analytics in digital decoding consumer issues, decoding customer sentiments from comments, Text mining from opinion platforms **Data Science Toolkits for Business Analytics Clustering** - K-Means, DBSCAN, Agglomerative and Hierarchical, Decision Tree – ID3, Factor Analysis, and Segmentation Analysis. Build spread sheet models, analysis using spread sheets – What-if analysis, Break even analysis.	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	Explain the various business analytical concepts, applications and models.	K2
CO2	Make use of statistical models for business analytics in data management.	K3
CO3	Apply various tool for business analytics applications.	K3
CO4	Make use of business analytical tools and techniques in Web Analytics and Ecommerce business analysis with data science methods.	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											2
CO2	3	3	2	2								3
CO3	3	3	2	2								3
CO4	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	Business Analytics: Methods, Models and Decisions	Evans, J.R.	Pearson Education	2/e, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Business analytics: Data analysis & decision making	Albright, S. Christian, and Wayne L. Winston	Cengage Learning	1st, 2014
2	Web Analytics Demystified: A Marketer's Guide to Understanding How Your Website Affects Your Business	Peterson	Celilo Group Media & CafePress	1st, 2014
3	Business Analytics: The art of Modeling with Spreadsheets	Stephen G. Powell, Kenneth R. Baker	John Wiley & Sons	1st, 2014

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

SEMESTER S8

INFORMATION SYSTEMS

Course Code	PEADT833	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	Elective

Course Objectives:

1. To provide students with a thorough understanding of the role and impact of information systems in organizations and society.
2. To develop students' ability to critically analyze and apply information security principles and ethical considerations in the management and implementation of information systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Information Systems – Introduction to Information Systems: Overview of Computer-Based Information Systems, Importance of Information Systems to Society, Business Processes: Business Process Reengineering, Business Process Improvement, and Business Process Management- Business Pressures, Organizational Responses, and Information Technology Support: Competitive Advantage and Strategic Information Systems. Ethics and Privacy	9
2	Information Security and Controls – Information Security and Controls: Introduction to Information Security- Unintentional Threats to Information Systems - Deliberate Threats to Information Systems - What Organizations Are Doing to Protect Information Resources - Information Security Controls - Personal Information Asset Protection	9

3	**Information Systems within the Organization :-** Information Systems within the Organization- Introduction- Transaction Processing Systems – Functional Area Information Systems- Enterprise Resource Planning Systems- ERP Support for Business Processes- Customer Relationship Management and Supply Chain Management	9
4	**Acquiring Information Systems and Applications :-** Acquiring Information Systems and Applications - Introduction -Planning for and Justifying IT Applications - Strategies for Acquiring IT Applications –Traditional Systems Development Life Cycle - Alternative Methods and Tools for Systems Development	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 Role and Impact of Information Systems in Organizations and Society	K2
CO2	Apply Knowledge of Information Security to Protect Organizational and Personal Assets	K3
CO3	Describe data and knowledge management principles and their importance in business decision-making	K2
CO4	Integrate and Manage Information Systems to Improve Organizational Efficiency	K3
CO5	Implement Information Systems Using Appropriate Development and Acquisition Strategies	K3

Note: *K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create*

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		1
CO2	3	3	3							3		3
CO3	3	3	3							3		3
CO4	3	3	3							3		3
CO5	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 information systems: supporting and transforming business	Rainer, R. Kelly; Brad Prince	Wiley	3/e, 2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Management Information System	C. Laudon Kenneth P. Laudon Jane	Pearson	13/e, 2008
2	E-Business and E-Commerce Management: Strategy, Implementation and Practice	Dave Chaffey	Pearson	5/e, 2013
3	Business Process Change	Paul Harmon	Elsevier	4/e, 2019

SEMESTER S6

DATA COMPRESSION

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

Course Code	PECST614	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basic Compression Techniques :-** Data Compression Approaches - Variable-Length Codes, Run-Length Encoding, Space - Filling Curves, Dictionary-Based Methods, Transforms, Quantization. Huffman Encoding - Huffman Decoding, Adaptive Huffman Coding, Facsimile Compression. Run Length Encoding (RLE), RLE Text compression, Dictionary based Coding- LZ77, LZ78, LZW and Deflate: Zip and Gzip compression.	10
2	**Advanced Techniques :-** Arithmetic Coding : The Basic Idea, Implementation,Underflow; Image Compression- Introduction, Approaches to Image Compression, History of Gray Codes, Image Transforms, Orthogonal Transforms, The Discrete Cosine Transform, Intermezzo: Statistical Distributions, JPEG, Human Vision and Color, The Wavelet Transform, Filter Banks, WSQ, Fingerprint Compression	10
3	**Video Compression :-** Video Compression - Analog video, Digital Video, Motion Compensation. MPEG standards MPEG, H.261	8

4	**Audio Compression –** Audio Compression - Companding, The Human Auditory System, [illegible] Using [illegible], 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 Outcomes	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- Analyze; K5- Evaluate; K6- Create

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	2									3
CO3	3	3	3									3
CO4	2	3	3									3
CO5	3	3										2

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Concise Introduction to Data Compression	David Salomon	Springer	1st, 2008
2	Data compression: The Complete Reference	David Salomon	Springer	4th, 2006
3	Introduction to Data Compression	Khalid Sayood	Morgan Kaufmann	3rd, 2005

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	1st, 1999
2.	Multimedia System	Steinmetz	Springer	1st, 1998
3.	The Data Compression Book	Mark Nelson, Jean-loup Gailly	BPB Publications	1st, 1998

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	An Introduction to Information Theory by Prof. Adrish Banerjee at IIT Kanpur https://onlinecourses.nptel.ac.in/noc22_ee69/preview

SEMESTER S5

COMPUTATIONAL BIOLOGY

Course Code	PEADT524	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 expertise in Computational Tools and Techniques for Biological Data Analysis
2. To equip students with hands-on experience in applying computational tools and software to biological problems and to familiarize them to current research trends in computational biology.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to bioinformatics, DNA, RNA, and Protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, translation, introduction to structure of prokaryotic and eukaryotic gene	9
2	Introduction to Biological Databases: NCBI, Genbank, Bio sequence formats: FASTA, Sequence alignment: Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices: PAM and BLOSUM, Database Similarity Searching, BLAST, Needleman and Wunsch and Smith-Waterman Method, Multiple Sequence Alignment, scoring function, Clustal,	10
3	Transcriptional Regulatory Networks: Genes and DNA Regulatory Regions, Genetic Interaction Map, Protein Interaction Networks, Experimental methodologies to obtain Protein Interaction Data, Computational methods to Predict Protein Protein Interactions, Visualization of Protein Interaction Networks, Metabolic Networks, Interacting Partners, Mathematical Representation.	10
4	Next-Generation Sequencing (NGS) Technologies, Illumina Reversible Dye-Terminator Sequencing, Ion Torrent Semiconductor Sequencing, Pacific	9

	Fluorescence Single Molecule Real-Time (SMRT) Sequencing, RNA sequencing (RNA-Seq), Protein-DNA Interaction Analysis (ChIP-Seq), Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Mapping Approaches and Algorithms	

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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 Outcomes		Bloom's Knowledge Level (KL)
CO1	Demonstrate the structure and function of DNA, RNA proteins, their structures and process of transfer of information from DNA to protein	K2
CO2	Identify biological data formats and databases and employ similarity searching tools and algorithms to align sequences to highlight the similarity	K3
CO3	Demonstrate Networks in Biology, types of networks and its representation	K3
CO4	Explain Next Generation sequencing Technologies and DNA Protein interaction analysis	K2
CO5	Apply computational tools and algorithms to analyze NGS data	K3

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

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	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	2	2									2

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Introduction to Bioinformatics	Lesk, Arthur M.	Oxford University Press	5th, 2019
2	Bioinformatics and Computational Biology A Primer for Biologists	Basant K. Tiwary	Springer Nature Singapore	1st, 2022
3	Bioinformatics An Introduction	Jeremy Ramsden	Springer London	3rd,2015
4	An Introduction to Bioinformatics Algorithms	Neil C. Jones, Pavel Pevzner	MIT Press	1st, 2004
5	Next Generation Sequencing Data Analysis	Wang, Xinkun	CRC Press	1st, 2016

Reference Books				
Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Bioinformatics and Computational Biology: A Primer for Biologists	Tiwary, Basant K.	Springer	1st, 2022
2	Quantitative Molecular Biology: An Introductory Course for Mathematicians, Physicists, and Computational Scientists	[illegible], Philip N.	Cold Spring Harbor Laboratory Press	1st, 2014
3	Bioinformatics	Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart	John Wiley & Sons	4th, 2020
4	Essentials of Bioinformatics	Shaik, Noor Ahmad, et al	Springer	1st, 2019
5	Applied Bioinformatics	Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer	Springer, Verlag	1st, 2008
6	Bioinformatics: Methods and Applications	S C Rastogi, N Mendiratta and P Rastogi	PHI Learning Private Limited	4th, 2013
7	Fundamental Concepts of Bioinformatics	D E Krane and M L Raymer	Pearson Education	1st, 2006
8	Bioinformatics: Sequence and Genome Analysis	Bradley K. Shapiro and Jennifer J. Dudock	Oxford Science	1st, 2007

Video Links (NPTEL, SWAYAM…)	
Module No.	
1	https://onlinecourses.swayam2.ac.in/cec21_bt04/preview
2	https://onlinecourses.nptel.ac.in/noc20_bt28/preview
3	https://onlinecourses.nptel.ac.in/noc22_bt54/preview
4	https://onlinecourses.nptel.ac.in/noc22_bt54/preview

SEMESTER S5

COMPUTER GRAPHICS & MULTIMEDIA

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

Course Code	PECST527	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	algorithm, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithm. **Three dimensional graphics** - Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm.	
4	**Fundamental of Multimedia** - Introduction to Multimedia, Authoring and Tools, Graphics and Image Data Representations, Popular File Formats, Fundamental Concepts and types of Video, Basics of Digital Audio and its types. **Compression Methods** - Lossless Compression Algorithms- Run-Length Coding, Arithmetic Coding. Lossy Compression Algorithms- Transform Coding. JPEG and JPEG-LS Standard. Image Compression, H.261. Video Compression Technique.	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles of computer graphics and displays	K2
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	K3
CO3	Illustrate 2D and 3D basic transformations and matrix representation	K3
CO4	Demonstrate different clipping algorithms and 3D viewing pipeline.	K3
CO5	Summarize the multimedia features and specific compression algorithms.	K2

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

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

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

Note: *1- Slight (Low), 2- Moderate (Medium), 3- Substantial (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, Debashish Jana	PHI	1st, 2010
2.	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4th, 2013
3.	Fundamentals of Multimedia	Ze-Nian Li and Mark S. Drew	Pearson	2003

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

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

SEMESTER S8

ADVANCED COMPUTER ARCHITECTURE

Course Code	PECST528	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PBCST404	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	branch predictors Dynamic Scheduling – Idea, Introduction to Tomasulo's scheme, Register Renaming, Hardware Speculation, Reorder Buffer Multiple issue and static scheduling, VLIW	
3	Data Level Parallelism: Vector Processor – How do they work, Memory Banks, Stride, Scatter Gather. SIMD-comparison with vector GPU, Comparison of loops in C vs CUDA. NVIDIA GPU Memory structure Vector Processor vs GPU, Multimedia SIMD computers vs GPU Multiprocessor Architecture, Centralized shared memory architecture Cache coherence and snooping protocol (Implementation details – not required). Performance of Symmetric Shared-Memory Processors. Distributed Shared Memory and Directory based protocol – basics. Synchronization – Basic Hardware Primitives. Memory Consistency Models – Sequential and relaxed.	9
4	Warehouse Scale Computers – Goals and requirements. Programming frameworks for Batch processing – Map reduce and Hadoop Computer Architecture of Warehouse-scale computers Moore's Law, Dennard Scaling, Dark Silicon and the transition towards Heterogeneous Architectures Asymmetric multi-core architecture – Static and Dynamic (Overall Idea, example processors) Functional Heterogeneous Multicore architecture – GPUs, Accelerators, Reconfigurable Computing Beyond the textbook – Identify the processor used in your PC and mobile phone. Study about its architecture, is it homogeneous or heterogeneous, does it use GPUs, what information can you gather about it from the manufacturer's website – Discuss in the class	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Summarize the different classes of computers and where they are used in everyday life.	K2
CO2	Compare the effect of hardware/software enhancements on the speedup of a processor using Amdahl's law.	K3
CO3	Interpret possible dependencies that can cause hazards in a given block of code.	K3
CO4	Summarize different strategies followed to ensure Instruction Level Parallelism.	K2
CO5	Compare different strategies followed to ensure Instruction Level Parallelism and different strategies followed to ensure Data Parallelism.	K3
CO6	Illustrate the need for memory consistency models and cache coherence protocols and explain the principle behind it.	K3

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer architecture: A Quantitative Approach	Hennessy, J. and Patterson, D	Morgan Kaufman	5th, 2012
2	The Dark Side of Silicon: Energy Efficient Computing in the Dark Silicon Era	Rahmani, Amir, et al.	Springer	1st, 2017

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

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/102/106102229/

SEMESTER S5

FUNDAMENTALS OF DIGITAL IMAGE PROCESSING

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

Course 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 - contrast, acuity, 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 of the second derivative, Scale in Image Processing, Canny Edge Detection, Parametric Edge Models, Edges in Multi-spectral images, Line detection by	9

	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. Mean shift segmentation, Fuzzy connectivity, Introduction to 3D graph-based image segmentation. Matching, Template Matching, Control Strategies Templating, Evaluation Issues In Segmentation.	8
4	Image Transforms - 2D Fourier transform, Discrete Cosine Transform, Wavelet transform, Eigen-analysis, Singular value decomposition, Principal component analysis. Image texture - Statistical texture description, Methods Based On Spatial frequencies, Co-occurrence matrices, Edge frequency, Primitive Length(run length), texture energy measures, Local Binary Patterns LBPs, Fractal texture description, Other Statistical Methods Of Texture Description. Introduction to Object recognition - Knowledge representation, Statistical pattern recognition, Classification principles, Minimum distance classifier learning and classification, Nearest neighbor search with K-D trees.	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

1. Understanding of Core Concepts (30%)

- Fundamentals: Grasp of basic image processing concepts such as pixel operations, color models, and image transformations.
- Algorithms: Knowledge of common image processing algorithms like filtering, edge detection, and image segmentation.
- Mathematics: Proficiency in the mathematical principles underlying image processing techniques, such as linear algebra and calculus.

2. Application of Techniques (25%)

- Practical Skills: Ability to implement and apply image processing techniques using software tools or programming languages (e.g., MATLAB, Python with libraries like OpenCV).
- Problem Solving: Capability to choose appropriate algorithms for specific image processing tasks and troubleshoot issues effectively.

3. Analysis and Interpretation (25%)

- Evaluation: Skill in analyzing the results of image processing operations and evaluating their effectiveness.
- Comparative Analysis: Ability to compare and contrast different methods or algorithms and justify the choice of one over another.

4. Project and Case Study Work (20%)

- Project Execution: Ability to complete a project involving image processing from start to finish, including defining objectives, implementing solutions, and presenting findings.
- Case Study Analysis: Skill in analyzing real-world case studies or datasets to apply theoretical knowledge and solve practical problems.

Sample problems for assessment:

1. Develop a program that reads an input image and manipulates its resolution in the spatial and grey domains; for a range of images (synthetic, of man-made objects, of natural scenes) conduct experiments and make an assessment on the minimum resolution that leaves the image recognizable.
2. Write a program that computes an image histogram; plot the histogram of a range of images. Also acquire an RGB image and develop a program to obtain the YIQ and HSI representations. Also plot the histogram of the three components of a color image when represented as (a) RGB (b) YIQ (c) HSI
3. Develop programs for spatial domain image preprocessing techniques and provide a quantitative analysis of the effectiveness of different methods.
4. Develop a program for training and classification using the minimum distance classifier. Assess classification correctness: (a) Train and test using data sets TRAIN1 and TEST1. (b) Train and test using data sets TRAIN2 and TEST2.
5. Using the World Wide Web, find several images of dissimilar homogeneous textures (Brodatz textures [Brodatz, 1966] from a Web-based database may be a good choice)

   1. Create your personal database TD1 from these images of at least 8 texture types ranging gradually from fine to coarse.

   2. Create a texture database TD2 of three dissimilar texture classes with at least ten images belonging to each class.

   3. Create a database TD3 of at least three homogeneous directional textures (use preferably several images from each class) and rotate each in 9 random angles this will form a database of 30 directional images for each texture.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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	Analyze the preparation of monochrome/colour images along with the effect of different types of noise in images.	K4
CO2	Apply different programming techniques to visualize image enhancement	K3
CO3	Understand and evaluate the different methods of image segmentation techniques.	K2
CO4	Analyze and evaluate the various transforms and the different image compression techniques used in image processing.	K3
CO5	Create a feature database for an object recognition problem.	K6

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

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	Fundamentals of Digital Image Processing	Anil K. Jain	Pearson	1st, 2015
2	Digital Image Processing	Rafael Gonzalez, Richard Woods	Pearson	4th, 2018
3	Digital Image Processing	S Jayaraman, S Esakkirajan, T Veerakumar	McGraw Hill	2nd, 2020
4	Fundamentals of Digital Image Processing	Anil K. Jain	Pearson	1st, 2015

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

SEMESTER S5

ROBOTICS LAB

Course Code	PCADL507	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 students with exposure to the common sensor and actuator interfacing, setting up mobile robots and familiarizing intelligent systems.

Expt. No.	Experiments
PART A	
1	Familiarization of Arduino IDE,Arduino microcontroller I/O interfacing(LED, LCD,Serial Monitor)
2	Interfacing IR and Ultrasonic sensor with Arduino
3	Interfacing DC motors with arduino - speed and direction control
4	Interfacing Servo Motors with Arduino - angle of rotation
5	Familiarization of Raspberry Pi and its I/O interfacing
6	Mobile Robot assembly
7	Networking with Arduino using BLE
PART B	
8	Writing a Simple Publisher and Subscriber, Simple Service and Client, Recording and playing back data, Reading messages from a bag file(Python/C++)
9	Localization of a mobile robot using LIDAR (ROS)

10	Implementing a weather station using Raspberry pi
11	Line following Robot using IR sensor
12	Image Recognition using ESP32 CAM module
13	Obstacle avoidance of a mobile robot while moving to a point
14	Navigation simulation using turtlebot in ROS

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

	Course Outcomes	Bloom's Knowledge Level (KL)
CO1	Interface different peripherals to Arduino and Raspberry Pi.	K3
CO2	Assemble a mobile robot with different sensors and actuators	K3
CO3	Familiarize about localization of mobile robots	K3
CO4	Impart intelligence to robot using standard algorithms	K3
CO5	Familiarize the robot navigation	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, 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										1
CO2	3	3										1
CO3	2	2			2							2
CO4	3	3	3	3	3							1
CO5	2	3	3	3	3							2

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Autonomous Mobile Robots	Siegwart, Roland	MIT Press,	2/e, 2004
2	Robotics, Vision and Control : Fundamental Algorithms in MATLAB	Peter Corke	Springer	2011
3	Introduction to Robotics	John J Craig	Pearson Education Asia	2005
4	Introduction to Robotics	SK Saha	Mc Graw Hill Education	2004
5	Robotics and Control	RK Mittal and I J Nagrath	Tata McGraw Hill	2003
6	Robotic Tactile Sensing	Dahiya, Ravinder S., Valle, Maurizio	Springer	2013
7	https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/			

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 (20 Marks)

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

5. Record (5 Marks)

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

SEMESTER S6

DATA ANALYTICS LAB

Course Code	PCCDL608	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)	PCCST303	Course Type	Lab

Course Objectives:

1. To impart the knowledge on the Big Data Technologies for processing the Different types of Data. Configure Hadoop and perform File Management Tasks
2. To enable the learner to analyze big data using machine learning techniques

Expt. No.	Experiments
1	Set up and install Hadoop and explore the various shell commands in Hadoop and Implement file management tasks.
2	Implement a word count program using Map Reduce to find the number of occurrences of specific keywords from an input file.
3	Using the structure of the Word Count program, write a Hadoop program that calculates the average word length of all words that start with each character.
4	Write a Map Reduce program for removing stop words from the given text files
5	Implement matrix multiplication with Hadoop Map Reduce.
6	Implement Pig Latin scripts to sort, group, join, project, and filter data.
7	Implementing Database Operations on Hive
8	Write an R program to find the factorial and check for palindrome.
9	Implement a program to find variance, covariance and correlation between different types of attributes
10	Write an R program to solve linear regression and make predictions.
11	Write an R program to solve logistic regression.

12	Implement SVM and Decision tree Classifier using R.
13	Implement KNN and Naive Bayes Classifier using R.
14	Implement a Spark program that does the following: i) Count the total number of observations included in the dataset ii). Count the number of years over which observations have been made iii) Display the oldest and the newest year of observation.
15	Implement clustering techniques using SPARK.

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 Outcomes		Bloom's Knowledge Level (KL)
CO1	Configure Hadoop and perform File Management Tasks	K3
CO2	Implement different tasks using Hadoop Map Reduce programming model	K3
CO3	Apply different data processing tools like Pig and Hive to real time issues like weather dataset and sales of a company	K3
CO4	Implement data extraction from files and analyze big data using machine learning techniques in R.	K3
CO5	Illustrate the knowledge of Spark to analyze data in real-life scenarios	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mastering Apache Spark	Mike Frampton	Packt Publishing	1st,2015
2	Hadoop: The Definitive Guide	Tom White	O'reilly Media	4th, 2015
3	Machine Learning with Spark	Nick Pentreath	Packt Publishing	1st, 2015
4	Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large Scale Data Analysis	Mohammed Guller	Apress	1st,2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Big Data Fundamentals: Concepts, Drivers & Techniques	Thomas Erl, Wajid Khattak, and Paul Buhler	Pearson	1st,2016
2	Programming Pig: Dataflow Scripting with Hadoop	Alan Gates	O'Reilly	1st, 2011
3	Programming Hive	Jason Rutherglen, Dean Wampler, Edward Capriolo	O'Reilly	1st, 2012
4	BIG DATA	Black Book TM	DreamTech	1st,2016

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	Big Data Computing: https://nptel.ac.in/courses/106104189
2	Data Science on Apache Spark: Databricks: https://databricks.com/blog/2015/06/01/databricks-launches-mooc-data-science-on-spark
3	Advanced R Programming for Data Analytics in Business https://nptel.ac.in/courses/110104113

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

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

SEMESTER S5

DEEP LEARNING

Course Code	PCADT501	**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)	PCCST503	**Course Type**	Theory

Course Objectives:

1. To get an insight into various design parameters of a deep learning model.
2. To introduce deep learning architectures for various domains such as text, multimedia and GenAI tools.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Deep learning**: Introduction, Deep feed forward network, Activation functions – Sign, Sigmoid, Tanh, ReLU, leaky ReLU, Hard Tanh, Softmax, Loss function, Training a Neural Network with Backpropagation, Practical issues in neural network training: Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance.	10
2	**Network Design parameters**: Introduction, setup and initialization: Kaiming, Xavier weight initialization, Vanishing and exploding gradient problems, Optimization techniques - Gradient Descent (GD), Stochastic GD- GD with momentum, GD with Nesterov momentum, Parameter specific learning rates: AdaGrad- RMSProp- Adam. Regularization Techniques - L1 and L2 regularization- Early stopping, Dataset augmentation- Parameter tying and sharing, Ensemble methods- Dropout- Batch normalization.	12
3	**Convolutional Neural Networks**: Basic structure of a CNN, Basic layers and operations in CNN: Convolution operation: effect of stride and padding, Fully Connected layers, CNN layers, Building a CNN model, Training a CNN, Estimation of Tensor size number of features in CNN layers, Transfer	11

	learning (loss similarity metric) Pretrained architectures: AlexNet, ResNet-18, GoogleNet	
4	**Deep learning models for text processing:** Recurrent Neural Network architecture; Variants of RNN architectures: Deep Recurrent Neural Networks- Recursive Neural Network- Bidirectional recurrent neural network, Encoder-Decoder architecture, LSTM, GRU. **Auto Encoders and Generative models:** Autoencoders- Variational AutoEncoders-under complete Auto-encoder, stochastic encoder, denoising encoder, Applications of Autoencoders. Generative models - Boltzmann machines, Deep Belief Networks, Generative Adversarial Networks	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 Outcomes		Bloom's Knowledge Level (KL)
CO1	Outline the standard regularization and optimization techniques for the effective training of deep neural networks	K3
CO2	Use Convolutional Neural Network (CNN) models and pretrained networks for different use cases.	K3
CO3	Apply the concepts of Recurrent Neural Network, its variants and familiarize natural language processing fundamentals.	K3
CO4	Apply the concepts of auto encoder, generative models for advanced AI operations	K3
CO5	Apply the concepts of generative models for advanced AI operations	K3

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

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
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 Authors	Name of the Publisher	Edition and Year
1	Deep Learning	Goodfellow, I., Bengio, Y., and Courville, A.	MIT Press	1st, 2016
2	Neural Networks and Deep Learning	Aggarwal, Charu C.	Springer International	1st, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Deep Learning, Core Concepts, Methods and Applications	M Gopal	Pearson Education	1st, 2022
2.	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms	Nikhil Buduma and Nicholas Locascio	O'Reilly Media	1st, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://d2l.ai/
2	https://nptel.ac.in/courses/106106184
3	https://cs230.stanford.edu/
4	https://study.iitm.ac.in/ds/course_pages/BSCS3004.html

SEMESTER S6

INTERNET OF THINGS

Course Code	PCADT602	**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 fundamentals of IoT architecture, including its origins, impact, and the convergence with IT.
2. To explore the components of IoT networks such as smart objects, sensors, actuators, and communication technologies, with a focus on IP optimization and application protocols.
3. To learn about data analytics for IoT, covering machine learning, big data tools, and methods for securing IoT systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**IoT Architectures** - What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures. Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.	8
2	**Engineering IoT Networks** - Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks,Connecting Smart Objects, Communications Criteria, IoT Access Technologies. IoT Network Layer: IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT.	14
3	**IoT protocols** – Application Protocols for IoT(COAP, MQTT, SMAP, SOAP, HTTP only), Transport Layer, IoT Application Transport Methods.	12

	Data Analytics for IoT: Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology.	
4	Developing IoT Systems - IoT Logical Design using Python, IoT Physical Devices and Endpoints - Raspberry Pi interfaces, Programming Raspberry Pi using Python, WAMP. Developing Tools: Arduino, Apache NetBeans, Kinoma, IBM Watson IoT, Node-RED) Case study: IoT in Agriculture, IoT in Smart city.	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 Outcomes		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of IoT architecture, including its genesis and impact	K2
CO2	Learn to engineer IoT networks with smart objects, sensors, and actuators.	K2
CO3	Become familiar with IoT protocols such as XMPP, MQTT, CoAP, SOAP, and HTTP.	K2
CO4	Develop skills in data analytics for IoT, using machine learning and big data tools.	K3
CO5	Gain practical experience in developing IoT systems using Python, Raspberry Pi, and Arduino.	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3	3			2							
CO3	3											
CO4	3											
CO5	3		2		2		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	IoT Fundamentals: Networking Technologies, Protocols, and use cases for the Internet of Things	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry	Pearson Education	1st, 2018
2	Internet of Things: A hands-on approach	Arshdeep Bahga, Vijay Madisetti	University Press	1st, 2014

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	1st,2017
2	Architecting the Internet of Things	Dieter Uckelmann, Mark Harrison, Florian Michahelles	Springer Science & Business Media,	1st, 2011
3	Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems	Dr. Ovidiu Vermesan, Dr. Peter Friess.	River Publishers	1st, 2013
4	Programming Arduino: Getting Started with Sketches	Simon Monk	McGraw Hill	1st, 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1,2,3	https://onlinecourses.nptel.ac.in/noc22_cs53/preview

SEMESTER S6

SOFTWARE TESTING

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

Course Code	PECST631	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Testing & Automation:-** Introduction to Software Testing - Concepts, importance of testing, software quality, and real-world failures (e.g., Ariane 5, Therac 25), Software Testing Processes - Levels of thinking in testing; Testing Terminologies - Verification, validation, fault, error, bug, test cases, and coverage criteria; Types of Testing - Unit, Integration, System, Acceptance, Performance (stress, usability, regression), and Security Testing; Industry Trends - AI in test case automation, Introduction to GenAI in testing; Testing Methods - Black-Box, White-Box, and Grey-Box Testing; Automation in Testing - Introduction to automation tools (e.g., Selenium, Cypress, JUnit); Case Study- Automation of Unit Testing and Mutation Testing using JUnit.	9
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	9

	generation and optimization, impact on automation; Industry Tools - Application of AI-driven testing tools in automation and predictive testing; Case Study - Mutation testing using PIT, 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.	[illegible]
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.	[illegible]

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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.	K3
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									1
CO2	3	3	3	3	2							1
CO3	3	3	3									1
CO4	3	3	3	3								1
CO5	3	3	3		3							1
CO6	2	3	3	1	2							1

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	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 Patton	Pearson	2/e, 2006
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/108/101/108101[illegible]/
2	https://archive.nptel.ac.in/courses/108/101/108101[illegible]/
3	https://archive.nptel.ac.in/courses/108/101/108101[illegible]/
4	https://archive.nptel.ac.in/courses/108/101/108101[illegible]/

SEMESTER S5

COMPUTATIONAL LINGUISTICS

Course Code	PEADT522	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 and methodologies in computational linguistics.
2. To equip the practical skills in applying language processing tools, such as Python and NLTK.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Linguistic Essentials-** Parts of Speech and Morphology, Nouns and Pronouns, Words that Accompany Nouns: Determiners and Adjectives, Verbs, Other Parts of Speech, Phrase Structure, Phrase Structure Grammars, Semantics and Pragmatics, Corpus-Based Work, The Ambiguity of Language (NLP Challenges). **Mathematical Essentials-** Probability Theory, Probability Space, Conditional Probability and Independence, Bayes Theorem, Random Variables, Expectation and Variance, Notation, Joint and Conditional Distributions, Standard Distributions, Bayesian Statistics.	12
2	**Statistical Inference:** n-gram Models over Sparse Data, Bins: Forming Equivalence Classes, Reliability vs Discrimination, n-gram Models **Markov Models-** Hidden Markov Models, Use of HMMs, General Form of HMM, Probability of an Observation, Best State Sequence	8

3	Word Sense Disambiguation: Methodological Preliminaries, Supervised and unsupervised learning, Pseudowords, Upper and lower bounds on performance. Supervised Disambiguation, Bayesian classification, Dictionary based Disambiguation, Disambiguation based on sense definitions, Thesaurus based disambiguation, Lexical Acquisition, Evaluation Measures, Verb subcategorization, Attachment Ambiguity, PP attachment, Selectional preferences, Semantic Similarity, Word2Vec and Doc2Vec	10
4	Grammars and tools: Part-of-Speech Tagging, The Information Sources in Tagging, Markov Model Taggers, Hidden Markov Model Taggers, Applying HMMs to POS Tagging, Probabilistic Context Free Grammars, Some Features of PCFGs, Questions for PCFGs, The Probability of a String, Using Inside Probabilities, Using Outside Probabilities, Finding the Most Likely Parse for a Sentence, Parsing for Disambiguation, Parsing Model versus Language Model, Language Processing with Python using NLTK	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 linguistic concepts, including parts of speech, morphology, phrase structure, semantics, and pragmatics to analyze natural language data.	K2
CO2	Describe probabilistic and statistical models, such as n-gram models and Hidden Markov Models (HMMs), to process and predict linguistic patterns in sparse data.	K2
CO3	Demonstrate knowledge of word sense disambiguation techniques, including supervised and unsupervised learning methods.	K2
CO4	Evaluate and employ lexical acquisition methods, such as verb subcategorization and semantic similarity measures	K3
CO5	Utilize computational tools and grammars, such as part-of-speech tagging, probabilistic context-free grammars (PCFGs), and Python NLTK, to develop and implement language processing applications	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3			3							
CO3	2	2			2							
CO4	3	3			3							
CO5	2	2			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 Authors	Name of the Publisher	Edition and Year
1	Foundations of Statistical Natural Language Processing	C.D. Manning H. Schutze	MIT Press	1st, 1999
2	Natural Language Processing with Python and NLTK	Steven Bird, Ewan Klein, Edward Loper	O'reilly Pub	1st, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Speech and Language Processing Introduction to Natural Language Processing Computational Linguistics and Speech Recognition, PHI	D. Jurafsky, JH Martin	Pearson	1st., 2008
2	Natural Language Understanding	James Allen	Benjamin-Cummings	1st., 1988
3	Natural Language Processing: Python and NLTK	Nitin Hardeniya, Jacob Perkins, Deepti Chopra, Nisheeth Joshi, Iti Mathur	Packt Publishing	1st., 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1,2,3	https://onlinecourses.nptel.ac.in/noc20_cs87/preview

SEMESTER S6

MACHINE LEARNING IN COMPUTATIONAL BIOLOGY

Course Code	PEADT633	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	Course Type	Theory

Course Objectives:

1. To familiarize students with a foundational understanding of computational biology, including its scope, significance and key challenges.
2. To introduce the ethical considerations, limitations, and challenges in applying machine learning to biological data, including issues related to data privacy, biases in algorithms, and the reproducibility of results.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Role of Machine Learning in Computational Biology Introduction - Creation and analysis of sequence data, Challenges of Machine Learning in Computational Biology, Future directions of Machine Learning in Computational Biology.	8
2	Clustering problems Computational Biology Hierarchical Clustering, Partition Clustering, Overview- Model-Based Clustering, k-Means clustering, k-Means clustering algorithm, Advantages, Disadvantages, illustrative example of k- Means clustering, Clustering for creating phylogenetic trees, Using Clustering Approach to Identify Patients' Subtypes, Application of clustering algorithms on gene expression data.	9

3	**Supervised techniques for Computational Biology** Proteomics Datasets, Data Preprocessing Algorithms, Dimension and Feature Subset Selection, Partial Least Squares (PLS), Linear Discriminant Analysis (LDA), Protein Classification, Support Vector Machine with Feature Elimination. Data Errors, Mean Square Error Generative versus Discriminative, Approximation Versus Explanation, Single Versus Multiple Methods.	10
4	**Machine Learning Algorithms for Computational Biology** Machine-Learning Algorithms for Feature Selection from Gene Expression Data, Feature Extraction and Feature comparison from sequence data, measures of a Feature, Dimensionality reduction - Principal Component Analysis (PCA), Decision Trees in Bioinformatics, Artificial Neural Network (ANN) in Bioinformatics, Genetic Algorithms (GA) in Bioinformatics.	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 basic concepts of Machine Learning, Classification, regression and clustering problems, parameters and measures	K2
CO2	Demonstrate the clustering algorithm on computational biology problems	K3
CO3	Apply Dimensionality reduction techniques and Decision Trees in computational biology	K3
CO4	Illustrate Feature Extraction and Pattern recognition and Classification in the domain of Computational Biology analysis	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									2
CO2	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	Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications	K. G. Srinivasa, G. M. Siddesh, S. R. Manisekhar	Springer	1st, 2020
2	Machine Learning Approaches in Bioinformatics	Zheng Rong Yang	World Scientific	1st, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Deep Learning in Bioinformatics: Techniques and Applications in Practice	Izadkhah, Habib	Elsevier	1st, 2022
2.	Artificial Intelligence in Bioinformatics: From Omics Analysis to Deep Learning and Network Mining	Agapito, Giuseppe, et al.	Elsevier	1st, 2022
3.	Data Analytics in Bioinformatics: A Machine Learning Perspective	Rabinarayan Satpathy et. al.	Wiley	1st, 2021
4.	Introduction to Machine Learning and Bioinformatics	Michailidis, George, et al.	CRC Press	1st, 2008
5.	Machine Learning in Bioinformatics	Zhang, Yanqing, Rajapakse, Jagath C.	Wiley	1st, 2009

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_bt12/preview
2	https://onlinecourses.nptel.ac.in/noc22_bt12/preview

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.	8
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	8

	Schema, XML Documents, 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 databases - 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	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 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- Analyze; K5- Evaluate; K6- Create

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	2	2									3
CO3	3	3	3		2							3
CO4	2	2	2		2							3
CO5	3	3	2		3							3

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Database Systems	Ramez Elmasri, Shamkant B. Navathe	Pearson	7e, 2017
2	Database System Concepts	A. Silberschatz, H. Korth, S. Sudarshan	McGraw Hill	7e, 2021
3	Database Management Systems	R. Ramakrishnan, J. Gehrke	McGraw Hill	3e, 2018
4	Graph Databases	Ian Robinson, Jim Webber & Emil Eifrem	O'Reilly	2e, 2015
5	Database Systems	T. M. Connolly, C. Begg	Pearson	6e, 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	1e, 2018
2	Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems	M. Kleppmann	O'Reilly	1e,2017
3	Database Systems: The Complete Book	Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom	Prentice Hall	2e, 2009
4	Next generation databases: NoSQL, newSQL, and big data, Apress	Guy Harrison	Apress	1e, 2015
5	Foundations of Multidimensional and Metric Data Structures	Hanan Samet	Morgan Kaufmann	1e, 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/106/106/106106093
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

WEB MINING

Course Code	PEADT606	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 essential skills in web mining and social network analysis, covering theoretical foundations, association rule and sequential pattern mining, information retrieval, text preprocessing, advanced search techniques, and web crawling, preparing them to tackle real-world data analysis challenges effectively.
2. To impart in-depth knowledge and practical skills in structured data extraction and web usage mining, including wrapper generation, schema matching, and various extraction techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction – Web Mining – Theoretical background – Association rule mining – Sequential Pattern Mining -Information retrieval and Web search – Information retrieval Models-Relevance Feedback- Text and Web page Preprocessing – Inverted Index – Latent Semantic Indexing –Web Search – Meta-Search – Web Spamming	9
2	Introduction -Social Network Analysis- Co-Citation and Bibliographic Coupling- Page Rank- PageRank Algorithm, Link-Based Similarity Search, Enhanced Techniques for Page Ranking - HITS- HITS Algorithm, Finding Other Eigenvectors-Community Discovery- Problem Definition, Bipartite Core Communities Web Crawling :A Basic Crawler Algorithm- Breadth First Crawlers, Preferential Crawlers, Universal Crawlers- Focused Crawlers and Topical Crawlers	9
3	Structured Data Extraction: Wrapper Generation – Preliminaries- Wrapper Induction- Instance Based Wrapper Learning - Automatic Wrapper Generation: Problems - String Matching and Tree Matching -Multiple	9

	Alignment - Building DOM Trees - Extraction Based on a Single List Page and Multiple pages- Introduction to Schema Matching – Schema Level Match -Domain and Instance Level Matching – Extracting and Analyzing Web Social Networks.	
4	Web Usage Mining - Data Collection and Pre-Processing- Sources and Types of Data, Key Elements of Web Usage Data - Data Modelling for Web Usage Mining - Discovery and Analysis of Web Usage Patterns – Applications- Recommender Systems and Collaborative Filtering –Query Log Mining	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 data mining process and techniques, specifically those that are relevant to Web mining.	K2
CO2	Identify the use of Social Networks Analysis in Web Mining and basics of Information retrieval.	K3
CO3	Use different web crawling algorithms, such as breadth-first, preferential, universal, focused, and topical crawlers, to evaluate their effectiveness in gathering and processing web data	K3
CO4	Apply advanced solutions for structured data extraction, including innovative methods for wrapper generation, automatic wrappers, and matching techniques for various web pages.	K3

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data-Centric Systems and Applications)	Bing Liu.	Springer	2/e, 2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Mining the Web: Uncovering Patterns in Web Content, Structure, and Usage	Zdravko Markov, Daniel T. Larose	John Wiley & Sons,	1st, 2007
2	Web Mining and Social Networking: Techniques and Applications	Guandong Xu, Yanchun Zhang, Lin Li,	Springer	1st, 2010
3	Mining the Web: Discovering Knowledge from Hypertext Data	Soumen Chakrabarti	Morgan Kaufmann	1st, 2002
4	Graph-Theoretic Techniques for Web Content Mining	Adam Schenker	World Scientific Publishing	1st, 2005

SEMESTER S6

FUNDAMENTALS OF CRYPTOGRAPHY

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

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

Course Objectives:

1. To develop a foundational understanding of mathematical concepts in cryptography.
2. To gain comprehensive knowledge of cryptographic methods.

SYLLABUS

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

	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 certificate, 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- Analyze, K5- Evaluate, K6- Create

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								3
CO3	2	2	2									2
CO4	2	2	2									2

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography & Network Security: Principles and practice	William Stallings	Pearson	7th, 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	2E, 2007
2	Security in Computing	Charles P. Pfleeger, Shari L. Pfleeger, Jonathan Margulies	Prentice Hall	5e, 2015
3	A Classical Introduction to Cryptography: Applications for Communications Security	S. Vaudenay	Springer	1e, 2006
4	Introduction to Cryptography: Principles and Applications	H. Delfs, H. Knebl	Springer-Verlag	1E, 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/L27.html
3	https://onlinecourses.nptel.ac.in/noc22_cs90/preview

SEMESTER S6

QUANTUM COMPUTING

(Common to CS/CM/CR/AD/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 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	1	3									1
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 Authors**	**Name of the Publisher**	**Edition and Year**
1.	Quantum Computing: From Linear Algebra to Physical Realizations	Mikio Nakahara Tetsuo Ohmi	CRC Press	1st, 2008
2.	Quantum Computation and Quantum Information	Michael A. Nielsen & Isaac L. Chuang	Cambridge University Press	1st, 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Authors**	**Name of the Publisher**	**Edition and Year**
1.	Quantum Computing for Programmers	Robert Hundt	Cambridge University Press	1st, 2022
2.	Quantum Computing for Everyone	Chris Bernhardt	MIT Press	1st, 2019
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/[illegible]/
2	https://archive.nptel.ac.in/noc/[illegible]

SEMESTER S8

NATURAL LANGUAGE PROCESSING

Course Code	PEADT835	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	3/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To introduce the comprehensive understanding of Natural Language Processing (NLP)
2. To discuss various parsing techniques and ambiguity resolution
3. To discuss the advanced semantic interpretation and knowledge representation

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Natural Language Understanding and Linguistics: Levels of language analysis, Syntax, Semantics, Pragmatics. Linguistic Background, An Outline of English Syntax, Lexicons, POS Tagging, Word Senses Project 1: Comprehensive Analysis of English Language Processing: Syntax, Semantics, and Pragmatics using NLTK and spaCy	8
2	Parsing Techniques and Ambiguity Resolution: Grammars and Parsing Features, Agreement and Augmented Grammars, Grammars for Natural Language, Parsing methods and Efficient Parsing, Ambiguity Resolution, Statistical Methods, Probabilistic Context Free Grammar Project 2: Implementation and Evaluation of Probabilistic Context-Free Grammars (PCFG) for Natural Language Parsing using NLTK	8
3	Semantic Interpretation and Knowledge Representation in NLP: Semantics and Logical Form, Linking Syntax and Semantics, Ambiguity	10

	Resolution, other Strategies for Semantic Interpretation, Scoping and the Interpretation of Noun Phrases. Knowledge Representation and Reasoning, Local Discourse Context and Reference, Using World Knowledge, Discourse Structure, Defining a Conversational Agent. Project 3: Strategies for Semantic Interpretation and Ambiguity Resolution in NLP using NLTK and spaCy **Assignment:** Knowledge Representation and Reasoning for NLP Applications	
4	Language Models: Pre-trained Models-BERT, GPT-2, ELMO, RoBERT Applications and Challenges- Machine Translation, Information Retrieval and Extraction, Sentiment Analysis, Text Categorization and Summarization. Project 4: Strategies for Semantic Interpretation and Ambiguity Resolution in NLP using NLTK and spaCy	10

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Examination	Evaluate	Analyse	Total
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

1. Code Implementation (40%) – 8 Marks
   - Correctness (4 Marks): Implementation of the code correctly.
   - Efficiency and Robustness (4 Marks): Code optimization for efficiency.
2. Results Analysis (60%) – 12 Marks
   - valuation Metrics (6 Marks): Proper use of evaluation metrics
   - Insightful Analysis (6 Marks): Interpretation of the results

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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 syntax, semantics, and pragmatics in NLP tasks.	K3
CO2	Explain semantic lexicon usage, POS tagging, and word sense disambiguation.	K2
CO3	Implement and utilize various grammars and parsing methods, including resolving ambiguities.	K3
CO4	Link syntax and semantics, interpret noun phrases, and use knowledge representation for discourse management.	K3
CO5	Implement NLP models like BERT, GPT-2, ELMO, and RoBERT for tasks like machine translation, sentiment analysis, and text summarization.	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3	3										3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	3	3	2	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	Speech and Language Processing	D. Jurafsky and J. H. Martin	Prentice Hall India	1st, 2008
2	Natural Language Understanding	James Allen	Benjamin-Cummings	1st, 2008

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	Charniak, Eugene	Addison-Wesley	1st, 1985
2	Modern Information Retrieval	Ricardo Baeza-Yates and Berthier Ribeiro-Neto	Addison-Wesley	1st, 1999
3	Natural Language Processing and Information Retrieval.	U. S. Tiwary and Tanveer Siddiqui	Oxford University Press	1st, 2008

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1,2	https://onlinecourses.nptel.ac.in/noc24_cs68/preview
4	https://link.springer.com/chapter/10.1007/978-3-031-23190-2_2

SEMESTER 6

DATA MINING AND WAREHOUSING

Course Code	**PBADT604**	**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)	PBADT304	**Course Type**	Theory

Course Objectives:

1. To understand the principles of Data warehousing and Data Mining.
2. To be familiar with the Data warehouse architecture and its Implementation.
3. To perform classification, association, and prediction of data.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Data Mining:** Introduction, What is Data Mining, Definition, KDD, Challenges, Data Mining life cycle, Data Pre-processing concepts **Association Rule Mining:** - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.	18
2	**Cluster Analysis:** - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.	15
3	**Classification and Prediction:** - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.	15

4	Introduction To Data Warehousing : Evolution of Decision Support Systems. Data warehousing Components –Building a Data warehouse, Data Warehouse and DBMS, Data marts, Metadata, Multidimensional data model, OLAP vs OLTP, OLAP operations, Data cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations.	10

Suggestion on Project Topics

Students can implement various data related projects, from any domain, using the techniques studied in the syllabus. It may contain modules for data storage, data pre-processing and small levels of data mining to recognize patterns in the data. Socially relevant project domains are highly appreciated. Check the datasets available at https://www.kaggle.com/datasets and perform data pre-processing operations such as data cleaning, missing value management and mine useful information from the dataset.

A suggestive list of projects are added here. Similar projects could be added by concerned faculty:

1. Perform association techniques on customer data and agriculture data set
2. Create the data warehouse for any medical shop having 3 or more branches
3. Predict traffic conditions for allocating more buses on various routes by bus controller
4. Predict Job opportunities Computer IT field looking into the work generated last year

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	Comprehend the key process of data mining and Analyze the kinds of patterns that can be discovered by association rule mining	K3
CO2	Implement various clustering methods	K3
CO3	Identify interesting patterns from large amounts of data for predictions and classifications	K3
CO4	Understand warehousing architectures for organizing large database	K3
CO5	Use tools for systematically organizing large databases and use their data to make strategic decisions	K3

Note: *K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create*

CO-PO Mapping Table:

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Data mining Concepts and Techniques	Jiawei Han, Micheline Kamber, Jian Pei	Elsevier	3rd, 2011
2	Data Mining: Introductory And Advanced Topics	Margaret H Dunham	Pearson Education	1st,2006
3	Data Warehousing, Data Mining & OLAP	Alex Berson and Stephen J. Smith	Mc Graw Hill	1st, 2008
4	Introduction to Data Mining	Pang-Ning Tan, Michael Steinbach and Vipin Kumar	Pearson Education	1st, 2007

Reference Books

Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Insight into Data mining Theory and Practice	K.P. Soman, Shyam Diwakar and V. Ajay	Prentice Hall of India	1st,2006
2	Data Mining Techniques	Arun K. Pujari	Universities Press	4th, 2016
3	Introduction to Data Mining with Case Studies	G. K. Gupta	Prentice Hall of India	3rd, 2014

Video Links (NPTEL, SWAYAM…)

Module No.	Link ID
1	https://nptel.ac.in/courses/110107092
2	https://nptel.ac.in/courses/106105174

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 3 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 6

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									2
CO2	3	3	3									2
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 Authors	Name of the Publisher	Edition and Year
1	Fundamentals of Data Structures in C	Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed,	Universities Press	2nd, 2007
2	Introduction to Algorithms	Thomas H Cormen, Charles Leiserson, Ronald L Rivest, Clifford Stein	PHI	3rd, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Classic Data Structures	Samanta D	Prentice Hall India	2nd, 2018
2	Data Structures and Algorithms	Aho A. V., J. E. Hopcroft and J. D. Ullman	Pearson Publication	1st, 2003
3	Introduction to Data Structures with Applications	Tremblay J. P. and P. G. Sorenson	Tata McGraw Hill	2nd, 2007
4	Theory and Problems of Data Structures	Lipschutz S.	Schaum's Series	2nd, 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	8

	Keying (FSK), Phase Shift Keying (PSK). Analog data to analog signal - Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).	
3	Multiplexing - Frequency Division Multiplexing (FDM), Wavelength Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread spectrum techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).	9
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	K3
CO5	Use error detection, correction and switching techniques in data communication	K3

Note: K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create

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	2	2		2								2
CO4	2	2	2	2								2
CO5	2	2	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	Data Communications and Networking	Forouzan B. A.	McGraw Hill	4th, 2017
2	Data and Computer Communications	William Stallings	Pearson	10th, 2018

Reference Books				
S. 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 Factorization - 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	3rd, 2007
2	Security in Computing	Charles P. Pfleeger, Shari L. Pfleeger, Jonathan Margulies	Prentice Hall	5th, 2015
3	Introduction to Cryptography: Principles and Applications	H. Delfs, H. Knebl	Springer	1st, 2002
4	A Classical Introduction to Cryptography: Applications for Communications Security	Serge Vaudenay	Springer	1st, 2006

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

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://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	OECST694	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 a posteriori estimation (MAP), Bayesian formulation. **Supervised Learning** Feature Representation and Problem Formulation, Role of loss functions and optimization **Regression** - Linear regression with one variable, Linear regression with multiple variables - solution using gradient descent algorithm and matrix method.	10
2	**Classification** - Naïve Bayes, KNN **Generalisation and Overfitting** - Idea of overfitting, LASSO and RIDGE	8

	regularization, Ideas 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	
5	**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
6	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	3							2
CO3	3	3	3	3	3							2
CO4	3	3	3	3	3							2
CO5	3	3	3	3	3							2

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	3rd, 2014
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki, Wagner Meira	Cambridge University Press	1st, 2014

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	1st, 2018
3	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1995
4	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	1st, 2012
5	The Elements Of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer	2nd, 2009

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://youtu.be/[illegible]
2	https://youtu.be/[illegible]
3	https://youtu.be/[illegible]
4	https://youtu.be/[illegible]

SEMESTER S3

OBJECT ORIENTED PROGRAMMING

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

Course Code	GECST305	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Java - Java programming Environment and Runtime Environment (Command Line & IDE); Java compiler; Java Virtual Machine; Primitive Data types and Wrapper Types; Casting and Autoboxing; Arrays; Strings; Vector class; Operators - Arithmetic, Bitwise, Relational, Boolean Logical, Assignment, Conditional (Ternary); Operator Precedence; Control Statements - Selection Statements, Iteration Statements and Jump Statements; Functions; Command Line Arguments; Variable Length Arguments; Classes; Abstract Classes; Interfaces; OOP Concepts - Data abstraction, encapsulation, inheritance, polymorphism, Procedural and object oriented programming paradigm; Microservices; Object Oriented Programming in Java - Declaring Objects; Object Reference; Introduction to Methods; Constructors; Access Modifiers; this keyword.	18

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

Note: *K1- Remember, K2- Understand, K3- Apply, K4- Analyze, 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: 8, 10, 1, 2, 3, 4)
2	https://nptel.ac.in/courses/106105191 (Lecture no: 6, 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 06

DEEP LEARNING LAB

Course Code	BCADL607	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:2:0	SEE Marks	50
Credits	2	Exam Hours	3 Hrs. 30 Min.
Prerequisites (if any)	[illegible] [illegible]	Course Type:	Lab

Course Objectives:

1. To get hands-on experience in machine learning.
2. 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	Implement a Python program to perform logistic regression on a dataset.
3	Write a Python program to implement Naïve Bayes classifier and calculate the accuracy, precision, and recall for your data set.
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	Assuming a set of data that need to be classified, use a Support Vector Machine classifier to perform this task and evaluate the accuracy.
6	Implement any 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. Analyze 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 pretrained 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 naive bayes, decision tree, ANN and SVM.	K3
CO2	Implement a deep learning model for computer vision tasks and increase the performance of the model through hyper parameter tuning.	K4
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.	K4
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	3	3	2	3	3	2		1				2
CO2	1	1	1	1	3	3		1				3
CO3	1	1	3	3	3	3		1				3
CO4	1	1	3	3	2	3		1				3

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Authors**	**Name of the Publisher**	**Edition and Year**
1	Hands-On Machine Learning with Scikit-Learn and TensorFlow	Aurélien Géron	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 Authors**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	2/e,2010
2	Deep Learning	Goodfellow, I., Bengio, Y., and Courville, A.	MIT Press	1/e,2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://d2l.ai
2	https://onlinecourses.nptel.ac.in/noc23_cs87/preview
3	https://nptel.ac.in/courses/106106184

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

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

SEMESTER S7

FORMAL METHODS IN SOFTWARE ENGINEERING

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

Course Code	PECST7[illegible]	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-procedural verification of programs, ghost statements.	9
4	**Program Verification:-** Inter-procedural 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	1	3	-	-	-	-	-	-	-	-	-	-
CO2	2	3	2	3	2	-	-	-	-	-	-	-
CO3	1	1	1	1	-	-	-	-	-	-	-	-
CO4	1	1	1	1	1	-	-	-	-	-	-	-

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	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 Authors	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	PECST793	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 Pages 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	8
2	**Scripting language** - Client-Side Scripting, Data Types, Conditionals, Loops, Arrays , Objects , Function Declarations vs Function Expressions , Nested Functions , The Document Object Model (DOM) - Nodes and NodeLists, Document Object, Selection Methods, Element Node Object, Event Types. **Asynchronous JavaScript and XML** – AJAX : Making Asynchronous	9

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcomes		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- Analyze; K5- Evaluate; K6- Create

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	2	3	-	3	-	-	-	-	-	-	3
CO3	3	2	3	-	3	-	-	-	-	-	-	3
CO4	3	2	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	1st, 2017
2	Building User Interfaces with ReactJS - An Approachable Guide	Chris Minnick	Wiley	1st, 2022
3	Internet & World Wide Web - How to Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson	1st, 2011
4	SPA Design and Architecture: Understanding Single Page Web Applications	Emmit Scott	Manning Publications	1st, 2015

Reference Books				
Sl. No	Title of the Book	Name of the Authors	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	1st, 2022
2	Advanced Web Development with React	Mohan Mehul	BPB	1st, 2020
3	JavaScript Frameworks for Modern Web Development	Tim Ambler, Sufyan bin Uzayr, Nicholas Cloud	Apress	2nd, 2019

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

SEMESTER S7

RECOMMENDATION SYSTEMS

Course Code	**PECDT741**	**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 facilitate the learner to get an overview of recommender systems.
2. To introduce learners to the concepts of Collaborative Filtering, Content-based recommendation, Knowledge based recommendation, Hybrid approaches and Evaluating Recommender Systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to basic concepts and Recent developments.Collaborative recommendation - User-based nearest neighbour recommendation, Item-based nearest neighbour recommendation, Collaborative recommendation ratings , Model-based and pre-processing based approaches, Recent practical approaches and systems. Content-based recommendation - Content representation and content similarity, Similarity-based retrieval and Other text classification methods	8
2	Knowledge-based recommendation : Knowledge representation and reasoning, Constraints, Cases and similarities, Interacting with constraint-based recommenders - Defaults, Dealing with unsatisfiable requirements and empty result set, Proposing repairs for unsatisfiable requirements, Ranking the items/utility-based recommendation, Interacting with case-based recommenders, Critiquing, Compound critiquing, Dynamic critiquing	9
3	Hybrid recommendation approaches : Opportunities for hybridization Recommendation paradigms, Hybridization designs, Monolithic	8

	hybridization design - Feature combination hybrids, Feature augmentation hybrids, Parallelized hybridization design -Mixed hybrids, Switching hybrids, Weighted hybrids, Pipelined hybridization design - Cascade hybrids, Meta-level hybrids. Limitations of hybridization strategies	
4	Evaluating Recommender Systems - Introduction - Evaluation Paradigms , User Studies , Online Evaluation , Offline Evaluation with Historical Data Sets, General Goals of Evaluation Design - Accuracy, Coverage , Confidence and Trust , Novelty , General Goals of Evaluation Design - Serendipity ,Diversity , Robustness and Stability , Scalability, Design Issues in Offline Recommender Evaluation - Case Study of the Netflix Prize Data Set, Segmenting the Ratings for Training and Testing: Hold-Out , Cross-Validation , Comparison with Classification, Accuracy Metrics in Offline Evaluation - Measuring the Accuracy of Ratings Prediction , RMSE versus MAE, Impact of the Long Tail, Evaluating Ranking via Correlation , Evaluating Ranking via Utility , Evaluating Ranking via Receiver Operating Characteristic, Limitations of Evaluation Measures - Avoiding Evaluation Gaming	18

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
05	15	10	10	40

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
- 2 Questions from each module. - Total of 10 Questions, each carrying 3 marks (10x3 =30 marks)	- Each question carries 14 marks - 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. (5x14 = 70 marks)	100

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Describe the basic concepts of recommender systems	K2
CO2	Summarize the features of constraint-based and case-based knowledge-based recommender systems	K2
CO3	Illustrate the use of hybridizing algorithms	K2
CO4	Examine the design issues in offline recommender evaluation	K3

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

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	Recommender Systems: An Introduction	Jannach D., Zanker M. and Felfernig A.	Cambridge University Press	1st, 2011
2	Recommender Systems: The Textbook	C.C. Aggarwal	Springer	1st, 2016

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Recommender systems handbook	F. Ricci, L Rokach, B. Shapira and P.B. Kantor	Springer	1st, 2011
2	Recommender Systems For Learning	Manouselis N., Drachsler H., Verbert K., Duval E.	Springer	1st, 2013

SEMESTER 7

FINANCIAL DATA SCIENCE

(Common CD/AD/CB)

Course Code	PECDT742	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 students an understanding of how data science techniques can be applied to solve complex financial problems, such as risk modelling, fraud detection, and algorithmic trading.
2. To enable the students to implement machine learning algorithms for financial applications, including portfolio optimization, and trading strategies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of Financial Systems - Financial markets, instruments, and data; Data Science in Finance - Role of data science, types of data in finance (structured, unstructured, time-series, etc.); Financial Data Acquisition - Sources of financial data, Data retrieval from the Internet, Data Preprocessing - Data cleaning, handling missing data, outlier detection, normalization, and scaling; Exploratory Data Analysis - Visualizing financial data (candlestick charts, histograms), statistical summaries.	9
2	Supervised Learning in Finance - Decision trees, random forests, and support vector machines (SVM) for stock prediction; Unsupervised Learning for Financial Clustering - K-means clustering and principal component analysis (PCA) for risk classification; Neural Networks in Finance - Overview of deep learning techniques, simple models for predicting financial outcomes. Model Evaluation and Performance Metrics: Evaluation metrics like RMSE, R^2, confusion matrix, accuracy, precision, and recall.	9

3	Financial Risk Types - Credit risk, market risk, liquidity risk, Risk Modeling Techniques - Value at Risk (VaR), Monte Carlo simulations, Stress Testing and Scenario Analysis - Techniques for testing portfolio resilience under extreme conditions, Fraud Detection Algorithms - Anomaly detection techniques on transaction data (e.g., autoencoders, isolation forests), Case Study: Implementing a credit risk scoring model.	9
4	Introduction to Algorithmic Trading - Basics of trading strategies, high-frequency trading, Algo-bots, Financial Portfolio Theory - Modern Portfolio Theory (MPT), Efficient Frontier, Optimization Algorithms - Gradient Descent, Genetic Algorithms for portfolio optimization, Backtesting Trading Strategies - Python libraries for backtesting (e.g., Backtrader, QuantConnect)	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 Outcomes		Bloom's Knowledge Level (KL)
CO1	Explain how data science methods are applied in financial markets, trading, risk management, and fraud detection.	K2
CO2	Apply various machine learning algorithms (such as decision trees, SVM, and neural networks) to solve financial problems.	K3
CO3	Develop and implement trading algorithms and optimizing financial portfolios.	K3
CO4	Apply risk modeling techniques and implement fraud detection systems in financial contexts.	K3

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

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*

Reference Books				
Sl. No	Title of the Book	Name of the Author s	Name of the Publisher	Edition and Year
1.	Data Science for Economics and Finance	Sergio Consoli, Diego Reforgiato Recupero, Michaela Saisana	Springer	1st, 2021
2.	Hands-On Machine Learning for Algorithmic Trading	Stefan Jansen	Packt	1st, 2018
3.	Analyzing Financial Data and Implementing Financial Models Using R	Clifford S. Ang	Springer	2nd, 2021
4.	Adventures in Financial Data Science	Graham L. Giller	World Scientific	2nd, 2022
5.	Hands-On Data Analysis in R for Finance	Jean-Francois Collard	CRC Press	1st, 2023
6.	Financial Data Analytics: Theory and Application	Sinem D. Koseoglu	Springer	1st, 2022

SEMESTER S7

CLOUD COMPUTING

(Common to AD/CR)

Course Code	PEADT746	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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	2	3	3	2								2
CO3	3	3	3	2								2
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	Cloud Computing: A Practical Approach for Learning and Implementation	A. Srinivasan, J. Suresh	Pearson	1st, 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	2nd, 2023
2	Cloud Computing	Sandeep Bhowmik	Cambridge University Press	1st, 2017
3	Cloud Computing: A Hands-On Approach	Arshdeep Bahga and Vijay Madisetti	Universities Press	1st, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_cs[illegible]/preview

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 approaches 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, Decentralization, Distributed Ledger Technology, Blockchain variants.	7
2	Cryptography in Blockchain and Consensus Mechanisms Concept of Hashing, Creating a Transaction Hash, Merkle Trees - Importance of Merkle tree, Chaining of Blocks, Building the Network, Accessing the network, Types of Wallets. Need for Consensus, Two Generals' Problem, Byzantine Generals' Problem, Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT)- working, Paxos and Raft Algorithms.	9
3	Cryptocurrencies - Bitcoin and Ethereum Bitcoin: Components, Nodes in Bitcoin network, Transactions and memory	10

	pools, Proof of Work-Mining Cryptocurrencies, Hard and Soft Forks, Tracking Bitcoin-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, Decentralized 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.	18

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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	2	2	2									2
CO2	3	3	3									2
CO3	3	3	3									2
CO4	3	3	3		1							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	1st, 2023
2	Blockchain Technology	Chandramouli Subramanian, Asha A George	Universities Press	1st, 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	1st, 2020
2	Mastering Blockchain	Imran Bashir	Packt Publishing	1st, 2020
3	Solidity programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain	Ritesh Modi	Packt Publishing	1st, 2018

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://youtube.com/playlist?list=PL[illegible]
2	https://youtube.com/playlist?list=PL[illegible]
3	https://youtube.com/playlist?list=PL[illegible]
4	https://youtube.com/playlist?list=PL[illegible]

SEMESTER S7

GENERATIVE AI

Course Code	PEADT746	**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	**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 Networks (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 mechanism, 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 sustainability, 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- Analyze; K5- Evaluate; K6- Create*

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	-	-	-	-	-	-	-	3
CO3	2	2	2	2	-	-	-	-	-	-	-	2
CO4	2	2	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.	Generative Deep Learning	David Foster	O'Reilly	1st, 2019
2.	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT press	1st, 2016
3.	Large Language Model-Based Solutions: How to Deliver Value with Cost-Effective Generative AI Applications	Shreyas Subramanian	Wiley	1st, 2024

Reference Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Deep Learning Illustrated	Jon Krohn, Grant Beyleveld, Aglae Bassens	Pearson	1st, 2020
2	Prompt Engineering for Generative AI	James Phoenix, Mike Taylor	O'Reilly	1st, 2024
3	GANs in Action: Deep learning with Generative Adversarial Networks	Jakub Langr, Vladimir Bok	Manning	1st, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	Deep Generative Models: An Introduction (https://www.youtube.com/watch?v=[illegible])
2	Generative Adversarial Networks-Part II (https://www.youtube.com/watch?v=[illegible])
3	Introduction to Transformer Architecture (https://www.youtube.com/watch?v=[illegible])
4	Generative Adversarial Networks-Part II (https://www.youtube.com/watch?v=[illegible])

SEMESTER S7

COMPUTER VISION

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals in Computer Vision :-** Camera Calibration- Pinhole camera model, Geometric Image Features - Curves, Surfaces, Analytical Image Features - Elements of Analytical Euclidean Geometry, Geometric Camera Parameters, Stereopsis - Binocular Camera Geometry, Epipolar Constraint, Binocular Reconstruction, Local Methods for Binocular Fusion, Global Methods for Binocular Fusion.	9
2	**Features and Filters :-** Linear Filters- Linear Filters and Convolution, Shift Invariant Linear Systems. Estimating Derivatives with Finite Differences, Noise, Edges and Gradient-based Edge Detectors. Image Gradients - Computing the Image Gradient, Gradient Based Edge and Corner Detection. Filters as Templates - Normalized Correlation and Finding Patterns.	8

3	Machine Learning for Computer Vision :- Machine Learning - Introduction, Dataset for Machine Perception- Labelled and Unlabelled Data, Basics of Classification and Clustering, Multi-Class Perception. 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 architectures - ResNet, Neural Architecture Search Design - NASNet	9
4	Segmentation and Object detection :- Segmentation Using Clustering Methods - Human vision: Grouping and Gestalt, Applications: Shot Boundary Detection, Background Subtraction, Image Segmentation by Clustering Pixels- Simple Clustering Methods, Clustering and Segmentation by K-means. Object detection - YOLO, Segmentation-Mask R-CNN and Instance Segmentation, U-Net and Semantic Segmentation, Model Quality Metrics *A case study to compare performance of various models on a suitable dataset.*	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Understand the basic concepts and terminologies like Camera Calibration, Stereopsis in computer vision	K2
CO2	Apply filters for feature extraction and for finding patterns	K3
CO3	Build different machine learning models for computer vision	K3
CO4	Implement segmentation and object detection models	K3
CO5	Analyze different machine learning models for segmentation/object detection	K4

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Computer vision: A modern approach	Forsyth, David, and Jean Ponce	Prentice hall	2011
2	Emerging topics in computer vision	Medioni, Gerard and Sing Bing Kang	PHI	2004
3	Practical Machine Learning for Computer Vision	Valliappa Lakshmanan, Martin Görner, Ryan Gillard	O'Reilly Media	2021

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

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

SEMESTER S7

COMPUTATIONAL HEALTH INFORMATICS

Course Code	[illegible]	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 foundational knowledge in various types of health data, including electronic health records (EHRs), imaging data, genomic data, and patient-generated data.
2. To teach how computational methods can be applied to improve clinical decision-making, enhance patient care, support personalized medicine, and optimize healthcare operations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction and Emerging Technologies in Health Informatics Definition, scope, and objectives of health informatics, current trends in health informatics, Health informatics frameworks and models, Health data standards (HL7, SNOMED CT, ICD, etc.), Interoperability challenges and solutions, Data capture, storage, and retrieval in health informatics, Data quality and integrity. Internet of Things (IoT) and its applications in healthcare, Blockchain technology in health informatics, Clinical research informatics,IoT devices for healthcare, Data sharing and secondary use of health data.	10
2	Medical Image Processing Overview of medical image processing and its significance in healthcare, Challenges and opportunities in medical image analysis, Principles of X-ray imaging, Magnetic Resonance Imaging (MRI) basics, Computed Tomography (CT) fundamentals, Ultrasound imaging and its characteristics. Image Enhancement Techniques, Image Segmentation, Thresholding techniques for image segmentation, Region-based segmentation algorithms.	9
3	Artificial Intelligence and Machine Learning in Medical Image Analysis	8

	Artificial intelligence (AI) and machine learning in healthcare, Contrast enhancement methods for medical images, Noise reduction and image denoising techniques, Image sharpening and edge enhancement, Feature Extraction and Representation. Supervised and unsupervised learning algorithms, Classification and regression techniques for medical image analysis, Performance evaluation and validation of machine learning models	
4	**Deep Learning for Medical Image Processing** Convolutional Neural Networks (CNNs) for medical image analysis, Segmentation and object detection using deep learning, Transfer learning and pretrained models in medical imaging, Volumetric image analysis and 3D reconstruction, Image-based modeling and simulation, Advanced imaging modalities (functional MRI, diffusion tensor imaging), Artificial intelligence in medical image 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	Describe health informatics, including its principles, concepts, and applications of computational methods and techniques used in health informatics. Illustrate latest trends, advancements, and emerging technologies in computational health informatics.	K3
CO2	Demonstrate application of computational methods and techniques to analyze and manipulate medical images for various purposes, such as diagnosis, treatment planning, and research.	K3
CO3	Use the machine learning techniques to health images to aid in various aspects of healthcare, including diagnosis, treatment planning, and disease monitoring.	K3
CO4	Implement deep learning techniques to analyze and interpret medical images.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Translational Bioinformatics in Healthcare and Medicine	Khalid Raza, Nilanjan Dey	Elsevier Science	1st, 2021
2.	Computational Analysis and Deep Learning for Medical Care: Principles, Methods, and Applications	Amit Kumar Tyagi	Wiley	2021

Reference Books

Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Introduction to Computational Health Informatics.	Arvind Kumar Bansal, Javed Iqbal Khan, S. Kaisar Alam	CRC Press.	2020
2	Signal Processing Techniques for Computational Health Informatics.	Ahad, M. and Ahmed, M. U.	Springer	2020
3	Computational Intelligence and Healthcare Informatics	Editors: Om Prakash Jena, Alok Ranjan Tripathy, Ahmed A. Elngar, Zdzislaw Polkowski	Wiley	1st, 2021
4	Computational Intelligence for Machine Information Learning and Healthcare.	R Srivastava, PK Mallick, SS Rautaray, M Pandey	De Gruyter	2020
5	Healthcare Systems and Health Informatics: Using Internet of Things	PS Mehra, LM Goyal, A Dagur, AK Dwivedi	CRC Press	1st, 2022

SEMESTER S7

RESPONSIBLE ARTIFICIAL INTELLIGENCE

Course Code	PECST783	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 exPlanations), LIME(Local Interpretable Model-agnostic Explanations)	10
3	**Ethics, Privacy and Security -** Ethics and Accountability - Auditing AI models, fairness assessment, Principles for ethical practices. Privacy preservation - Attack models, Privacy-preserving Learning, Differential privacy- Working, The Laplace Mechanism, Introduction to	10

	Federated learning. Security - Security in AI Systems, Strategies for securing AI systems and protecting against adversarial attacks	
4	**Future of Responsible AI and Case Studies: -** Future of Responsible AI - Emerging trends and technologies in AI ethics and responsibility Case Studies - Recommendation systems, Medical diagnosis, Computer Vision, Natural Language Processing.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify and describe key aspects of responsible AI such as fairness, accountability, bias, and privacy.	K2
CO2	Describe AI models for fairness and ethical integrity.	K3
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- Analyze; K5- Evaluate; K6- Create*

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	1st, 2019
2	Interpretable Machine Learning	Christoph Molnar	Lulu	1st, 2020

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/[illegible]
2	https://youtu.be/[illegible] 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/[illegible]/model-explainability-with-shap-only-guide-u-need
3	https://www.youtube.com/live/[illegible]
4	https://youtu.be/[illegible] Case Studies https://www.kaggle.com/code/[illegible]-with-lime https://www.kaggle.com/code/[illegible]/using-lime-to-explaining-the-predictions-from-ml

SEMESTER S7

GRAPH DATABASES AND ANALYSIS

Course Code	PECBT7[illegible]	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 an insight into graph databases and to study in detail the technology in designing graph databases.
2. To give the student an understanding of data modelling with graphs, to learn different graph algorithms and to do predictive analysis of graphs in real world applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to the Graph Data Model: Graphs are the future of data, The relevance of data relationships, High-level view of Graph Space, The Power of Graph Databases, Options for Storing Connected Data: Relational Databases Limitations, NoSQL Databases, Graph Databases, Defining Graph Analytics and Graph Data Science.	8
2	Data Modelling with Graphs: Models and Goals, The Property Graph Model, Querying Graphs: An Introduction to Cypher, Other Cypher Clauses, Comparison of Relational and Graph Modelling, Cross-Domain Models, Common Modelling Pitfalls. **Building a Graph Database Application:** Data Modelling, Application Architecture, Redundancy.	9
3	Graph Algorithms: Graph Algorithms in Neo4j, Graph Algorithm Concepts, The Neo4j Graph Algorithms Library, Pathfinding and Graph Search Algorithms, Centrality Algorithms, Community Detection Algorithms, Graph Algorithms in Practice	9

4	Predictive Analysis with Graph Theory in Real World: Real-World Examples, Looking at Graphs in the Health Industry, Graph Database Internals: Native Graph Processing, Native Graph Storage, Programmatic APIs, Non-functional Characteristics Depth and Breadth-First Search, Path-Finding with Dijkstra's Algorithm, The A* Algorithm, Graph Theory and Predictive Modelling	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 key concepts of NoSQL and Graph databases by understanding the new database models, and how these databases fit into the overall ecosystem.	K2
CO2	Apply appropriate techniques to design a property graph data model and build graph database applications for entity-relationship, and modelling projects.	K3
CO3	Apply appropriate algorithms in Neo4j graph databases, and model solutions for computing problems.	K3
CO4	Use appropriate predictive analysis with graph theory for processing, storing, searching and modelling in real world applications.	K3

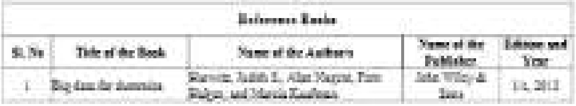
Note: K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create

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	Graph Databases	Ian Robinson, Jim Webber, Emil Eifrem	O'Reilly	2e, 2015
2	Graph Data Science for Business: Predicting Changing Demand Patterns in the New Digital Economy	Pierson, Lillian	John Wiley & Sons	2e, 2021
3	A Comprehensive Guide to Graph Algorithms	Mark Needham, Amy E. Hodler	Neo4j.com	1e,2020
4	Graph Databases for Beginners	Bryce Merkl Sasaki, Joy Chao & Rachel Howard	Neo4j.com	1e, 2018



Reference Books				
Sl. No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1	Big data for dummies	Hurwitz, Judith S., Alan Nugent, Fern Halper, and Marcia Kaufman	John Wiley & Sons	1st, 2013

SEMESTER S7

DIGITAL FORENSICS

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

Course Code	PECST794	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 Artifacts, 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	8
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, NAC, 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 forensic analysis of hard disk, Network, and mobile phones	K3
CO2	Experiment with the network traffic dump	K3
CO3	Examine the analytic 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		2							2
CO3	3	3	3		2							2
CO4	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	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/nou23_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 interactions
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.	10
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 mechanisms, 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	2									2
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	1st, 2004
2	Game Theory and Mechanism Design	Y. Narahari	World Scientific and IISc Press	1st, 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	1st,
2	Game Theory - An Introduction	Steven Tadelis	Princeton University Press	1st, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/101/106101237/
2	https://www.[illegible].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										1
CO2	3	3										1
CO3	3	3	3	2								1
CO4	3	3	3	2								1

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to High Performance Computing for Scientists and Engineers	Georg Hager Gerhard Wellein	CRC Press	1st, 2011
2	High Performance Computing: Modern Systems and Practices	Thomas Sterling, Maciej Brodowicz, Matthew Anderson	Morgan Kaufmann	1st, 2017

Reference Books				
Sl. No	**Title of the Book**	**ame of the Authors**	**Name of the Publisher**	**Edition and Year**
1	Parallel and High-Performance Computing	Robert Robey Yuliana Zamora	Manning Publications	1st, 2021
2	High-Performance Computing	Charles Severance Kevin Dowd	O'Reilly Media	2nd, 1998
3	Computer Architecture And Parallel Processing	Kai Hwang Faye Alaye Briggs	McGraw Hill	1st, 1984
4	Computer Architecture: A Quantitative Approach	John L. Hennessy David A. Patterson	Morgan Kaufman	6th, 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	[illegible]	**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 Outcomes	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.	K2
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- Analyze; K5- Evaluate; K6- Create

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Programming languages: principles and practices.	Kenneth C Louden	Cengage Learning	3rd, 2011
2	Concepts of programming languages	Sebesta R. W.	Pearson	11th, 2020
3	Programming languages: concepts and constructs.	Sethi R.	Pearson	2nd, 2006

Reference Books				
S.No	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
1.	Programming Languages: Principles and Paradigms	Allen Tucker, Robert Noonan	McGraw-Hill	2nd, 2017
2	Principles of programming languages	Gilles Dowek	Springer	1st, 2008
3	Principles of Programming Languages	Rajiv Chopra	Wiley	1st, 2019

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

SEMESTER S7

TIME SERIES MODELLING

Course Code	PEADT7[illegible]	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To help the students in understanding the usability of time series data and its analysis and time series models that can be used in different time series models that can be used in scientific business application.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to time series forecasting: Forecasting, Types of forecasting – Short term, long term. Forecasting data and methods – Qualitative forecasting, Quantitative forecasting. Simple Forecasting methods: Average method, Naïve method, Drift Method. Steps in forecasting. Introduction to Time series Forecasting – Time Series Characteristics – Types of Data – Time Series Data, Cross-Section Data, Longitudinal Data. Understanding Time Series Data, Time series pattern- trend, seasonality, cyclicity, and irregularity. Detecting Trends using Hodrick-Prescott filter and Detrending time series. Detecting Seasonality and De-seasoning, Detecting Cyclic Variation. Error, Irregular Component and residuals. Time Series Decomposition: Additive Models, Multiplicative models. Data wrangling and preparation for time series using python: Loading Data, Exploring Pandas and pandasql, Ascending and Descending Data order, Aggregation, Join, Data Resampling by week, month, quarter, year, Handling Missing Data.	9
2	Exponential Smoothing: Simple exponential smoothing, Methods with trend, methods with seasonality, estimation and modelling, Forecasting with ETS models.	9

	Regression Estimation Techniques for time series data Types of stationary behaviour in time series, Making data stationary, Augmented Dickey-Fuller Test, Using stationary data techniques – Differencing, Random walk, Trend Differencing, Seasonal Differencing Time series as a discrete parameter stochastic process, Auto correlation Function (ACF), Partial Autocorrelation Function (PACF) and cross correlations, Auto Correlation Plots – Trend and seasonality in ACF plots	
3	Autoregressive (AR), Moving Average (MA), Autoregressive Moving Average (ARMA), Autoregressive Integrated Moving Average (ARIMA) models, Seasonal ARIMA (SARIMA) models Introduction to Multivariate Time series Modelling, Vector Autoregressive models, Vector ARMA Models, Fitting VAR and VARMA models	9
4	Dynamic Regression Models – Estimation, Regression with ARIMA errors using R packages (fable), forecasting, stochastic and deterministic trends Introduction to Hierarchical Time series and Grouped Time series with suitable examples. Advanced Forecasting models- Prophet model, Neural Network models, Bootstrapping and Bagging	9

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyze	Total
5	15	10	10	40

Criteria for Evaluation (Evaluate and Analyze): 20 marks

Assess the students with questions of the following nature:

Time Series Decomposition:

- "Given a dataset exhibiting seasonality and trend, decompose the time series using both additive and multiplicative models. Compare the results and analyze which model better fits the data and why."

ACF and PACF Analysis:

- "Analyze the ACF and PACF plots for the given time series data. Identify the presence of any significant trends or seasonality and justify which time series model (AR, MA, or ARMA) would be most appropriate for forecasting based on these plots."

Model Selection for Forecasting:

- "Evaluate the performance of ARIMA and Prophet models on the same time series dataset. Discuss their respective advantages and disadvantages in terms of accuracy, computational efficiency, and applicability to different types of time series patterns."

Dynamic Regression Models:

- "Using a given dataset, implement and evaluate a dynamic regression model with ARIMA errors. Assess the model's forecasting performance compared to a standard ARIMA model and discuss the impact of incorporating external regressors.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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 different types of forecasting, fundamental principles of time series data, analyze various time series processes and gain proficiency in preparing and wrangling time series data.	K3
CO2	Apply and interpret a variety of time series models and determine the most suitable model for various types of time series data.	K4
CO3	Apply exponential smoothing methods for forecasting and analyze time series patterns.	K3
CO4	Implement dynamic regression models and develop proficiency in advanced forecasting methods.	K3

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Authors**	**Name of the Publisher**	**Edition and Year**
1	Forecasting: Principles and Practice	Robin John Hyndman, George Athanasopoulos	OTexts	3rd, 2021
2	Hands-on Time Series Analysis with Python	BV Vishwas, Ashish Patel	Apress	1st, 2020
3	The Analysis of Time Series An Introduction with R	Chris Chatfield, Haipeng Xing	Chapman & Hall	7th, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Authors**	**Name of the Publisher**	**Edition and Year**
1	Time series Analysis and its Applications	Shumway, R. H and Stoffer	Springer	1st, 2006
2	Time Series Analysis and Its Applications: With R Examples	Robert H. Shumway and David S. Stoffer	Springer	4th, 2017
3	Time Series Analysis: Forecasting and Control	George E. P. Box, Gwilym M. Jenkins, and Gregory C. Reinsel	Wiley	5th, 2015
4	Applied Time Series Analysis	Wayne A. Woodward, Henry L. Gray, and Alan C. Elliott	CRC Press	2nd, 2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_ch28/preview

SEMESTER S7

CYBER SECURITY

Course Code	OECST731	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-loggers, 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	K3
CO3	Discuss the malware and the protection mechanisms against malware	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	3	3										2
CO2	3	3	2									2
CO3	3	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	3rd, 2011
2	Cyber Security- Understanding Cyber Crimes, Computer Forensics and Legal Perspectives	Nina Godbole, Sunit Belapure	Wiley	1st, 2011
3	Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives	B.B Gupta, D.P Agrawal, Haoxiang Wang	CRC Press	1st, 2018
4	Cyber Security Essentials	James Graham, Richard Howard, Ryan Olson	Auerbach	1st, 2010

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/[illegible]
2	https://[illegible]/index.php/[illegible]/article/download/[illegible]
	https://www.coursera.org/learn/data-security-privacy#modules
3	https://nptel.ac.in/courses/[illegible]
4	https://archive.nptel.ac.in/courses/[illegible]

SEMESTER S7

CLOUD COMPUTING

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)	None	Course Type	Theory

Course Objectives:

1. To understand the core principles, architectures, 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.	K2
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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									3
CO2	3	3	3	3								3
CO3	2	3	3	2								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: A Practical Approach for Learning and Implementation	A.Srinivasan, J.Suresh	Pearson	1st, 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	2nd, 2023
2	Cloud Computing	Sandeep Bhowmik	Cambridge University Press	1st, 2017
3	Cloud Computing: A Hands-On Approach	Arshdeep Bahga and Vijay Madisetti	Universities Press	1st, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_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	10

	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, 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, Organizational 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	1	1	2									1
CO2	1	1	1									1
CO3	1	1	1									1
CO4	2	2	2									2

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	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	Yingxu 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=[illegible]
2	https://www.youtube.com/watch?v=[illegible]
3	http://digimat.in/nptel/courses/video/[illegible].html
4	https://www.youtube.com/watch?v=[illegible]
5	https://[illegible].ac.in/courses/[illegible]/

SEMESTER S7

COMPUTER NETWORKS

Course Code	OECST704	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, fibre, 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	8

	Layer - Application Layer Paradigms, Client-server applications, World Wide Web and HTTP, FTP, Electronic Mail, DNS, Peer-to-peer paradigm - P2P Networks.	

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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.	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	1	1										1
CO2	2	2	2									2
CO3	3	3	3									3
CO4	2	2	2									2

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

Text Books				
Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	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/[illegible]

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 OECST611	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

	Networking in Flutter: HTTP Requests, JSON Parsing, RESTful APIs Data Persistence: SQLite, Shared Preferences, Hive Asynchronous Programming with Dart: Futures, async-await, and Streams	
4	Industry Practices and App Deployment: Advanced UI Components and Animations, App Security Best Practices, Testing and Debugging Flutter Applications, Publishing Apps to Google Play Store and Apple App Store, Industry Trends and Future of Mobile Development with Flutter	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcomes		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- Analyze; K5- Evaluate; K6- Create*

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	2	2	2	2	2							2
CO3	2	2	2	2	2							2
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

<table>
<tr><th colspan="5">Reference Books</th></tr>
<tr><th>S. No</th><th>Title of the Book</th><th>Name of the Author/s</th><th>Name of the Publisher</th><th>Edition and Year</th></tr>
<tr><td>1</td><td>Flutter in Action</td><td>Eric Windmill</td><td>Manning</td><td>1st, 2019</td></tr>
<tr><td>2</td><td>Flutter and Dart: Up and Running</td><td>Deepti Chopra, Roopal Khurana</td><td>BPB</td><td>1st, 2023</td></tr>
</table>

<table>
<tr><th colspan="2">Video Links (NPTEL, SWAYAM…)</th></tr>
<tr><th>No.</th><th>Link ID</th></tr>
<tr><td>1</td><td>https://www.youtube.com/watch?v=[illegible]</td></tr>
</table>

SEMESTER 8

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

SEMESTER S8

SOFTWARE ARCHITECTURES

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)	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.	9
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.	9
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									1
CO2	3	3	3		2							3
CO3	3	2	2		1							3
CO4	3	3	3		2							1

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Software Architecture	A.Bijlsma, B.J.Heeren, E.E.Roubtsova, S. Stuurman	Free Technology Academy	1st, 2011
2	Software Architecture 1	Mourad Chabane Oussalah	Wiley	1st, 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	O'Reilly	1st, 2024

Video Links (NPTEL, SWAYAM…)	
No.	Link ID
1	https://www.youtube.com/playlist?list=[illegible]

SEMESTER S8

BIO INSPIRED OPTIMIZATION TECHNIQUES

Course Code	PEADT8[illegible]	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3 0 0 0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	Other Swarm Intelligence algorithms - Fish Swarm, Bacteria foraging, Intelligent Water Drop Algorithms, Applications of biologically inspired algorithms in engineering. Case Studies: - ACO and PSO for NP-hard problems - Routing problems, Assignment problems, Scheduling problems, Subset problems, Machine Learning Problems, Travelling Salesman Problem.	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	Describe the fundamentals in bio-inspired optimization techniques which influence computing	K2
CO2	Make use of the concepts of Genetic algorithms in various domains	K3
CO3	Comprehend the concepts of Swarm Intelligence and collective systems such as ACO, ABC, and PSO	K2
CO4	Illustrate the concepts of biologically inspired algorithmic design	K3

Note: *K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create*

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

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

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://www.academia.edu/12627326/Nature_inspired_computing_technology_and_applications
2	https://nptel.ac.in/courses/112103301
3	http://digimat.in/nptel/courses/video/106105082/L35.html
4	https://onlinecourses.nptel.ac.in/noc21_me40/preview

SEMESTER S8

NETWORK SECURITY PROTOCOLS

(Common to CA/AD)

Course Code	PECAT865	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)	PCCST504	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	Application Layer Security and System Security-Hypertext Transfer Protocol Secure (HTTPS) –Connection initiation, Closure. Secure Shell (SSH) –Transport layer protocol, User authentication protocol, Connection protocol. Secure Electronic Transaction (SET) – Overview, Features, Participants, Dual signature, Payment processing. Firewalls – Firewall characteristics, Types of Firewalls, Firewall configurations, Encrypted Tunnels. Trusted systems – Data access control, The concept of Trusted Systems, Trojan horse defense.	10

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcomes		Bloom's Knowledge Level (KL)
CO1	Explain authentication protocols, X.509 authentication service and Public Key Infrastructure (PKI).	K2
CO2	Identify the security mechanisms in E-mail security services	K2
CO3	Summarize the network and transport layer security services provided in a secure communication scenario	K2
CO4	Describe application layer security protocols	K3
CO5	Explain the concepts of system security and firewalls	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography and Network Security – Principles and Practices	William Stallings	Pearson Education	4 e, 2022
2	Network Security: Private Communications in a Public World	C.Kaufman,R.Perlman and M.Speciner	Addison-Wesley Professional	3 e,2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography and Network Security	Behrouz A. Forouzan, Debdeep Mukhopadhyay	McGraw Hill Education (India) Private Limited	3 e, 2015
2	Network Security Essentials: Applications and Standards	William Stallings	McGraw Hill	6 e, 2016
3	Network security : the complete reference	Bragg, Roberta	McGraw-Hill/Osborne	1 e, 2004

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1, 2, 3, 4	https://nptel.ac.in/courses/[illegible] https://nptel.ac.in/courses/[illegible] https://nptel.ac.in/courses/[illegible]

SEMESTER S5

COMPUTATIONAL COMPLEXITY

(Common to CS/CM/AD/CB/CN/CU/CR/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)	PCCST303, 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 8)	8
4	Circuit Complexity - Boolean circuits and circuit complexity, Circuit lower bounds, Complexity of specific functions. (Text 2 - Ch 8) Quantum Complexity - Basics of quantum computation, Quantum complexity classes: BQP, QMA, Quantum algorithms and their complexity. (Text 2 - 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 theorems 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- Analyze, K5- Evaluate, K6- Create

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	2	2	2									2
CO4	2	2	2									2
CO5	2	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	Computational Complexity: A Modern Approach	Sanjeev Arora, Boaz Barak	Cambridge University Press	1st, 2009
2	Introduction to the Theory of Computation	Michael Sipser	Cengage	3rd, 2014
3	Quantum Computing: A Gentle Introduction	Eleanor Rieffel, Wolfgang Polak	MIT Press	1st, 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	1st, 2004
2	Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis	Michael Mitzenmacher and Eli Upfal	Cambridge University Press	2nd, 2017
3	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	The MIT Press Cambridge	4th, 2022
4	The Probabilistic Method	Noga Alon and Joel H. Spencer	Wiley-Blackwell	4th, 2016
5	Approximation Algorithms	Vijay V. Vazirani	Springer	4th, 2013
6	Theory of Computation: Classical And Contemporary Approaches	Dexter C Kozen	Springer	6th, 2006
7	Computational Complexity: A Conceptual Perspective	Oded Goldreich	Cambridge University Press	1st, 2008

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_cs46/preview https://onlinecourses.nptel.ac.in/noc22_cs46/preview
2	https://onlinecourses.nptel.ac.in/noc22_cs46/preview https://onlinecourses.nptel.ac.in/noc22_cs46/preview
3	https://onlinecourses.nptel.ac.in/noc22_cs46/preview https://onlinecourses.nptel.ac.in/noc22_cs46/preview
4	https://onlinecourses.nptel.ac.in/noc22_cs46/preview https://onlinecourses.nptel.ac.in/noc22_cs46/preview https://archive.nptel.ac.in/courses/106/104/106104240

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)	PECST634	Course Type	Theory

Course Objectives:

1. To get familiarized 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.	8

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.	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	To recall various steps in the speech production process	K2
CO2	To summarize various speech processing approaches	K2
CO3	To develop speech processing applications in various domains	K3
CO4	To analyze 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	2e, 1999
2	Discrete-Time Speech Signal Processing: Principles and Practice	Thomas F. Quatieri	Prentice Hall	1e, 2001
3	Fundamentals of Speech Recognition	Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana	Pearson	1e, 2008

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

Video Links (NPTEL, SWAYAM…)	
No.	Link ID
1	https://youtu.be/[illegible]

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,RAID5,RAID1, 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	2	3									3
CO2	3	3	2									2
CO3	1	1	1									1
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	2e, 2015
2	Computer Storage Fundamentals	Susanta Dutta	BPB Publication	1e, 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	1e, 2021
2	Information Storage and Management	Somasundaram Gnanasundaram Alok Shrivastava	Wiley	2e, 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 conceptual tools 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.	8
2	**Techniques and Strategies in Prompt Engineering :-** Designing Effective Prompts - Best Practices and Common Pitfalls; Prompt Tuning and Fine-Tuning Language Model; Using Zero-Shot, Few-Shot, and Multi-Shot Learning in Prompts; Exploring the Role of Context, Repetition, and Specificity in Prompt Responses; Advanced Prompt Engineering Techniques: Prompt Chaining, Iterative Prompting. **Handson** : Crafting and optimizing prompts for specific tasks (e.g., text generation, summarization, Q&A); Using prompt engineering to fine-tune pre-trained models on specific datasets or tasks.	9

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 in a variety of real-world tasks	K3

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

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	2	2	2									2
CO5	3	3	3									3

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	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	O'Reilly	1st, 2009
2	Transformers for Natural Language Processing	Denis Rothman	Packt	1st, 2021

SEMESTER S8

NEXT GENERATION INTERACTION DESIGN

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

Course Code	PECST866	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None		

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Interaction Design and AR/VR :-** Fundamentals of Interaction Design - Principles of interaction design, Human-computer interaction (HCI) basics, User experience (UX) design principles. Introduction to AR and VR - Overview of AR and VR technologies (Key differences and Applications), 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 techniques, Usability testing methods, Iterative design and feedback loops	10
3	Advanced Interaction Techniques :- Gestures - 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,	12

	Microinteractions, 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 evaluate the quality of the interfaces / GUI based on various techniques such as user testing.
- The students may be assessed based on their ability to analyse various performances 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 Outcomes		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- Analyze; K5- Evaluate; K6- Create*

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	2	2	2	2	2							2
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 Authors	Name of the Publisher	Edition and Year
1	Augmented Reality - Theory, Design and Development	Chetankumar G Shetty	McGraw Hill	1st, 2020
2	Virtual Reality and Augmented Reality: Myths and Realities	Ralf Doerner, Wolfgang Broll, Paul Grimm, and Bernhard Jung	Wiley	1st, 2018
3	Augmented Reality: Principles and Practice	Dieter Schmalstieg and Tobias Hollerer	Pearson	1st, 2016
4	Human–Computer Interaction	Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale	Pearson	3rd, 2004
5	Evaluating User Experience in Games: Concepts and Methods	Regina Bernhaupt	Springer	1st, 2010
6	Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics	Bill Albert, Tom Tullis	Morgan Kaufmann	2nd, 2013
7	The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything	Robert Scoble and Shel Israel	Patrick Brewster	1st, 2016
8	Augmented Reality and Virtual Reality: The Power of AR and VR for Business	M. Claudia tom Dieck and Timothy Jung	Springer	1st, 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=[illegible]

SEMESTER S3

INTRODUCTION TO ALGORITHMS

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

Course Code	GECST301	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 analyzing algorithm efficiency and solve a variety of computational problems, including sorting, graph algorithms.
2. To provide an understanding in algorithmic problem-solving techniques, including Divide and Conquer, Greedy Strategy, Dynamic Programming, Backtracking, and Branch & Bound algorithms.

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Authors	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	4e, 2022
2	Fundamentals of Computer Algorithms	Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran	Universities Press	2e, 2008

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

Video Links (NPTEL, SWAYAM…)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/106/102/106102064/

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)	GXEST204	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 database** : 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 Outcomes		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- Analyze; K5- Evaluate; K6- Create*

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

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

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (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	1st, 2017
2	Building User Interfaces with ReactJS - An Approachable Guide	Chris Minnick	Wiley	1st, 2022
3	Internet & World Wide Web - How to Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson	1st, 2011
4	SPA Design and Architecture: Understanding Single Page Web Applications	Emmit Scott	Manning Publications	1st, 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	Prima Jashnani	Notion press	1st, 2022
2	Advanced Web Development with React	Mohan Mehul	BPB	1st, 2020
3	JavaScript Frameworks for Modern Web Development	Tim Ambler, Sufyan bin Uzayr, Nicholas Cloud	Apress	1st, 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	OECST8[illegible]	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.	9
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.	9

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.	18
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 applications; GenAI in Testing - Advanced use cases for predictive and regression testing across devices and environments; Case Study- Implementation of black-box, grey-box, and responsive testing using PEX and AI-driven tools.	18

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full 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- Analyze, K5- Evaluate, K6- Create

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1									1
CO2	3	3	2	3	3							3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	2	3		2							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 Patton	Pearson	2/e, 2006
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- PcDuino, 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	1st, 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	2nd, 2022
2	The Internet of Things –Key applications and Protocols	Olivier Hersent, David Boswarthick, Omar Elloumi	Wiley	1st, 2012
3	IoT fundamentals : Networking technologies, Protocols and use cases for the Internet of things	David Hanes Gonzalo Salgueiro, Grossetete, Robert Barton	Cisco Press	1st, 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	[illegible]	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

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 Authors	Name of the Publisher	Edition and Year
1.	Computer Graphics : Algorithms and Implementations	D. P. Mukherjee, Debashish Jana	PHI	1st, 2010
2.	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4th, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Authors	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	1st, 2020
2.	Computer Graphics and Multimedia	ITL ESL	Pearson	1st, 2013
3.	Computer Graphics	Zhigang Xiang and Roy Plastock	McGraw Hill	2nd, 2006
4.	Principles of Interactive Computer Graphics	William M. Newman and Robert F. Sproull	McGraw Hill	1st, 2001
5.	Procedural Elements for Computer Graphics	David F. Rogers	McGraw Hill	1st, 2017
6.	Computer Graphics	Donald D Hearn, M Pauline Baker	Pearson	2nd, 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