

SEMESTER 5

COMPUTER SCIENCE AND ENGINEERING

SEMESTER S5

COMPUTER NETWORKS

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

Course Code	PCCST501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of the Internet, Protocol layering (Book 1 Ch 1) Application Layer: Application-Layer Paradigms, Client-server applications - World Wide Web and HTTP, FTP. Electronic Mail, DNS. Peer-to-peer paradigm - P2P Networks, Case study: BitTorrent (Book 1 Ch 2)	6
2	Transport Layer: Services, Protocols, UDP, TCP (Book 1 Ch 3). <i>Hands-on: Sockets Introduction, Elementary TCP Sockets, TCP Client/Server Example, I/O Multiplexing: The select and poll Functions (Book 2 Ch 3 to 6), Elementary UDP Sockets (Book 2 Ch 8), Advanced I/O Functions (Book 2 Ch 14)</i> 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) <i>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)</i>	18

3	Data-Link Layer: Data link control (DLC), Multiple access protocols (MAC), Link-layer addressing, Ethernet protocol, Connecting devices (Book 1 Ch 5) Wireless LANs, Mobile IP (Book 1 Ch 6) <i>Hands-on: Datalink Provider Interface, SOCK_PACKET and PF_PACKET (Book 2 Ch 29)</i>	11
4	SNMP, ASN.1 (Book 1 Ch 9) Physical Layer: Data and signals, Digital transmission, Analog transmission, Bandwidth utilization, Transmission media (Book 1 Ch 7)	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the internetworking design in terms of protocol stack and the role of various application layer protocols	K2
CO2	Illustrate the functions of the transport layer from connectionless and connection-oriented perspectives	K3
CO3	Identify how the network layer achieves host-to-host connectivity and caters to the diverse service requirements of the host applications	K3
CO4	Explain the nuances of the data link layer design and demonstrate the various data link link layer protocols	K3
CO5	Describe the fundamental characteristics of the physical layer and understand how the physical layer supports the functionalities of the top layers	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017
2	Unix Network Programming, Volume 1: The Sockets Networking API	W. Richard Stevens, Andrew M. Rudoff, Bill Fenner	Pearson Education	3/e, 2004
3	TCP/IP Architecture, design, and implementation in Linux	Sameer Seth M. Ajaykumar Venkatesulu	Wiley	1/e, 2008

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

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

SEMESTER S5

DESIGN AND ANALYSIS OF ALGORITHMS

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

Course Code	PCCST502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	PCCST303	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

2	Disjoint Sets - Disjoint set operations, Union and find algorithms, Analysis of union by rank with path compression, Connected components of a Graph; Graphs – Representations, Traversals : BFS, DFS and their analysis, Strongly Connected Components; Topological Sorting. Divide and Conquer Strategy – Control Abstraction, Merge Sort, Strassen’s Matrix Multiplication, Analysis.	11
3	Greedy Strategy - Control Abstraction, Fractional Knapsack; Minimum Cost Spanning Tree – Kruskal’s and Prim’s, Analysis; Shortest Path Problem – Dijkstra’s Algorithm, Analysis; Dynamic Programming - Control Abstraction, Optimality Principle, Matrix Chain Multiplication, Analysis; All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm, Analysis; Backtracking - Control Abstraction, N – Queens Problem, Algorithm.	11
4	Branch and Bound - Control Abstraction, Travelling Salesman Problem, Algorithm; Complexity - Tractable and Intractable Problems; Complexity Classes : P, NP, NP- Hard and NP-Complete Classes; NP Completeness proof - Clique Problem and Vertex Cover Problem; Approximation algorithms - Bin Packing; Randomized Algorithms - Definitions of Monte Carlo and Las Vegas algorithms; Randomized version of Quick Sort algorithm with analysis.	11

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze any given algorithm and express its time and space complexities in asymptotic notations.	K4
CO2	Solve the recurrence equations using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms.	K3
CO3	Illustrate the operations of advanced data structures like AVL trees and Disjoint sets.	K3
CO4	Illustrate the representation, traversal and different operations on Graphs.	K3
CO5	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques.	K2
CO6	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability.	K4

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2								3
CO2	3	3	3									2
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3	2								2
CO6	3	3	3	2								2

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Algorithms	T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein,	Prentice-Hall India	4/e, 2018
2	Fundamentals of Computer Algorithms	Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran,	Orient Longman Universities Press	2/e, 2008
3	Computer Algorithms, Introduction to Design and Analysis	Sara Baase and Allen Van Gelder	Pearson Education	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Design and Analysis of Algorithms	Michael T. Goodrich Roberto Tamassia	Wiley	1/e, 2021
2	Algorithm Design	Jon Kleinberg, Eva Tardos	Pearson Education	1/e, 2005
3	Algorithms	Robert Sedgewick, Kevin Wayne	Pearson Education	4/e, 2011
4	Fundamentals of Algorithmics	Gilles Brassard, Paul Bratly	Pearson Education	1/e, 1996
5	The Algorithm Design Manual	Steven S. Skiena	Springer	2/e, 2008

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

SEMESTER S5

MACHINE LEARNING

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

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

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to ML :- Machine Learning vs. Traditional Programming, Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. Parameter Estimation - Maximum likelihood estimation (MLE) and maximum 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, Naïve Bayes, KNN, Decision Trees – ID3	9

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	4/e, 2020
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki Wagner Meira	Cambridge University Press	1/e, 2016
3	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1/e, 1998

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

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

SEMESTER S5

MICROCONTROLLERS

(Common to CS/CC)

Course Code	PBCST504	CIE Marks	60
Teaching Hours/Week (L:T:P:R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

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

Suggestion on Project Topics

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
<ul style="list-style-type: none"> • 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. <p style="text-align: center;">(4x6 = 24 marks)</p>	40

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the architectural features and instructions of the ARM microcontrollers.	K2
CO2	Develop applications involving interfacing of external devices and I/O with ARM microcontroller.	K3
CO3	Use various communication protocols of interaction with peer devices and peripherals.	K3
CO4	Demonstrate the use of a real time operating system in embedded system applications.	K3
CO5	Apply hardware security features of ARM in real world applications.	K3

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors	Joseph Yiu	Newnes - Elsevier	3/e, 2014
2	Mastering STM32	Carmine Noviello	Learnpub	2/e, 2022

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

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

PBL Course Elements

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

Assessment and Evaluation for Project Activity

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

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

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

Creativity in solutions and approaches

SEMESTER S5

SOFTWARE PROJECT MANAGEMENT

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

Course Code	PECST521	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hr.30 Min.
Prerequisites (if any)	PECST411	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	XP, FDD, DSDM, Crystal.	
4	Scrum and DevOps in project management :- Scrum - Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum, Case Study; DevOps - Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test-Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring, Case Study.	11

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand how effectively plan, and schedule projects within time and cost targets	K2
CO2	Apply project estimation and evaluation techniques to real world problem	K3
CO3	Discuss different Agile Project Methodologies	K2
CO4	Apply various SCRUM practices in project management.	K3
CO5	Demonstrate the techniques used in DevOps.	K3

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

CO-PO Mapping Table:

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Succeeding with Agile: Software Development Using Scrum	Mike Cohn	Addison-Wesley	1/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Agile Product Management with Scrum	Roman Pichler	Addison-Wesley	1/e, 2010
2	Agile Project Management with Scrum	Ken Schwaber	Microsoft Press	1/e, 2004

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs70/
2	https://www.youtube.com/watch?v=TPEgII1OiuU
3	https://www.youtube.com/watch?v=7Bxdds2siU8

SEMESTER S5

ARTIFICIAL INTELLIGENCE

Course Code	PECST522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	Reinforcement Learning :- Learning from Rewards, Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, Apprenticeship and Inverse Reinforcement Learning, Applications of Reinforcement Learning	10
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain how intelligent agents can solve problems.	K2
CO2	Use the different types of search methods to solve various problems.	K3
CO3	Formulate knowledge representation and examine resolution in propositional logic and first order logic.	K3
CO4	Utilize reinforcement learning techniques to create intelligent agents.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	AI – A Modern Approach	Stuart Russel, Peter Norvig	Pearson Education	4/e, 2021
2	Artificial Intelligence	Kevin Knight, Elaine Rich, Shivashankar B. Nair	Tata McGraw-Hill	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Artificial Intelligence and Expert Systems	Dan W. Patterson	Pearson Education	1/e, 2015
2	Artificial Intelligence: Structures and Strategies for Complex Problem Solving	George F. Luger	Pearson Education	6/e, 2009
3	Artificial Intelligence : Making a System Intelligent	Nilakshi Jain	Wiley	1/e, 2019

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

SEMESTER S5

DATA ANALYTICS

Course Code	PECST523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Association Between Ordinal and Continuous Variables, Visualization of Variables from Different Scales.	
3	<p>Statistical Description of data - Central tendency, Dispersion, Range, Quartiles, Variance, Standard Deviation, and Interquartile Range.</p> <p>Data Preprocessing - Cleaning, Integration, Reduction, Transformation, Discretization.</p> <p>Mining Frequent Patterns - Associations, Correlations, and Apriori Algorithms.</p> <p>Classification - General approach to classification, ID3, Attribute selection measures, Naive Bayesian Classification.</p> <p>Clustering - K-Means, Agglomerative versus Divisive Hierarchical Clustering, BIRCH, DBSCAN.</p>	9
4	<p>Text Processing :-</p> <p>Boolean retrieval, Example IR problem, inverted index, processing Boolean queries, tokenization, stemming, phrase queries, vector space model, finite automata and language model, query likelihood model, naïve bayes text classification.</p>	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the key concepts of data analytics	K2
CO2	Apply appropriate techniques to convert raw data into suitable format for practical data analytics tasks	K3
CO3	Extend the concept of association rule mining in real world scenario	K3
CO4	Select appropriate clustering and classification algorithms for various applications and extend data analytics methods to the new domains of data.	K4
CO5	Understand the basics of text analytics and text classification	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Statistics and Data Analysis	Christian Heumann and Michael Schomaker	Springer	1/e, 2016
2	Jiawei Han and Micheline Kamber	Data Mining Concepts and Techniques	Elsevier	3/e, 2012

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

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

SEMESTER S5

DATA COMPRESSION

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

Course Code	PECST524	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

3	Video Compression :- Video Compression - Analog video, Digital Video, Motion Compensation. MPEG standards MPEG, H.261	8
4	Audio Compression :- Audio Compression - Companding, The Human Auditory System, Heinrich Georg Barkhausen, Linear Prediction, μ -Law and A-Law Companding, Shorten	8

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the fundamental approaches in data compression techniques	K2
CO2	Illustrate various classical data compression techniques	K3
CO3	Illustrate various text and image compression standards	K3
CO4	Describe the video compression mechanisms to reduce the redundancy in video	K3
CO5	Understand the fundamental principles of audio data compression	K2

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

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

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

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Concise Introduction to Data Compression	David Salomon	Springer	1/e, 2008
2	Data compression: The Complete Reference	David Salomon	Springer	3/e, 2004
3	Introduction to Data Compression	Khalid Sayood	Morgan Kaufman	1/e, 2003

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

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

SEMESTER S5

DIGITAL SIGNAL PROCESSING

(Common to CS/CM/CA/AM)

Course Code	PECST526	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Signals and Systems	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

3	Realization structures for FIR filters- direct, cascade, parallel. IIR Filter realization structures (Direct form I, II, cascade and Parallel and transposed structures); Computational accuracy in DSP implementation- Number formats for signals and coefficients in DSP systems, Dynamic range and precision, Sources of error in DSP implementation - A/D conversion error, DSP computational error, D/A Conversion error.	9
4	<p>FFT and FIR Filter realization on a fixed point processor -finite wordlength effects - Quantization, rounding and truncation, overflow and scaling. DSP Algorithm representations, data flow, control flow, signal flow graphs, block diagrams - Loop bound, iteration bound, critical path - Pipelining, parallel processing, low power architectures - Retiming, folding and unfolding techniques, applications.</p> <p>Hands-on : -</p> <ul style="list-style-type: none"> ● FPGA based hardware realization of the FFT algorithm, circular convolution, IIR and FIR filter structures using iVerilog. ● To realize different DSP algorithms including basic multiply accumulation and shifting operations on a fixed point processor. ● Analyze the effect of the finite wordlength by implementing the FFT algorithm and FIR filters by using fixed point coefficient representation in different formats like Q7, Q15 etc. ● Design an FIR low pass filter using MATLAB/SCILAB and check how it filters a speech signal by recording it and playing the result. 	10

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept of DFT and apply it for determining the spectral information of data sequences.	K2
CO2	Apply algorithms for complexity reduction in the computation of DFT.	K3
CO3	Use the theory of FIR and IIR filters and be able to design FIR filters using the window method.	K3
CO4	Build the IIR and FIR filter transfer functions using suitable structures	K3
CO5	Identify the effect of finite wordlength on DSP algorithm implementation.	K3
CO6	Utilize the low power architectures for implementing the DSP algorithms	K3

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	3	3	3									2
CO3	3	3	3	3								2
CO4	3	3	3	3								2
CO5	3	3	3	3								2
CO6	3	3	3				3					2

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Signal Processing [Modules 1,2,3]	S. Salivahanan	McGraw Hill	10/e, 2019
2	Digital Signal Processing: A Computer - Based Approach [Modules 2]	Sanjit K.Mitra	McGraw Hill	4/e, 2013
3	VLSI Signal Processing Systems, Design and Implementation [Module 4]	Keshab K. Parhi	Wiley	1/e, 2007

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

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

SEMESTER S5

COMPUTER GRAPHICS & MULTIMEDIA

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

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

Course Objectives:

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

SYLLABUS

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

	<p>algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms.</p> <p>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.</p>	
4	<p>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.</p> <p>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.</p>	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Graphics : Algorithms and Implementations	D. P. Mukherjee, Debasish Jana	PHI	1/e, 2010
2	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4/e, 2013
3	Fundamentals of Multimedia	Ze-Nian Li and Mark S. Drew	Pearson	2003

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

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

SEMESTER S5

ADVANCED COMPUTER ARCHITECTURE

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S5

DATA MINING

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

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

Course Objectives:

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

SYLLABUS

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

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

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

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

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

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

SEMESTER S5

ADVANCED GRAPH ALGORITHMS

Course Code	PECST595	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GAMAT401 PCCST303 PCCST502	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Maximum Flow Algorithms - Dinic's Algorithm, Push-Relabel Algorithm. Applications - network bandwidth allocation, data center resource management.</p> <p>Minimum Cost Flow - Cycle-Canceling Algorithm, Capacity Scaling Algorithm. Applications - transportation logistics, network routing with cost constraints.</p> <p>Assignments:</p> <ol style="list-style-type: none">1. Network Bandwidth Allocation - Optimize bandwidth allocation in a communication network using Dinic's Algorithm. <p>Implement Dinic's Algorithm to solve a network flow problem where you are given a communication network represented as a directed graph with capacities on edges. Your goal is to maximize</p>	9

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

	<p>scheduling problems</p> <p>Assignments:</p> <ol style="list-style-type: none"> 1. Job Assignment Optimization - Solve job assignment problems using Edmonds' Algorithm. Implement Edmonds' Blossom Algorithm to address job assignment problems where you need to match workers to jobs in a way that maximizes the overall efficiency or minimizes the cost. Use a dataset with job assignments and associated costs or efficiencies. 2. Frequency Assignment - Allocate frequencies in wireless communication systems using graph coloring techniques. Apply graph coloring techniques to allocate frequencies to transmitters in a wireless communication network to avoid interference. The goal is to minimize the number of frequencies used while ensuring that adjacent transmitters do not use the same frequency. Use a dataset representing a network of transmitters with potential interference. 	
4	<p>Graph Partitioning and Community Detection - Kernighan-Lin Algorithm, Spectral Partitioning. Applications - social network community detection, large-scale data clustering.</p> <p>Parameterized Algorithms for Graph Problems - Fixed-parameter tractability for vertex cover, feedback vertex set. Applications - network security, bioinformatics.</p> <p>Assignments:</p> <ol style="list-style-type: none"> 1. Social Network Community Detection - Detect communities in a social network using the Kernighan-Lin Algorithm. Apply the Kernighan-Lin Algorithm to detect communities in a social network where nodes represent individuals and edges represent relationships. The goal is to find clusters of highly interconnected individuals. Use a social network dataset with nodes and edges representing social connections. 2. Network Security Analysis - Identify critical nodes in a network using parameterized algorithms to assess network security. Use parameterized algorithms to identify critical nodes and vulnerabilities in a network. These nodes are crucial for the network's connectivity, and their removal would impact the network's security and robustness. Use a dataset representing a network with nodes and edges, along with possible vulnerabilities. 	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Assignment evaluation pattern:

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop and implement advanced algorithms for network flow, graph connectivity, and matching, and evaluate their performance on real-world datasets.	K3
CO2	Analyze and compare the efficiency and effectiveness of various graph algorithms, including those for network optimization and community detection.	K4
CO3	Apply advanced graph algorithms to solve practical problems such as network optimization, job assignment, and frequency allocation, demonstrating their utility in real-world scenarios.	K3
CO4	Formulate and solve complex graph-related problems using appropriate algorithms, including those for graph traversal, minimum spanning trees, and network security analysis.	K5
CO5	Critically assess the strengths and limitations of different graph algorithms, and effectively communicate findings and recommendations through detailed reports and presentations.	K5

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	The MIT Press Cambridge	4/e 2023
2	Algorithms	Robert Sedgewick and Kevin Wayne	Addison-Wesley	4/e, 2023
3	Graph Algorithms	Shimon Even	Cambridge University Press	2/e, 2011
4	Graph Theory	Reinhard Diestel	Springer	4/e, 2010

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

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

SEMESTER S5

NETWORKS LAB

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

Course Code	PCCSL507	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

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

Expt. No.	Experiments
Warm up	
1	Familiarize Linux networking commands - ifconfig, ifplugstatus, iftop, ping, ip, traceroute, mtr, netstat, whois, nmap, nmcli, speedtest-cli, bmon, nslookup, tcpdump
Wireshark based	
2	<p>Start your web browser and clear the browser's cache memory. Open Wireshark and start capturing. Then visit any webpage of your choice. Type http in the filter field of the Wireshark and click Apply so that only HTTP messages are displayed. After enough packets have been captured, select the Capture from the pull-down menu and select Stop to stop capturing.</p> <p>Using the captured information, determine the following:</p> <ol style="list-style-type: none">(a) the source IP address and destination IP address of the first GET message(b) the medium format, the language, the encoding, and the character set that the client can accept. (Use the first GET message)(c) the URL of the website and the user agent (Use the first GET message)(d) the source IP address and destination IP address of the first response message(e) the status codes for the first response message.(f) when the HTML file that you are retrieving was last modified at the server

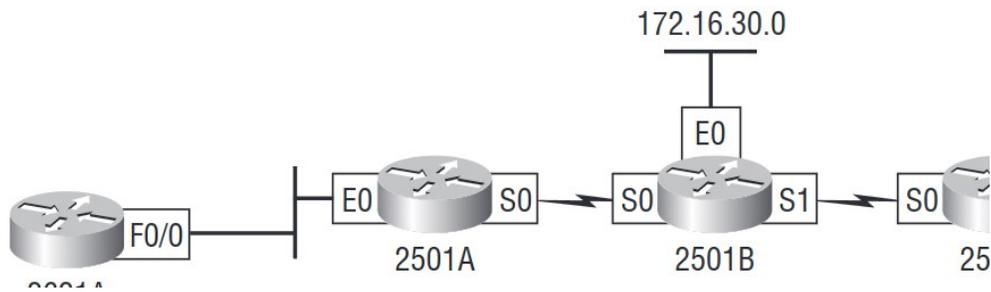
	<p>(g) value of the content-length field of the first response message</p> <p>(h) how long it took from the time the GET message was sent until the response message was received.</p> <p>(Use the timestamps of a GET message and that of the corresponding response message. By default, the time column's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

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

	back. The client then displays the received time value.
9	Develop a concurrent file server that will provide the file requested by the client if it exists. If not, the server sends an appropriate message to the client. The server should also send its process ID (PID) to clients for displaying along with the file contents or with the message.
10	Develop a packet-capturing application using raw sockets.

Cisco's Packet tracer based

11	<p>Familiarizing router commands</p> <ul style="list-style-type: none"> (a) Knowing the current mode (user or privileged), switching to privileged mode (b) Switching to configuration mode (c) Obtaining router information such as type, OS, memory stats, interface details etc. (d) Viewing the status of any routing protocols currently configured (e) Showing the routing table (f) Saving the running configuration (g) Viewing the command history (h) Viewing the router clock (i) Viewing the list of hosts (j) Displaying the statistics for all the interfaces (Both detailed and brief views) (k) Knowing the controller type (DTE or DCE) (l) Configuring serial and ethernet interfaces - enabling the interface, setting IP address, mask, and clock rate
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router	Interface	IP
2621	F0/0	172.16.10.1
2501A	E0	172.16.10.2
2501A	S0	172.16.10.3
2501B	E0	172.16.10.4
2501B	S0	172.16.10.5
2501B	S1	172.16.10.6

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

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

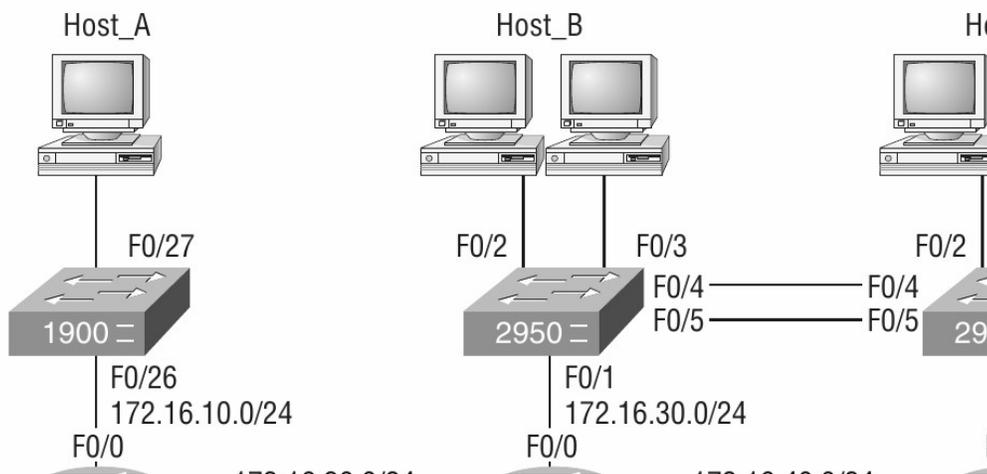


Figure 2: A portion of your college campus network

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

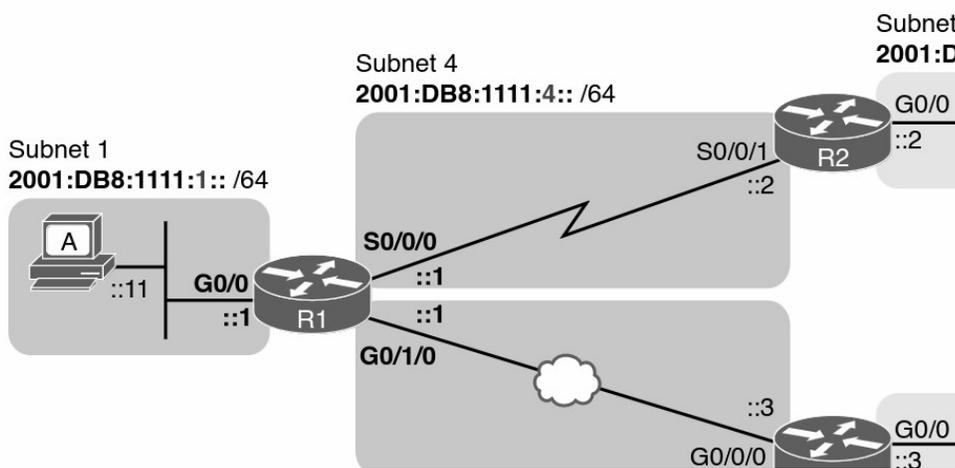


Figure 3: An IPv6 network

Course Assessment Method

(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the working of application layer protocols by analyzing the pertinent headers in actual data packets captured using network monitoring tools.	K3
CO2	Exploit the client server paradigm to develop real time networking applications using transport layer protocols.	K3
CO3	Employ IPv4 and IPv6 addressing, subnetting to efficiently design networks.	K3
CO4	Simulate core networking concepts using a network simulator.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Unix Network Programming, Volume 1: The Sockets Networking API	W. Richard Stevens, Andrew M. Rudoff, Bill Fenner	Pearson Education	3/e, 2004
2	CCNA Cisco certified network associate study guide Exam 640-802 6	Todd Lammle	Wiley	6/e, 2007
3	Beej's Guide to Network Programming: using Internet Sockets	Brian "beej Jorgensen" Hall	Amazon Digital Services	2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networks: A Top- Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017
2	Computer Networking: A Top- Down Approach Featuring Internet	J. F. Kurose and K. W. Ross	Pearson Education	8/e, 2022

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://nptel.ac.in/courses/106106091

Continuous Assessment (25 Marks)

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

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.

- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

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

3. Lab Reports and Record Keeping (6 Marks)

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

4. Viva Voce (5 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER 5
MACHINE LEARNING LAB

(Common to CS/CA)

Course Code	PCCSL508	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

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

Expt. No.	Experiments
1	<p>Implement linear regression with one variable on the California Housing dataset to predict housing prices based on a single feature (e.g., the average number of rooms per dwelling).</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the datase. ● Implement linear regression using both gradient descent and the normal equation. ● Evaluate the model performance using metrics such as Mean Squared Error (MSE) and R-squared. ● Visualize the fitted line along with the data points.
2	<p>Implement polynomial regression on the Auto MPG dataset to predict miles per gallon (MPG) based on engine displacement. Compare polynomial regression results with linear regression.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the dataset. ● Implement polynomial regression of varying degrees. ● Compare the polynomial regression models with linear regression using metrics such as MSE and R-squared. ● Visualize the polynomial fit.
3	<p>Implement Ridge and Lasso regression on the Diabetes dataset. Compare the performance of these regularized models with standard linear regression.</p> <p>Tasks:</p>

	<ul style="list-style-type: none"> ● Load and preprocess the dataset. ● Implement Ridge and Lasso regression. ● Tune hyperparameters using cross-validation. ● Compare performance metrics (MSE, R-squared) with standard linear regression.
4	<p>Estimate the parameters of a logistic regression model using MLE and MAP on the Breast Cancer Wisconsin dataset. Compare the results and discuss the effects of regularization.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the dataset. ● Implement logistic regression with MLE. ● Apply MAP estimation with different regularization priors (L1 and L2 regularization). ● Compare the performance and parameter estimates with MLE and MAP.
5	<p>Use MLE and MAP to estimate the parameters of a multinomial distribution on the 20 Newsgroups dataset. Explore the impact of different priors on the estimation.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the dataset. ● Implement MLE for multinomial distribution parameter estimation. ● Apply MAP estimation with various priors (e.g., Dirichlet priors). ● Compare results and evaluate the effect of different priors.
6	<p>Implement a logistic regression model to predict the likelihood of a disease using the Pima Indians Diabetes dataset. Compare the performance with and without feature scaling.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Pima Indians Diabetes dataset. ● Implement logistic regression for binary classification. ● Evaluate model performance with and without feature scaling. ● Analyze metrics such as accuracy, precision, recall, and F1-score.
7	<p>Implement a Naïve Bayes classifier to categorize text documents into topics using the 20 Newsgroups dataset. Compare the performance of Multinomial Naïve Bayes with Bernoulli Naïve Bayes.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the 20 Newsgroups dataset. ● Implement Multinomial Naïve Bayes and Bernoulli Naïve Bayes classifiers. ● Evaluate and compare the performance of both models using metrics such as accuracy and F1-score. ● Discuss the strengths and weaknesses of each Naïve Bayes variant for text classification.

8	<p>Implement the K-Nearest Neighbors (KNN) algorithm for image classification using the Fashion MNIST dataset. Experiment with different values of K and analyze their impact on model performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Fashion MNIST dataset. ● Implement KNN for multi-class classification. ● Experiment with different values of K and evaluate performance. ● Discuss the impact of different K values on model accuracy and computational efficiency.
9	<p>Implement a Decision Tree classifier using the ID3 algorithm to segment customers based on their purchasing behavior using the Online Retail dataset. Analyze the tree structure and discuss the feature importance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Online Retail dataset. ● Implement Decision Tree using the ID3 algorithm. ● Visualize the decision tree and analyze feature importance. ● Discuss how the tree structure helps in understanding customer behavior.
10	<p>Implement and compare Logistic Regression and Decision Trees on the Adult Income dataset for predicting income levels. Evaluate both models based on performance metrics and interpretability.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Adult Income dataset. ● Implement both Logistic Regression and Decision Trees. ● Compare the models based on metrics such as accuracy, precision, recall, and F1-score. ● Discuss the interpretability of both models and their suitability for the dataset.
11	<p>Implement a Linear Support Vector Machine (SVM) to classify the Iris dataset. Visualize the decision boundary and discuss how the margin is determined.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Iris dataset. ● Implement a Linear SVM for binary classification (e.g., classify Setosa vs. Non-Setosa). ● Visualize the decision boundary and margin. ● Discuss the concept of the margin and how it influences classification.
12	<p>Implement and compare the performance of SVM classifiers with linear, polynomial, and RBF kernels on the Fashion MNIST dataset. Analyze the advantages and disadvantages of each kernel type.</p>

	<p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Fashion MNIST dataset. ● Implement SVM with linear, polynomial, and RBF kernels. ● Compare the classification performance for each kernel. ● Discuss the strengths and weaknesses of each kernel type.
13	<p>Implement and train a Multilayer Feed-Forward Network (MLP) on the Wine Quality dataset. Experiment with different numbers of hidden layers and neurons, and discuss how these choices affect the network's performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Wine Quality dataset. ● Design and implement an MLP with varying architectures (different hidden layers and neurons). ● Train and evaluate the network. ● Discuss the impact of architecture choices on performance.
14	<p>Implement and compare the performance of a neural network using different activation functions (Sigmoid, ReLU, Tanh) on the MNIST dataset. Analyze how each activation function affects the training process and classification accuracy.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the MNIST dataset. ● Implement neural networks using Sigmoid, ReLU, and Tanh activation functions. ● Train and evaluate each network. ● Compare training times, convergence, and classification accuracy.
15	<p>Implement and perform hyperparameter tuning for a neural network on the Fashion MNIST dataset. Experiment with different learning rates, batch sizes, and epochs, and discuss the impact on model performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Fashion MNIST dataset. ● Experiment with different hyperparameters (learning rate, batch size, epochs). ● Train and evaluate the network. ● Discuss how hyperparameter choices affect model performance.
16	<p>Implement and compare hierarchical (agglomerative) and partitional (K-means) clustering algorithms on the Mall Customers dataset. Discuss the strengths and weaknesses of each method based on clustering results and evaluation metrics.</p> <p>Tasks:</p> <ul style="list-style-type: none"> ● Load and preprocess the Mall Customers dataset. ● Apply both hierarchical (agglomerative) and K-means clustering. ● Compare results using metrics such as inertia, silhouette score, and clustering

	<p>visualization.</p> <ul style="list-style-type: none"> • Discuss the advantages and disadvantages of each clustering method.
17	<p>Implement and apply K-means clustering to the Digits dataset. Experiment with different numbers of clusters and evaluate the clustering results using metrics such as inertia and silhouette score. Analyze how the choice of K affects clustering performance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> • Load and preprocess the Digits dataset. • Implement K-means clustering with various numbers of clusters. • Evaluate clustering performance using inertia and silhouette score. • Analyze the impact of the number of clusters on clustering quality.
18	<p>Implement bootstrapping and cross-validation on the Iris dataset. Compare the model performance metrics (e.g., accuracy, F1-score) obtained using these resampling methods. Discuss the advantages and disadvantages of each method.</p> <p>Tasks:</p> <ul style="list-style-type: none"> • Load and preprocess the Iris dataset. • Implement bootstrapping to generate multiple samples and evaluate the model. • Implement k-fold cross-validation and evaluate the model. • Compare the performance metrics and discuss the pros and cons of each resampling method.
19	<p>Implement bagging and boosting ensemble methods on the Titanic dataset. Compare the performance of both methods in terms of accuracy, precision, recall, and F1-score. Discuss how each method improves model performance and their respective strengths and weaknesses.</p> <p>Tasks:</p> <ul style="list-style-type: none"> • Load and preprocess the Titanic dataset. • Implement bagging using a base classifier (e.g., decision tree) and evaluate performance. • Implement boosting using a boosting algorithm (e.g., AdaBoost) and evaluate performance. • Compare performance metrics and discuss the strengths and weaknesses of each method.
20	<p>Investigate the bias-variance tradeoff using polynomial regression on the Boston Housing dataset. Plot the training and validation errors for various polynomial degrees and discuss the tradeoff between bias and variance.</p> <p>Tasks:</p> <ul style="list-style-type: none"> • Load and preprocess the Boston Housing dataset. • Implement polynomial regression with varying degrees.

	<ul style="list-style-type: none"> Plot training and validation errors for each degree. Discuss the bias-variance tradeoff and its impact on model performance.
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Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand complexity of Machine Learning algorithms and their limitations;	K2
CO2	Understand modern notions in data analysis-oriented computing;	K2
CO3	Apply common Machine Learning algorithms in practice and implement their own.	K3
CO4	Performing experiments in Machine Learning using real-world data.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	4/e, 2020
2	Machine Learning using Python	Manaranjan Pradhan U Dinesh Kumar	Wiley	1/e, 2019
3	Machine Learning: Theory and Practice	M.N. Murty, V.S. Ananthanarayana	Universities Press	1/e, 2024

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

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

Continuous Assessment (25 Marks)

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

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

2. Conduct of Experiments (7 Marks)

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

3. Lab Reports and Record Keeping (6 Marks)

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

4. Viva Voce (5 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

- Creativity and logic in algorithm or experimental design.

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER 6

COMPUTER SCIENCE AND ENGINEERING

SEMESTER S6
COMPILER DESIGN
(Common to CS/CD/CU/CC/CN/CB)

Course Code	PCCST601	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	PCCST302	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

3	<p>Bottom-Up Parsing - Shift Reduce Parser, The LR(1) Parsing Algorithm, Building LR(1) Tables, Errors in the Table Construction, Reducing the Size of LR (1) Tables.</p> <p><i>Hands-on: Building a calculator with YACC</i></p> <p>Intermediate Representations: An IR Taxonomy, Graphical IRs - Syntax-Related Trees, Graphs; Linear IRs - Stack-Machine Code - Three-Address Code - Representing Linear Codes</p> <p>Syntax-Driven Translation: Introduction, Translating Expressions, Translating Control-Flow Statements</p>	16
4	<p>Code generation: Code Shape - Arithmetic Operators, Boolean and Relational Operators, Control-Flow Constructs (Conditional Execution, Loops and Iteration, Case Statements only), Procedure Calls</p> <p>Code Optimization - Introduction, Opportunities for Optimization, Scope Of Optimization</p> <p>Local Optimization: Local Value Numbering, Tree-Height Balancing</p> <p>Regional Optimization: Superlocal Value Numbering, Loop Unrolling</p> <p>Global Optimization: Finding Uninitialized Variables with Live Sets, Global Code Placement</p>	14

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Use lexical analysis techniques to build a scanner for a given language specification. (Cognitive Knowledge Level: Apply)	K3
CO2	Construct parse trees for input programs using parsing algorithms and detect syntactic errors. (Cognitive Knowledge Level: Apply)	K3
CO3	Develop semantic analysis techniques to check program correctness. (Cognitive Knowledge Level: Apply)	K3
CO4	Build intermediate code representations by applying intermediate code generation techniques. (Cognitive Knowledge Level: Apply)	K3
CO5	Optimize generated code using code optimization strategies to improve performance. (Cognitive Knowledge Level: Apply)	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering a Compiler	Keith D. Cooper, Linda Torczon	Elsevier Science	3/e, 2023
2	Lex and YACC	John R. Levine, Tony Mason, Doug Brown	O' Reily	2/e, 1992

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/106/105/106105190/

SEMESTER S6

ADVANCED COMPUTING SYSTEMS

Course Code	PCCST602	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	GAEST203 PBCST404 PCCST403	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

3	<p>Virtualization:- Introduction, Virtualization at different levels and their comparison. VMM design requirements, OS level virtualization. Virtualization structures and mechanisms. CPU, Memory and I/O Virtualization. Virtual clusters and resource management. Live VM migration steps, migration of memory, files and network resources.</p>	9
4	<p>Cloud Computing, Microservices and Containers:-</p> <p>Cloud Computing and Service models:- Private, Public and Hybrid clouds. Cloud Design objectives and Cost Model. Infrastructure-as-a-Service, Platform-as-a-Service, Software-as-a-Service.</p> <p>Microservices:- – Introduction, advantages and disadvantages. Interprocess Communication – Types of interactions, Protocol, Standard and Message Format, Discovery Service, API Gateway, Service Registry</p> <p>Containers – Comparison of Virtual Machines and Containers. Introduction to Docker. Case Study - Docker Containers – Architecture, Components, Examples.</p>	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate the key enabling technologies for network-based systems, including multicore CPUs, multithreading, GPU computing, and virtualization, and how these technologies contribute to the performance and efficiency of distributed systems.	K3
CO2	Use computer cluster architectures, ensuring high availability, fault tolerance, and massive parallelism. They will also learn to implement effective job and resource management strategies within cluster environments.	K4
CO3	Explain various levels of virtualization, including CPU, memory, and I/O virtualization, and understand the design requirements and mechanisms of Virtual Machine Monitors (VMMs).	K2
CO4	Articulate the differences between private, public, and hybrid cloud models, and understand the design objectives and cost considerations associated with different cloud models.	K4
CO5	Explain microservices architecture, its advantages and disadvantages, and the principles of interprocess communication. They will also learn about the role of containers in modern computing, with a specific focus on Docker, including its architecture, components, and practical applications through case studies.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Distributed and Cloud Computing: From Parallel Processing to the Internet of Things	Kai Hwang, Geoffrey C. Fox, Jack Dongarra	Morgan Kaufmann	1/e, 2013
2	Microservices and Containers	Parminder Singh Kocher	Addison-Wesley	1/e, 2018

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

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

SEMESTER S6

SOFTWARE TESTING

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

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

Course Objectives:

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

SYLLABUS

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

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

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO1	3	3	3									3
CO2	3	3	3	3	3							3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3		3							3
CO6	3	3	3	3	3							3

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

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

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

Video Links (NPTEL, SWAYAM...)

Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/101/106101163/
2	https://archive.nptel.ac.in/courses/106/101/106101163/
3	https://archive.nptel.ac.in/courses/106/101/106101163/
4	https://archive.nptel.ac.in/courses/106/101/106101163/

SEMESTER S6
DEEP LEARNING

Course Code	PECST632	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient descent, Curse of Dimensionality, Deep feedforward networks.	8
2	Machine Learning and Deep learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.	9
3	CNN-Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, Alexnet – Applications. Recurrent Neural Networks, Bidirectional RNNs, Encoder – decoder sequence to sequence architectures – BPTT for training RNN, Long Short Term Memory Networks.	10
4	Computer Vision - Speech Recognition - Natural language Processing, Case studies in classification, Regression and deep networks. Regularized Autoencoder, stochastic Encoders and Decoders, Contractive Encoders. GAN and its variants	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Construct fundamental neural network architectures and algorithms, including Multilayer Perceptron and Back-propagation	K3
CO2	Apply advanced techniques such as Stochastic Gradient Descent and address the Curse of Dimensionality in the context of deep learning models.	K3
CO3	Build various deep learning architectures, including feed-forward networks, Convolutional Neural Networks (CNNs), and their applications in real-world problems.	K3
CO4	Develop and utilize Recurrent Neural Networks (RNNs) and Long Short-Term Memory Networks (LSTMs) for sequence modeling and natural language processing tasks.	K3
CO5	Apply unsupervised learning techniques such as Autoencoders and Generative Adversarial Networks (GANs) to solve complex problems in computer vision and speech recognition.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	1/e, 2016
2	Neural Networks and Deep Learning	Michael A. Nielsen	Determination Press,	2/e, 2015
3	Learning Deep Architectures for AI	Yoshua Bengio	Now Publishers Inc	1/e, 2009
4	Deep Learning: A Practitioner's Approach	Josh Patterson, Adam Gibson	O'Reilly	1/e, 2017

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

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

SEMESTER S6

WIRELESS & MOBILE COMPUTING

(Common to CS/CM/AM)

Course Code	PECST633	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	Mobile network layer – Mobile Internet Protocol (IP), Dynamic Host Configuration Protocol (DHCP), Mobile ad-hoc networks – Routing, Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV), Ad-hoc routing protocols; Mobile transport layer – Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP; Security issues in mobile computing - Information security, Security techniques and algorithms, Security models.	10
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the various mobile computing applications, services, design considerations and architectures	K2
CO2	Describe the various technology trends for next generation cellular wireless networks and use the spreading concept on data transmission	K2
CO3	Summarize the architecture of various wireless LAN technologies	K2
CO4	Identify the functionalities of mobile network layer & transport layer and various security issues in mobile computing	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mobile Computing Technology - Application and Service Creation	Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal	McGraw Hill	2/e, 2010
2	Mobile Communications	Jochen Schiller	Pearson	2/e, 2000
3	Fundamentals of 5G Mobile Networks	Jonathan Rodriguez	Wiley	1/e, 2015

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

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

SEMESTER S6

ADVANCED DATABASE SYSTEMS

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

Course Code	PECST634	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs: 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Schema, XML Presentation, XPath Queries, XQuery; NoSQL Databases - CAP Theorem, Document based; MongoDB Operation - Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment; Cassandra - Data Model, Key Space, Table Operations, CRUD Operations.	
4	Graph database - Introduction, Data Modelling with Graphs, Building a Graph Database application, Data Modeling, Predictive Analysis with Graph Theory; Depth and Breadth First Search; Path-Finding with Dijkstra's Algorithm; Graph Theory and Predictive Modeling	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply various measures for query processing and optimization, and apply techniques to tune database performance.	K3
CO2	Explain the architecture and fundamental concepts of distributed databases.	K2
CO3	Utilize semi-structured data, XML, and XML queries for effective data management	K3
CO4	Utilize NoSQL database systems to manage and manipulate data in real-time applications	K3
CO5	Develop advanced skills in graph database concepts, covering data modeling, application building, and the application of graph theory for predictive analysis and modeling.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Database Systems	Ramez Elmasri, Shamkant B. Navathe	Pearson	7/e, 2017
2	Database System Concepts	A. Silberschatz, H. Korth, S. Sudarshan	McGraw-Hill	7/e, 2021
3	Database Management Systems	R. Ramakrishnan, J. Gehrke	McGraw Hill	3/e, 2018
4	Graph Databases	Ian Robinson, Jim Webber & Emil Eifrem	O'Reilly	2/e, 2015
5	Database Systems	T. M. Connolly, C. Begg	Pearson	6/e, 2019

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

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

SEMESTER S6

DIGITAL IMAGE PROCESSING

(Common to CS/CM/CA/AM)

Course Code	PECST636	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Parametric Edge Models, Edges Multi-spectral images,, Line detection by local pre-processing operators, Detection of corners(interest points), Image Restoration - Degradations that are easy to restore, Inverse Filtering, Wiener Filtering	
3	Image Segmentation - Thresholding, Threshold Detection Methods- Optimal thresholding, Multi-spectral thresholding, Edge-based segmentation, Edge Image Thresholding, Edge Relaxation, Border Tracing, Border Detection As Graph Searching, Border Detection As Dynamic Programming, Hough Transforms, Border Detection Using Border location information, Region construction from borders, Region-based segmentation - Region merging, Region Splitting - Splitting And Merging, Watershed segmentation Matching, Template Matching, Control Strategies Templating, Evaluation Issues In Segmentation	9
4	Image Transforms - Discrete Cosine Transform, Wavelet transform, Eigen-analysis, Singular value decomposition, Principal component analysis Radon Transform; Image Compression - Image data Properties, Discrete Image Transforms In Image data compression, Predictive compression methods, Vector quantization, Hierarchical and Progressive Compression methods, Comparison Of Compression Methods, JPEG and MPEG image compression JPEG still image compression, JPEG–2000 compression, MPEG full-motion video compression.	10

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the properties of monochrome and colour images and the data structures for image analysis	K2
CO2	Apply different preprocessing techniques to visualize image enhancement	K3
CO3	Understand the concept of image segmentation and various techniques used for this.	K2
CO4	Understand the various transforms used for image processing	K2
CO5	Understand the concept of image compression and apply various image compression techniques.	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Image Processing, Analysis and Machine Vision	Milan Sonka, Vaclav Hlavac, Roger Boyle	Cengage	4/e, 2015

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

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

SEMESTER S6

FUNDAMENTALS OF CRYPTOGRAPHY

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

Course Code	PECST637	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Requirements for Public-Key Cryptography, The RSA Algorithm, Description of the Algorithm; Diffie–Hellman Key Exchange..	
4	Cryptographic Hash Functions - Applications of Cryptographic Hash Functions, Secure Hash Algorithm (SHA), SHA-3; MAC; MD5; Digital Signatures.; Key Management and Distribution - Symmetric Key Distribution; X.509 certificates; PKI.	8

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply number theory concepts in data security	K3
CO2	Explain the cryptographic concepts and apply the classical encryption methods for data confidentiality	K3
CO3	Describe the symmetric and asymmetric ciphers used for information security	K2
CO4	Explain the algorithms used for authentication and integrity	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography & Network Security: Principles and practice	William Stallings	Pearson	7/e, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography & Network Security	Behrouz A. Forouzan	McGraw Hill	3/E, 2007
2	Security in Computing	Charles P. Pfleeger, Shari L. Pfleeger, Jonathan Margulies	Prentice Hall	5/e, 2015
3	A Classical Introduction to Cryptography: Applications for Communications Security	S. Vaudenay	Springer	1/e, 2009
4	Introduction to Cryptography: Principles and Applications	H. Delfs, H. Knebl	Springer-Verlag	1/E, 2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/111/101/111101137/
2	https://nptel/courses/video/106105031/L17.html
3	https://onlinecourses.nptel.ac.in/noc22_cs90/preview

SEMESTER S6

QUANTUM COMPUTING

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

Course Code	PECST638	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To give an understanding of quantum computing against classical computing.
2. To understand fundamental principles of quantum computing, quantum algorithms and quantum information.

SYLLABUS

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

	quantum channels, Quantum Key Distribution, Quantum Communication protocols [Text 2 - Ch 11.3, Ch 12.1 - 12.5]	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the concept of quantum computing against classical computing.	K2
CO2	Illustrate various quantum computing algorithms.	K2
CO3	Explain the latest quantum communication & protocols.	K2
CO4	Experiment with new algorithms and protocols for quantum computing.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Quantum Computing : From Linear Algebra to Physical Realizations	Mikio Nakahara Tetsuo Ohmi	CRC Press	1/e, 2008
2	Quantum Computation and Quantum Information	Michael A. Nielsen & Isaac L. Chuang	Cambridge University Press	1/e, 2010

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

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

SEMESTER S6

RANDOMIZED ALGORITHMS

Course Code	PECST639	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GAMAT301 PCCST302 PCCST303 PCCST502	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Markov Chains and Random Walks - Introduction to Markov chains, Random walks on graphs, Applications in randomized algorithms. (Text 2 - Chapters 6, 7)	
3	The Probabilistic Method - Basics of the probabilistic method, Linearity of expectation, First and second-moment methods. (Text 4 - Chapters 1, 2) Chernoff Bounds and Concentration Inequalities - Markov's inequality, Chebyshev's inequality, Chernoff bounds, Applications of concentration inequalities. (Text 1 - Chapter 4)	9
4	Randomized Rounding and Martingales - Randomized rounding techniques, Applications in approximation algorithms, Introduction to martingales, Azuma's inequality. (Text 5 - Chapter 14) Randomized Complexity Classes - RP, ZPP, and BPP, Relationships between complexity classes, Amplification and derandomization techniques (Text 6 - Chapter 7)	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate a strong understanding of the basics of randomized algorithms, including probabilistic analysis, expectations, and the benefits of randomization	K3
CO2	Illustrate basic randomized algorithms, such as randomized quicksort, selection, and data structures, and evaluate their performance against deterministic alternatives.	K3
CO3	Apply advanced randomized techniques, including randomized graph algorithms, hashing, and Markov chains, to address complex graph and data structure problems.	K3
CO4	Show expertise in probabilistic methods, including Chernoff bounds, concentration inequalities, and randomized rounding, and use these methods to solve approximation and analysis problems in algorithms.	K3
CO5	Understand and apply concepts related to randomized complexity classes, such as RP, ZPP, and BPP, and explore amplification and derandomization techniques.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Randomized Algorithms	Rajeev Motwani and Prabhakar Raghavan	Cambridge University Press	1/e, 2004
2	Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis	Michael Mitzenmacher and Eli Upfal	Cambridge University Press	3/e, 2017
3	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	The MIT Press	4/e, 2023
4	The Probabilistic Method	Noga Alon and Joel H. Spencer	Wiley-Blackwell	4/e 2016
5	Approximation Algorithms	Vijay V. Vazirani	Springer Nature (SIE)	2/e, 2013
6	Computational Complexity: A Modern Approach	Sanjeev Arora and Boaz Barak	Cambridge University Press	1/e, 2019

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

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

SEMESTER S6

CLOUD COMPUTING

(Common to CS/CA/CM/AM)

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

Course Objectives:

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

SYLLABUS

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

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

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Ways of assessing at

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

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

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cloud Computing : Concepts, Technology, Security, and Architecture	Thomas Erl	Pearson	2/e, 2023
2	Cloud Computing	Sandeep Bhowmik	Cambridge University Press	1/e, 2017

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

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

SEMESTER S6

MOBILE APPLICATION DEVELOPMENT

(Common to CS/CA/CB/CN)

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

Course Objectives:

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

SYLLABUS

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

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

	<p>security measures in the Flutter application, Conduct thorough testing and debugging of the developed app.</p> <p><i>Milestone 4:</i> Complete the project, integrating all features and preparing it for deployment.</p>	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Analyze

Key Actions: Differentiate, Organize, Attribute

Metrics and Examples:

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

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

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

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

3. Bug Diagnosis:

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

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

Evaluate

Key Actions: Check, Critique, Judge

Metrics and Examples:

1. Code Quality Assessment:

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

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

2. UI/UX Design Evaluation:

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

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

3. Project Presentation and Defense:

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

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

Integration into the Syllabus - Example Use Cases

Basic Mobile Application Development

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

User Interface Design and User Experience

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

Advanced Flutter Development

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

Industry Practices and App Deployment

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

Example Evaluation Rubrics

Analyze:

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

Evaluate:

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain mobile application development using Flutter and different mobile platforms.	K2
CO2	Apply principles of effective mobile UI/UX design, Create responsive user interfaces using Flutter features.	K3
CO3	Experiment effectively with state in Flutter application, networking and data persistence.	K4
CO4	Apply security best practices in mobile app development, test, and debug Flutter applications effectively.	K5
CO5	Set up CI/CD pipelines for Flutter projects and deploy mobile apps to Google Play Store and Apple App Store.	K5

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flutter Cookbook	Simone Alessandria	Packt	2/e, 2023
2	Flutter for Beginners	Alessandro Biessek	Packt	1/e, 2019

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

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

SEMESTER S6

FUNDAMENTALS OF CYBER SECURITY

Course Code	PBCST604	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

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

Suggestion on Project Topics

Network Traffic Monitoring and Analysis using Wireshark:

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

OWASP ZAP (Zed Attack Proxy) Security Testing Framework:

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

Web Application Vulnerability Identification Using Burp Suite:

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

Penetration Testing Framework Using Metasploit:

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

Part A	Part B	Total
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Use assessment tools for vulnerability testing	K3
CO2	Use various security tools to study web based attacks	K3
CO3	Identify the network based attacks using network monitoring tools	K3
CO4	Illustrate the system security measures used for windows and Linux operating systems	K2

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

CO-PO Mapping Table:

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Build Your Own Security Lab	Michael Gregg	Wiley	1/e, 2008
2	Network security and Cryptography	B. Menezes	Cengage	1/e, 2010
3	Shellcoder's Handbook: Discovering and Exploiting Security Holes	Chris Anley, John Heasman, Felix Lindner, Gerardo Richarte	Wiley	2/e, 2007
4	Network Security Bible	Eric Cole, Ronald Krutz, James W Conley	Wiley	1/e, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography and Network Security	Behrouz A Forouzan	Tata McGraw-Hill.	3/e,2015
2	The Complete Reference: Information Security	Mark Rhodes-Ousley	McGraw-Hill	2/e,2012

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

PBL Course Elements

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

Assessment and Evaluation for Project Activity

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

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

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

Creativity in solutions and approaches

SEMESTER S6

DATA STRUCTURES

Course Code	OECST611	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course Objectives:

1. To provide the learner a comprehensive understanding of data structures and algorithms.
2. To prepare them for advanced studies or professional work in computer science and related fields.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Concepts of Data Structures Definitions; Data Abstraction; Performance Analysis - Time & Space Complexity, Asymptotic Notations; Polynomial representation using Arrays, Sparse matrix (<i>Tuple representation</i>); 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
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S6

DATA COMMUNICATION

(Common to CS/CM/CD/CA)

Course Code	OECST612	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Keying (FSK), Phase Shift Keying (PSK). Analog data to analog signal - Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).	
3	Multiplexing - Frequency Division Multiplexing (FDM), Wavelength Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread spectrum techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).	8
4	Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming distance, Hamming code. Basic principles of switching - Circuit switching, Packet switching, Message switching.	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify the characteristics of signals for analog and digital transmissions so as to define the associated real world challenges.	K3
CO2	Select transmission media based on characteristics and propagation modes.	K3
CO3	Choose appropriate signal encoding techniques for a given scenario	K3
CO4	Illustrate multiplexing and spread spectrum technologies	K2
CO5	Use error detection, correction and switching techniques in data communication	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Communications and Networking	Forouzan B. A	McGraw Hill	6/e, 2019
2	Data and Computer Communication	William Stallings	Pearson	10/e, 2016

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

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

SEMESTER S6

FOUNDATIONS OF CRYPTOGRAPHY

Course Code	OECST613	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Integer Arithmetic – Divisibility, Greatest Common Divisor Euclid’s and Extended Euclid’s Algorithm for GCD; Modular Arithmetic – Operations, Properties, Polynomial Arithmetic; Algebraic Structures – Group Ring Field.	9
2	Prime numbers and Prime Factorisation - Primitive Roots, Existence of Primitive Roots for Primes, Fermat’s Theorem, Primality Testing, Euler’s Theorem, Euler’s Totient Function, Discrete Logarithms, Modular Arithmetic, Chinese Remainder Theorem.	9
3	Principles of security - Types of Security attacks, Security services, Security Mechanisms; Cryptography - Introduction, cryptographic notations, substitution techniques, Transposition Techniques, limitations of classical cryptography.	9
4	Symmetric key Ciphers - Block Cipher principles & Algorithms- DES, AES, Differential and Linear Cryptanalysis; Asymmetric Key Ciphers- RSA, ECC; Hash Functions - MD5, SHA-1.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the integer arithmetic operations including divisibility and GCD algorithms, modular arithmetic operations and properties, polynomial arithmetic, and algebraic structures such as groups, rings, and fields.	K2
CO2	Describe the number theory concepts essential for cryptographic applications and mathematical problem-solving.	K2
CO3	Explain the security principles, types of attacks, and protective measures, alongside a thorough understanding of cryptographic techniques and their applications in securing data.	K2
CO4	Discuss symmetric and asymmetric key cryptography, including block cipher principles, algorithms, public key cryptosystems, and hash functions	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography & Network Security	Behrouz A. Forouzan	McGraw Hill	3/e, 2007
2	Security in Computing	Charles P. Pfleeger, Shari L. Pfleeger, Jonathan Margulies	Prentice Hall	5/e, 2015
3	Introduction to Cryptography: Principles and Applications	H. Delfs, H. Knebl	Springer	1/e, 2002
4	A Classical Introduction to Cryptography: Applications for Communications Security	Serge Vaudenay	Springer	1/e, 2009

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/111/101/111101137/
2	https://nptel/courses/video/106105031/L17.html
3	https://onlinecourses.nptel.ac.in/noc22_cs90/preview

SEMESTER S6

MACHINE LEARNING FOR ENGINEERS

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

Course Code	OECST614	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide the basic concepts and algorithms in machine learning.
2. To discuss the standard and most popular supervised and unsupervised learning algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to ML Machine Learning vs. Traditional Programming, Machine learning paradigms - supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation (MLE) and maximum 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

	<p>regularization, Idea of Training, Testing, Validation</p> <p>Evaluation measures – Classification - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC).</p> <p>Regression - Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R Squared/Coefficient of Determination.</p>	
3	<p>Neural Networks (NN) - Perceptron, Neural Network - Multilayer feed-forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm.</p> <p>Decision Trees – Information Gain, Gain Ratio, ID3 algorithm</p>	8
4	<p>Unsupervised Learning</p> <p>Clustering - Similarity measures, Hierarchical Clustering - Agglomerative Clustering, partitional clustering, K-means clustering</p> <p>Dimensionality reduction - Principal Component Analysis, Multidimensional scaling</p> <p>Ensemble methods - bagging, boosting</p> <p>Resampling methods - Bootstrapping, Cross Validation. Practical aspects - Bias-Variance trade-off</p>	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
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 3 marks <p>(8x3 =24marks)</p>	<ul style="list-style-type: none">• Each question carries 9 marks.• Two questions will be given from each module, out of which 1 question should be answered.• Each question can have a maximum of 3 sub divisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

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

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	2/e, 2010
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki, Wagner Meira	Cambridge University Press	1/e, 2016

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

Video Links (NPTEL, SWAYAM...)

Module No.	Link ID
1	https://youtu.be/fC7V8QsPBec?si=8kqBn-_7x1RG5V1J
2	https://youtu.be/g__LURKulj4?si=Xj10NPfMfpQSOhVx
3	https://youtu.be/yG1nETGyW2E?si=ySlxpeWuFAUQBf7-
4	https://youtu.be/zop2zuwF_bc?si=W7TpSHLdi4rykva4

SEMESTER S6

OBJECT ORIENTED PROGRAMMING

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

Course Code	OECST615	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Java - Java programming Environment and Runtime Environment (Command Line & IDE); Java compiler; Java Virtual Machine; Primitive Data types and Wrapper Types; Casting and Autoboxing; Arrays; Strings; Vector class; Operators - Arithmetic, Bitwise, Relational, Boolean Logical, Assignment, Conditional (Ternary); Operator Precedence; Control Statements - Selection Statements, Iteration Statements and Jump Statements; Functions; Command Line Arguments; Variable Length Arguments; Classes; Abstract Classes; Interfaces; OOP Concepts - Data abstraction, encapsulation, inheritance, polymorphism, Procedural and object oriented programming paradigm; Microservices; Object Oriented	10

	Programming in Java - Declaring Objects; Object Reference; Introduction to Methods; Constructors; Access Modifiers; <i>this</i> keyword.	
2	Polymorphism - Method Overloading, Using Objects as Parameters, Returning Objects, Recursion; Static Members, Final Variables, Inner Classes. Inheritance - Super Class, Sub Class, Types of Inheritance, The <i>super</i> keyword, protected Members, Calling Order of Constructors; Method Overriding, Dynamic Method Dispatch, Using <i>final</i> 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, <i>try</i> Block and <i>catch</i> Clause, Multiple catch Clauses, Nested <i>try</i> Statements, <i>throw</i> , <i>throws</i> and <i>finally</i> , Java Built-in Exceptions, Custom Exceptions.	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
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none">• Each question carries 9 marks.• Two questions will be given from each module, out of which 1 question should be answered.• Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

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

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

CO-PO Mapping Table:

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

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

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

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

SEMESTER S6

SYSTEMS LAB

Course Code	PCCSL607	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

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

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Implement lexical and syntax analyzer using the tools LEX and YACC	K3
CO2	Develop Top-Down and Bottom-Up parsers.	K3
CO3	Implement intermediate code for expressions.	K3
CO4	Experiment with a cluster of virtual machines in a virtualized environment.	K3
CO5	Demonstrate the data sharing and communication between virtual machines.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering a Compiler	Keith D. Cooper Linda Torczon	Katey Birtcher	3/e, 2023
2	Lex and Yacc	John R Levine, Tony Mason& Doug Brown	O'Reilly Media, Inc	2/e, 2013
3	Distributed and Cloud Computing: From Parallel Processing to the Internet of Things	Kai Hwang, Jack Dongarra, Geoffrey C. Fox	Morgan Kaufman	1/e, 2018
4	Virtual Machines	Manan Shah, Charusmita Shah	Lambert Academic Publishing	1/e, 2018

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

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

Continuous Assessment (25 Marks)

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

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

2. Conduct of Experiments (7 Marks)

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

3. Lab Reports and Record Keeping (6 Marks)

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

4. Viva Voce (5 Marks)

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

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

Evaluation Pattern for End Semester Examination (50 Marks)

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

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

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

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

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

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

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

4. Viva Voce (10 Marks)

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

5. Record (5 Marks)

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

SEMESTER 7

**COMPUTER SCIENCE AND
ENGINEERING**

SEMESTER S7

FORMAL METHODS IN SOFTWARE ENGINEERING

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

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

Course Objectives:

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

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

WEB PROGRAMMING

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

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7
BIOINFORMATICS

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

Course Objectives:

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

SYLLABUS

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

4	<p>R FOR BIOINFORMATICS</p> <p>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.)</p> <p>Indicative Laboratory/Microproject Tasks</p> <p>Biological Databases, Sequence alignment: BLAST family of programs, FASTA, ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, Related Programs in R.</p>	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

INFORMATION SECURITY

(Common to CS/CM/CA/AM)

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

Course Objectives:

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

SYLLABUS

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

	Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP, S/MIME.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

EMBEDDED SYSTEMS

(Common to CS/CM/AM)

Course Code	PECST746	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Development - Embedded Firmware Design, Embedded Firmware Development Languages, Programming in Embedded C.	
4	Integration and Testing of Embedded Hardware and Firmware :- Integration of Hardware and Firmware, Boards Bring up, The Embedded System Development Environment - The Integrated Development Environment (IDE), Types of files generated on CrossCompilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the core components, characteristics, and applications of embedded systems, and their difference from general computing systems	K2
CO2	Apply knowledge of the 8051 microcontroller, its architecture, instruction set, and addressing modes, to design and develop embedded systems.	K3
CO3	Develop embedded firmware using appropriate languages, and understand the key concepts in hardware-software co-design.	K3
CO4	Use the integration of embedded hardware and firmware, and utilize tools for system testing and validation	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Embedded Systems	Shibu K V	McGraw Hill	2/e, 2017

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

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

SEMESTER S7

BLOCKCHAIN AND CRYPTOCURRENCIES

Course Code	PECST747	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PBCST604	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	<p>pools, Proof of Work-Mining Cryptocurrencies, Hard and Soft Forks, Tracking Bitcoins-Unspent Transaction Outputs.</p> <p>Ethereum: Transition from Bitcoin to Ethereum, Concept of Ethereum World Computer, Ethereum Virtual Machine, Ethereum Network, Transition from PoW to PoS- Working of PoS, Smart Contracts in Ethereum, Decentralised Applications in Ethereum, Tools used in Ethereum.</p>	
4	<p>Blockchain Ethereum Platform using Solidity and Use Cases in Blockchain :-</p> <p>Solidity Language - Remix IDE, Structure of a Smart Contract Program, Modifiers, Events, Functions, Inheritance, External Libraries, Error Handling.</p> <p>Permissioned Blockchains, Introduction to Hyperledger Foundation, Hyperledger Distributed Ledger frameworks, Hyperledger Fabric.</p> <p>Use Cases in Blockchain - Finance, Education, Government, Healthcare and Supply Chain Management.</p>	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
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamental concepts of Blockchain technology.	K2
CO2	Illustrate the cryptographic building blocks of Blockchain technology and understand the consensus mechanisms.	K2
CO3	Explain the concepts of cryptocurrency bitcoin, mining processes, and wallet management.	K2
CO4	Use the concepts of Ethereum platform and understand the use cases of blockchain technology	K3
CO5	Develop skills in designing and deploying simple applications using Solidity language.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Blockchain Technology: Algorithms and Applications	Asharaf S, Sivadas Neelima, Adarsh S, Franklin John	Wiley	1/e, 2023
2	BlockchainTechnology	Chandramauoli Subrahmaniyan, Asha A George	Universities Press.	1/e ,2020

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtube.com/playlist?list=PLrKK422S1aMma8IDA2JJjEUUpC2ycuApuC&si=1OXTYDEZ4A5M8M4Q
2	https://youtube.com/playlist?list=PLHRLZtgrF2jl8yqucJsMFqh5XpRLTgCI4
3	https://youtube.com/playlist?list=PL6gx4CwI9DGBrtymuJUiv9Lq5CAYpN8Gl
4	https://youtube.com/playlist?list=PLWUCKsxdKl0oksYr6IG_wRsaSUySQC0ck

SEMESTER S7

REAL TIME SYSTEMS

(Common to CS/CM/CA/AM)

Course Code	PECST748	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST402, PCCST403	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the various Real Time applications, services, design considerations and architectures	K2
CO2	Develop efficient algorithms for real-time task scheduling in uniprocessor and multiprocessor environments	K3
CO3	Identify the limitations of a non real-time operating system in running a real-time application	K2
CO4	Identify and address the important issues in real-time communications	K2
CO5	Understand the concepts of use real-time databases	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Real-Time Systems: Theory and Practice	Rajib Mall	Pearson Education,	1/e, 2007
2	Real-Time Systems	Jane W. S. Liu	Pearson Education,	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Real-Time Systems Design and Analysis, Wiley	Philip A. Laplante, Seppo J. Ovaska	Wiley	1/e, 2012

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

SEMESTER S7

APPROXIMATION ALGORITHMS

Course Code	PECST749	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Fully polynomial-time approximation schemes (FPTAS), Examples: knapsack problem, Euclidean TSP. (Chapter 9)	
4	Inapproximability Results - Introduction to inapproximability, Reductions and hardness of approximation, PCP theorem and its implications. (Chapter 10) Network Design Problems - Steiner tree problem, Traveling Salesman Problem (TSP), Multicommodity flow problem. (Chapter 7)	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate a foundational understanding of approximation algorithms, including performance guarantees, approximation ratios, and common examples of approximation problems.	K3
CO2	Illustrate the principles of greedy algorithms and apply them to solve classic problems such as the set cover and vertex cover problems, understanding their efficiency and limitations.	K3
CO3	Show proficiency in local search algorithms and linear programming relaxation methods, including the primal-dual method, and apply these techniques to solve combinatorial optimization problems.	K3
CO4	Understand and implement rounding techniques, both randomized and deterministic, and learn the basics of semi-definite programming (SDP), including algorithms like Goemans-Williamson for the MAX-CUT problem.	K3
CO5	Demonstrate polynomial-time approximation schemes (PTAS) and fully polynomial-time approximation schemes (FPTAS), and explore inapproximability results, including reductions, hardness of approximation, and the PCP theorem.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Approximation Algorithms	Vijay V. Vazirani	Springer Nature (SIE)	2/e, 2013

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

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

SEMESTER S7

COMPUTER VISION

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

Course Objectives:

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

SYLLABUS

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

3	<p>Machine Learning for Computer Vision :-</p> <p>Machine Learning - Introduction, Dataset for Machine Perception- Labelled and Unlabelled Data, Basics of Classification and Clustering, Multi-Class Perspective.</p> <p>Machine Learning for Computer Vision -Machine Learning -Deep Learning Use Cases.</p> <p>Machine Learning Models for Vision - Image Vision-Pretrained Model, Transfer Learning, Fine-Tuning, Convolutional Networks, Convolutional Filters, Stacking Convolutional Layers, Pooling Layers - AlexNet, VGG19, , Modular architecture - ResNet, Neural Architecture Search Design - NASNet</p>	9
4	<p>Segmentation and Object detection :-</p> <p>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</p> <p>Object detection - YOLO, Segmentation-Mask R-CNN and Instance Segmentation, U-Net and Semantic Segmentation, Model Quality Metrics</p> <p><i>A case study to compare performance of various models on a suitable dataset.</i></p>	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

TOPICS IN THEORETICAL COMPUTER SCIENCE

Course Code	PECST795	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST303 PCCST502	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Spectral Graph Theory - Introduction to Spectral Graph Theory, Graph Laplacians: Definition and Properties, Eigenvalues and Eigenvectors of Laplacian matrices, Cheeger's Inequality, Graph Partitioning.</p> <p>Assignments:</p> <ol style="list-style-type: none">1. Implement Cheeger's inequality for a set of sample graphs. Compare the theoretical results with empirical data to analyze the effectiveness of different partitioning algorithms. Use a set of sample graphs such as Erdős-Rényi Random Graphs, Barabási-Albert Model: Known for scale-free properties, and Regular Graphs. Compare theoretical results with empirical data using different partitioning algorithms such as Spectral Clustering - Uses the eigenvectors of the Laplacian matrix, K-means Clustering - Applied to spectral embeddings of the graph, Normalized Cut - Minimizes the normalized cut criterion. Measure how close the empirical conductance is to the theoretical lower bound provided by Cheeger's inequality. Analyze which algorithms produce cuts with conductance values closer to the	9

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

	<p>added noise and measure the performance of the expander code in correcting errors. Evaluate the BER, code rate, and error correction capability by comparing the number of errors corrected versus the total number of errors introduced.</p>	
4	<p>LP- and SDP-based Approximation Algorithms for NP-Hard Problems - Linear Programming (LP) Relaxations and their Use in Approximation: Vertex Cover and Set Cover, Semidefinite Programming (SDP) and its Applications: Max-Cut Problem.</p> <p>Assignments:</p> <ol style="list-style-type: none"> 1. Implement and evaluate LP relaxations for vertex cover and set cover problems (use Erdős-Rényi Graphs). Compare the results with exact solutions and analyze the quality of the approximations. 2. Develop and test approximation algorithms for Max-cut problem using SDP relaxations. Assess the performance and efficiency of your algorithms on various datasets. To assess the performance and efficiency of the SDP-based Max-Cut approximation, test the algorithm on various types of graphs, including: Erdős-Rényi Graphs, Barabási-Albert Graphs, and Real-world Graphs. Compare the cut values obtained from the SDP relaxation and rounding with known or exact solutions if available. For large graphs, use heuristics or bounds for comparison. Measure the time taken to solve the SDP relaxation and perform the rounding. This includes the time for solving the SDP problem and the time for eigen-decomposition. 	9

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Assignment evaluation pattern:

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

End Semester Examination Marks (ESE):

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

Part A	Part B	Total
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none">• 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. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and explain fundamental concepts of Spectral Graph Theory, including Laplacian matrices and their applications.	K2
CO2	Apply spectral clustering techniques to real-world data and evaluate clustering performance using appropriate metrics.	K5
CO3	Construct and analyze expander graphs, and assess their applications in network design and error-correcting codes.	K4
CO4	Develop and implement LP- and SDP-based approximation algorithms for solving NP-Hard problems, and compare their performance.	K5
CO5	Demonstrate the ability to solve complex theoretical problems using advanced algorithms and techniques covered in the course.	K4

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Spectral Graph Theory (CBMS Regional Conference Series)	Fan R. K. Chung	American Mathematical Society	1/e, 1997
2	Algebraic Graph Theory	Norman Biggs	Cambridge India	2/e, 2016
3	Approximation Algorithms	Vijay V. Vazirani	Springer Nature	2/e, 2013
4	Convex Optimization	Stephen Boyd, Lieven Vandenberghe	Cambridge University Press	1/e, 2004

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

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

SEMESTER S7

ADVANCED COMPUTER NETWORKS

Course Code	PECST751	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Engineering, Network Function Virtualization (NFV) - NFV Concepts, Virtualizing Network Functions and Services; NFV Infrastructure (NFVI) and Management (MANO); Service Function Chaining (SFC); NFV in Telecom Networks.	
4	Data Center Interconnect (DCI) - Technologies for Data Center Interconnection(VPLS, OTV, and VXLAN), DCI Design and Deployment Considerations; Intent-Based Networking (IBN) - Introduction to Intent-Based Networking; Content Distribution on the Internet - Architectures for Information-Centric Networking; Content Naming, Routing and Caching, Security in Named Data Networking; Network Automation and Orchestration; Automation Tools - Ansible, Terraform; Orchestration Frameworks - Kubernetes.	10

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain and critically analyze advanced networking protocols and technologies, including MPLS, VPNs, and SDN, and their applications in modern networks	K3
CO2	Demonstrate an understanding of data center network architectures, including the design considerations and protocols that ensure scalability, redundancy, and efficiency.	K3
CO3	Use Software-Defined Networking (SDN) and Network Function Virtualization (NFV) to automate and optimize network operations.	K3
CO4	Explain emerging trends such as Intent-Based Networking (IBN) and network automation, applying this knowledge to modernize and innovate networking solutions.	K2

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networking: A Top-Down Approach	James F. Kurose, Keith W. Ross	Pearson	8/e, 2022
2	Data Center Virtualization Fundamentals: Understanding Techniques and Designs for Highly Efficient Data Centers with Cisco Nexus, UCS, MDS, and Beyond	Gustavo A. A. Santana	CISCO Press	1/e, 2013
3	MPLS and VPN Architectures	Jim Guichard, Ivan Pepelnjak, Jeff Apcar	CISCO Press	1/e, 2000
4	High-speed networks and Internet: Performance and Quality of Service	William Stallings	Pearson	2/e, 2002
5	Software Defined Networks: A Comprehensive Approach	Paul Goransson, Chuck Black, Timothy Culver	Morgan Kaufman	2/e, 2016
6	Information-Centric Networking (ICN): Content-Centric Networking (CCNx) and Named Data Networking (NDN) Terminology	B. Wissingh, C. Wood, A. Afanasyev, L. Zhang, D. Oran, C. Tschudin	RFC 8793	2020

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

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

SEMESTER S7

RESPONSIBLE ARTIFICIAL INTELLIGENCE

Course Code	PECST752	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify and describe key aspects of responsible AI such as fairness, accountability, bias, and privacy.	K2
CO2	Describe AI models for fairness and ethical integrity.	K2
CO3	Understand interpretability techniques such as simplification, visualization, intrinsic interpretable methods, and post hoc interpretability.	K2
CO4	Comprehend the ethical principles, privacy concerns, and security challenges involved in AI development and deployment.	K3
CO5	Understand responsible AI solutions for practical applications, balancing ethical considerations with model performance.	K3

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

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

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

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

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way	Virginia Dignum	Springer Nature	1/e, 2019
2	Interpretable Machine Learning	Christoph Molnar	Lulu	1/e, 2020

Reference Books

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/3-xhMXeYIcg?si=x8PXmk0TabaWxQV
2	https://youtu.be/sURHNhBMnFo?si=Uj0iellJs3oLOmDL [SHAP and LIME] https://c3.ai/glossary/data-science/lime-local-interpretable-model-agnostic-explanations/ https://shap.readthedocs.io/en/latest/ https://www.kaggle.com/code/bextuychiev/model-explainability-with-shap-only-guide-u-need
3	https://www.youtube.com/live/DA7ldX6OIG4?si=Dk4nW1R1zi_UMG_4
4	https://youtu.be/XIYhKwRLerc?si=IeU7C0BLhwn9Pvmi Case Studies https://www.kaggle.com/code/teesoong/explainable-ai-on-a-nlp-lstm-model-with-lime https://www.kaggle.com/code/victorcampelo/using-lime-to-explaining-the-predictions-from-ml

SEMESTER S7

FUZZY SYSTEMS

(Common to CS/CA)

Course Code	PECST753	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

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

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

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

DIGITAL FORENSICS

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

Course Code	PECST754	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>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.</p> <p>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.</p> <p>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</p> <p>Tools suggested : Hex Viewer , FTK Imager , OS Forensics</p>	10

2	<p>Windows Forensics - OS Artefacts, Registry Analysis, Analysis of USB Connections, Event Logs, Applications, Slack Space, Overwritten Files, Data Recovery Techniques, Volatile and Non-Volatile Data, Hibernation file analysis, Pagefile analysis, prefetch files, thumbnails, Timestamps, File Signatures, File System Analysis Tools, Techniques for Recovering Deleted Files, File Carving; Memory Forensics - RAM dump and analysis; Linux and MAC Forensics; Anti Forensics Methods - Steganography, Encryption, Alternate Data Streams.</p> <p>Tools suggested : Hex Viewer, FTK Imager, Autopsy, RegRipper, Volatility, Dumpit</p>	9
3	<p>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.</p> <p>Tools suggested : MobileCheck, BlueStacks(Android Emulator), SQLite Database viewer</p>	9
4	<p>Network Forensics - Introduction to Network Forensics, Overview of Network Architectures and Protocols, Capturing and Analyzing Network Traffic using Wireshark/Tcpdump, Log Analysis, Email and Web Forensics, Email Header Analysis; Endpoint Security systems - Intrusion Detection Systems, Firewall, Router Forensics, NAS, Proxy, VPN; Public Key Infrastructure Systems; Digital Signature - Concepts of Public Key and Private Key, Certification Authorities and Their Role, Creation and Authentication of Digital Signature.</p> <p>Tools Suggested : Wireshark , Apache Log Viewer</p>	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
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks <p align="center">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> • Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. <p align="center">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Perform forensics analysis of hard disk, Network, and mobile phones.	K3
CO2	Experiment with the network traffic dump.	K3
CO3	Examine the analyse logs of the systems and identify the anomalies.	K3
CO4	Plan an onsite triage in case of an incident.	K3

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

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

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

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

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Digital Forensics and Incident Response	Gerard Johansen	Packt	2/e, 2020
2	Guide to Computer Forensics and Investigations	Bill Nelson, Amelia Phillips, Christopher Steuart	Cengage	6/e, 2020
3	Practical Mobile Forensics	Rohit Tamma, Oleg Skulkin , Heather Mahalik, Satish Bommisetty	Packt	4/e, 2020
4	Mobile Forensics - Advanced Investigative Strategies	Oleg Afonin, Vladimir Katalov	Packt	1/e, 2016
5	Network Forensics : Tracking Hackers Through Cyberspace	Sherri Davidoff, Jonathan Ham	Pearson	1/e, 2013
6	File system forensic analysis	Brian Carrier	Addison-Wesley	1/e, 2005
7	Windows Forensics: The Field Guide for Corporate Computer Investigations	Chad Steel	Wiley	1/e, 2006
8	Android Forensics: Investigation, Analysis and Mobile Security for Google Android	Andrew Hoog	Syngress	1/e, 2011

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

SEMESTER S7

GAME THEORY AND MECHANISM DESIGN

Course Code	PECST753	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	Introduction to VCG mechanism, VCG in Combinatorial allocations, applications to Internet advertising, slot allocation and payments in position auctions, pros and cons of VCG mechanism; Affine maximizers, single object allocation, Myerson's lemma, optimal mechanism design; Single and multi-agent optimal mechanism design, examples of optimal mechanisms	8
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Differentiate between different types of games Identify various equilibria within games	K3
CO2	Identify strategic interactions.	K3
CO3	Describe the basic concepts of non-cooperative and cooperative games.	K2
CO4	Apply the concepts in different game scenarios.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	An Introduction to Game Theory	Martin Osborne	Cambridge University Press	1/e, 2004
2	Game Theory and Mechanism Design	Y. Narahari	World Scientific and IISc Press	1/e, 2013

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

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/101/106101237/
2	https://www.masfoundations.org/
3	
4	

SEMESTER S7

HIGH PERFORMANCE COMPUTING

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

Course Code	PECST757	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Modern processors: Stored-program computer architecture- <i>General-purpose cache-based microprocessor architecture</i> - Performance metrics and benchmarks -Moore's Law - Pipelining - Super scalarity - SIMD - <i>Memory hierarchies</i> - Cache , Cache mapping, Prefetch, Multicore processors - Multithreaded processors - <i>Vector processors</i> - Design principles - Maximum performance estimates - Programming for vector architectures.	9
2	Parallel computers - Taxonomy of parallel computing paradigms - <i>Shared-memory computers</i> - Cache coherence - UMA, ccNUMA, Distributed-memory computers - Hierarchical (hybrid) systems - <i>Networks</i> - Basic performance characteristics of networks, Buses, Switched and fat-tree networks - Mesh networks - Hybrids.	9
3	Shared-memory parallel programming with OpenMP:- <i>Short introduction to OpenMP</i> - 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 - <i>A short introduction to MPI</i> , A simple example, Messages and point-to-point communication, Collective communication, Nonblocking point-to-point communication, Virtual topologies. <i>Example- MPI parallelization of a Jacobi solver</i> - MPI implementation - Performance properties.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe parallel computing architectures supported by modern processors.	K2
CO2	Classify parallel computing paradigms and network topologies.	K2
CO3	Implement shared-memory parallel programming with OpenMP.	K3
CO4	Design and implement parallel algorithms using distributed-memory parallel programming with MPI	K3

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

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

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

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

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

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

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

SEMESTER S7

PROGRAMMING LANGUAGES

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

Course Code	PECST758	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Type Checking, Type Conversion, Polymorphic Type Checking, Explicit Polymorphism, Case Study: Type Checking in TinyAda.	
3	Expressions and Statements - Expressions, Conditional Statements and Guards, Loops and Variations on WHILE, The GOTO Controversy and Loop Exits, Exception Handling, Case Study: Computing the Values of Static Expressions in TinyAda. Procedures and Environments- Procedure Definition and Activation, Procedure Semantics, Parameter-Passing Mechanisms, Procedure Environments, Activations, and Allocation, Dynamic Memory Management, Exception Handling and Environments, Case Study: Processing Parameter Modes in TinyAda.	9
4	Abstract Data Types and Modules- The Algebraic Specification of Abstract Data Types, Abstract Data Type Mechanisms and Modules, Separate Compilation in C, C++ Namespaces, and Java Packages, Ada Packages, Modules in ML, Modules in Earlier Languages, Problems with Abstract Data Type Mechanisms, The Mathematics of Abstract Data Types.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the history of programming languages and introduce abstraction, the concept of different language paradigms, and an overview of language design criteria.	K1
CO2	Describe how the syntactic structure of a language can be precisely specified using context-free grammar rules in Backus-Naur form (BNF).	K2
CO3	Explain the abstractions of the operations that occur during the translation and execution of programs.	K2
CO4	Apply the data types in various languages	K3
CO5	Apply procedure activation and parameter passing; and exceptions and exception handling.	K4

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Programming languages: principles and practices.	Kenneth C Louden	Cengage Learning	3/e, 2011
2	Concepts of programming languages.	Sebesta R W.	Pearson	12/e, 2023
3	Programming languages: concepts and constructs.	Sethi R	Pearson	2/e, 2006

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

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

SEMESTER S7

PARALLEL ALGORITHMS

(Common to CS/CM/CD/AM)

Course Code	PECST759	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST303 PCCST502	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Parallel Search Algorithms - Parallel search algorithms: parallel binary search, parallel search trees, Applications and analysis.	
4	Parallel Programming with OpenMP - Introduction to OpenMP, Parallel programming constructs in OpenMP, Performance tuning and optimization Parallel Programming with MPI - Introduction to MPI, Message passing model and MPI basics, Advanced MPI features and applications Parallel Numerical Algorithms - Solving linear systems: parallel Gaussian elimination, parallel LU decomposition, Parallel algorithms for eigenvalue problems, Applications and analysis.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and articulate the fundamental principles and architectures of parallel computing.	K2
CO2	Implement and evaluate parallel algorithms for basic operations such as sorting and searching.	K3
CO3	Develop and analyze parallel algorithms for complex problems, including graph and numerical algorithms.	K3
CO4	Apply parallel programming techniques to real-world problems and assess the efficiency and performance of parallel solutions.	K3

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Parallel Computing	Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar	Addison-Wesley	2/e, 2003
2	Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers	Barry Wilkinson and Michael Allen	Pearson India	2/e, 2006
3	An Introduction to Parallel Algorithms	Joseph Jaja	Addison-Wesley Professional	1/e, 1992
4	Parallel Algorithms	Henri Casanova, Arnaud Legrand, Yves Robert	Chapman and Hall/CRC	1/e, 2020
5	Parallel Scientific Computing in C++ and MPI	George Em Karniadakis and Robert M. Kirby II	Cambridge University Press	1/e, 2003

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

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

SEMESTER S7

INTERNET OF THINGS

(Common to CS/CM/CA)

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

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Why IoT? Trends in IT Space, Internet of Things Era, Device-to-Device/Machine-to-Machine Integration, Device-to-Cloud (D2C) Integration, IoT Platform as a Service (PaaS), Cloud-to-Cloud (C2C) Integration, IoT Key Application Domains, Emerging IoT Flavors; IoT Ecosystem - Architecture for IoT, Mobile Technologies, Mobile Application Development Platforms, LPWAN.	8
2	Infrastructure and Service Discovery Protocols - Layered Architecture for IoT, Protocol Architecture of IoT, Infrastructure Protocols, Device or Service Discovery for IoT, Protocols & products for IoT Service Discovery; Integration Technologies and Tools - Smart Enterprises and Environments, Sensor and Actuator Networks, The IoT Device Integration Concepts, Standards, and Implementations, The Device Integration Protocols and Middleware, The Protocol Landscape.	10
3	Platforms for IoT Applications and Analytics - The IoT Building Blocks, Usecases, M2M Application Platform, IoT Architectural Building Blocks, Data Analytics Platforms, IoT Data Virtualization Platforms and capabilities, The IoT Edge Data Analytics; Clouds for IoT Applications and Analytics -	8

	Reflecting the Cloud Journey, The Key Motivations for Cloud-Enabled Environments, IoT and Cloud-Inspired Smarter Environments, Hybrid, Federated, and Special-purpose cloud, The Emergence of Edge/Fog Clouds, SDN and SDS.	
4	Introduction to Raspberry Pi, Creating your first project, Creating a Sensor to Measure Ambient Light, Creating an Actuator for Controlling Illumination, Publishing Information Using MQTT & HTTP, Creating Web Pages for Your Devices.	10

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

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

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

End Semester Examination Marks (ESE):

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

Part A	Part B	Total
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> • 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. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

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

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

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

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

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

Text Books

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

Reference Books

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

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

SEMESTER S7

ALGORITHMS FOR DATA SCIENCE

(Common to CS/AM/CM)

Course Code	PECST785	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Mins.
Prerequisites (if any)	PCCST303 PCCST502	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	dimensionality reduction techniques to simplify the dataset. Implement data transformation and normalization processes.	
2	<p>Algorithms for Data Summarization and Visualization :- Data Summarization Techniques - Central tendency measures: mean, median, mode; Dispersion measures - variance, standard deviation, Interquartile range (IQR), Quantiles, percentiles, and outlier detection; Visualization Algorithms - Basics of data visualization, histograms, bar charts, scatter plots; Advanced visualization techniques - heatmaps, correlation matrices, and pair plots; Visualization tools and libraries - Matplotlib, Seaborn, Plotly; Algorithmic Approaches to Data Grouping - Clustering: k-means, hierarchical clustering, DBSCAN; Association rule learning - Apriori, FP-Growth.</p> <p>Project 2: Exploratory Data Analysis and Visualization Perform exploratory data analysis (EDA) and create visualizations to uncover patterns and insights in the dataset like Kaggle - Titanic Dataset</p> <p>Tasks: Summarize the dataset using statistical measures. Create various visualizations to explore relationships and patterns in the data. Implement clustering algorithms to identify natural groupings within the data.</p>	9
3	<p>Algorithms for Data Modeling :- Regression Algorithms - Linear regression and polynomial regression; Regularization techniques - Ridge, Lasso, Elastic Net; Evaluation metrics - RMSE, MAE, R²; Classification Algorithms - Logistic regression, decision trees, and k-Nearest Neighbors (k-NN); Performance metrics - accuracy, precision, recall, F1-score, ROC-AUC; Algorithmic Optimization Techniques - Gradient descent and its variants: stochastic, mini-batch; Hyperparameter tuning - grid search, random search, Bayesian optimization.</p> <p>Project 3: Predictive Modeling and Evaluation - Build and evaluate predictive models using regression and classification algorithms using datasets like Kaggle - House Prices: Advanced Regression Techniques</p> <p>Tasks: Implement linear and polynomial regression models to predict house prices. Apply classification algorithms to classify houses into different categories. Evaluate the models using appropriate performance metrics and fine-tune them for better accuracy.</p>	9
4	<p>Algorithms for Big Data and Scalability :- Introduction to Big Data Algorithms - Overview of big data challenges and</p>	9

	<p>processing techniques; Distributed computing frameworks - Hadoop, Spark; MapReduce paradigm - concepts and applications; Scalable Data Processing Algorithms - Algorithms for large-scale data processing : sorting, searching, filtering; Data partitioning and shuffling techniques in distributed systems; Handling data with memory constraints - external memory algorithms.</p> <p>Project 4: Scalable Data Processing with Spark - Implement scalable algorithms using Apache Spark to process large datasets efficiently using datasets like Kaggle - Google Analytics Customer Revenue Prediction</p> <p>Tasks: Set up a Spark environment for large-scale data processing. Implement scalable algorithms for sorting, searching, and filtering the dataset. Analyze the performance of your algorithms on different dataset sizes and optimize for scalability.</p>	
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**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Assignment evaluation pattern:

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

End Semester Examination Marks (ESE):

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

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● 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. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Implement data preprocessing and cleaning techniques to prepare raw data for analysis, ensuring the quality and reliability of the datasets.	K3
CO2	Perform exploratory data analysis (EDA) and create insightful visualizations that help in understanding the underlying patterns and trends in the data.	K4
CO3	Develop predictive models using various regression and classification algorithms, and optimize them for better performance, applying appropriate evaluation metrics.	K5
CO4	Implement scalable algorithms using distributed computing frameworks like Apache Spark to process large datasets efficiently.	K6

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

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

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

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Algorithms for Data Science Hardcover	Brian Steele, John Chandler, Swarna Reddy	Springer International	1/e, 2016
2	Mining of Massive Datasets	Jure Leskovec, Anand Rajaraman, Jeff Ullman	Cambridge University Press	2/e, 2020

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

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

SEMESTER S7

CYBER SECURITY

Course Code	OECST721	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

4	Mobile App Security :- Security Implications of Mobile Apps, Mobile App Permission Management and Best Practices, Risks of Location-Based Social Networks, Data Security on Mobile Devices- Importance of Data Security on Mobile Devices to Protect Sensitive Information, Risks of Unencrypted Data Storage and Communication on Mobile Platforms, Benefits of Device Encryption, Secure Messaging Apps, and Encrypted Storage Solutions.	9
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**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the attacks, security mechanisms and services to user information	K2
CO2	Identify the cybercrimes and discuss the cyber laws against the crimes	K2
CO3	Discuss the malwares and the protection mechanisms against malwares	K3
CO4	Describe the issues and solutions related with mobile applications	K2

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

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

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

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

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Security: Principles and Practices	William Stallings	Pearson	5/e, 2011
2	Cyber Security- Understanding Cyber Crimes, Computer Forensics and Legal Perspectives	Nina Godbole, Sunit Belapure	Wiley	1/e, 2011
3	Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives	B.B.Gupta, D.P Agrawal, Haoxiang Wang.	CRC Press	1/e, 2018
4	Cyber Security Essentials	James Graham, Richard Howard, Ryan Otson	Auerbach	1/e, 2010

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

SEMESTER S7

CLOUD COMPUTING

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

Course Objectives:

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

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	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	2	2	2									2
CO2	2	2	2	2								2
CO3	2	2	2	2								2
CO4	2	2	2	2								2

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

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

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

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

SEMESTER S7

SOFTWARE ENGINEERING

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

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>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.</p> <p>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.</p> <p><i>Case study:</i> SRS for College Library Management Software</p>	9
2	<p>Software design - Software architecture and its importance, Software architecture patterns: Component and Connector, Layered, Repository, Client-Server, Publish-Subscribe, Functional independence – Coupling and Cohesion</p> <p><i>Case study:</i> Ariane launch failure</p> <p>Object Oriented Software Design - UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram,</p>	10

	<p>Sequence diagram</p> <p><i>Case Studies:</i> Voice mail system, ATM Example</p> <p>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</p>	
3	<p>Coding, Testing and Maintenance:</p> <p>Coding guidelines - Code review, Code walkthrough and Code inspection, Code debugging and its methods.</p> <p>Testing - Unit testing , Integration testing, System testing and its types, Black box testing and White box testing, Regression testing</p> <p>Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD), <i>Case study</i> – Netflix.</p> <p>Software maintenance and its types- Adaptive, Preventive, Corrective and Perfective maintenance. Boehm’s maintenance models (both legacy and non-legacy)</p>	10
4	<p>Software Project Management - Project size metrics – LOC, Function points and Object points. Cost estimation using Basic COCOMO.</p> <p>Risk management: Risk and its types, Risk monitoring and management model</p> <p>Software Project Management - Planning, Staffing, Organisational structures, Scheduling using Gantt chart. Software Configuration Management and its phases, Software Quality Management – ISO 9000, CMM, Six Sigma for software engineering.</p>	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
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks <p align="center">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> • Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. <p align="center">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

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

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

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

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

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

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

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

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

Video Links (NPTEL, SWAYAM...)

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

SEMESTER S7

COMPUTER NETWORKS

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

Course Objectives:

1. To Introduce the core concepts of computer networking.
2. To Explore routing protocols and their role in network communication

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Computer Networks:- Introduction, Network Components, Network Models, ISO/OSI, TCP/IP, Physical Topology, Overview of the Internet, Protocol layering; Physical Layer-Transmission media (copper, fiber, wireless), Datagram Networks, Virtual Circuit networks, Performance.	7
2	Data Link Layer:- Error Detection and Correction - Introduction, Hamming Code, CRC, Checksum; Framing-Methods, Flow Control- Noiseless Channels, Noisy Channels; Medium Access Control- Random Access, Controlled Access; Wired LANs - IEEE Standards, Ethernet, IEEE 802.11;	11
3	Network Layer:- Logical Addressing- IPv4 and IPv6 Addresses; Internet Protocol- IPV4 and IPv6; Unicast Routing Protocols- Distance Vector Routing, Link State Routing Multicast Routing Protocols.	9
4	Transport Layer:- Transport Layer Protocols- UDP, TCP; Congestion Control- Open Loop Vs Closed Loop Congestion Control, Congestion Control in TCP; Application Layer - Application Layer Paradigms, Client-server applications, World Wide Web and HTTP, FTP. Electronic Mail, DNS; Peer-to-peer paradigm - P2P Networks.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Comprehend the OSI and TCP/IP models, the functioning of different network layers, and the protocol stack used in computer networks.	K2
CO2	Evaluate various transmission media (copper, fiber, wireless), error detection/correction methods, and medium access control mechanisms in both wired and wireless LANs.	K2
CO3	Demonstrate a working knowledge of IPv4 and IPv6 addressing schemes, routing protocols (unicast and multicast), and apply them to network scenarios.	K3
CO4	Summarize UDP and TCP protocols, explain congestion control mechanisms, and understand client-server and peer-to-peer applications like HTTP, FTP, DNS, and P2P networks.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networks, A Systems Approach	L. L. Peterson and B. S. Davie	Morgan Kaufmann	5/e, 2011
2	TCP/IP Architecture, design, and implementation in Linux	Sameer Seth M. Ajaykumar Venkatesulu	Wiley	1/e, 2008
3	Computer Networks	Andrew Tanenbaum	Pearson	6/e, 2021
4	Computer Networking: A Top-Down Approach Featuring Internet	J. F. Kurose and K. W. Ross	Pearson Education	8/e, 2022

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://nptel.ac.in/courses/106/105/106105183/

SEMESTER S7

MOBILE APPLICATION DEVELOPMENT

(Common to CS/CA/CM/CD/CR/AI/AM/AD)

Course Code	OECST725	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	0	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST204 OR OECST615	Course Type	Theory

Course Objectives:

1. To impart a Comprehensive Mobile Development Knowledge
2. To give Proficiency in Flutter and Dart, UI/UX Design Skills
3. To present the Industry Practices and Deployment such as app security, testing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Mobile Application Development: Introduction to Mobile Application Development, Overview of Mobile Platforms: iOS and Android, Introduction to Flutter: History, Features, and Benefits, Setting Up the Flutter Development Environment*, Mobile App Architectures (MVC, MVVM, and BLoC), Basics of Dart Programming Language.	9
2	User Interface Design and User Experience: Principles of Mobile UI/UX Design, Designing Responsive UIs with Flutter, Using Flutter Widgets: StatelessWidget and StatefulWidget, Layouts in Flutter: Container, Column, Row, Stack, Navigation and Routing in Flutter, Customizing UI with Themes and Styles.	9
3	Advanced Flutter Development: State Management in Flutter: Provider, Riverpod, and BLoC	9

	Networking in Flutter: HTTP Requests, JSON Parsing, RESTful APIs Data Persistence: SQLite, SharedPreferences, Hive Asynchronous Programming with Dart: Futures, async/await, and Streams	
4	Industry Practices and App Deployment: Advanced UI Components and Animations, App Security Best Practices, Testing and Debugging Flutter Applications, Publishing Apps to Google Play Store and Apple App Store, Industry Trends and Future of Mobile Development with Flutter	9

**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the basics of mobile application development and different mobile platforms and the environment setup.	K2
CO2	Apply principles of effective mobile UI/UX design, develop responsive user interfaces using Flutter widgets.	K3
CO3	Experiment effectively with state in Flutter applications. networking and data persistence in Flutter apps.	K3
CO4	Apply security best practices in mobile app development and debug Flutter applications effectively.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flutter Cookbook	Simone Alessandria	Packt	2/e, 2023
2	Flutter for Beginners	Alessandro Biessek	Packt	1/e, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flutter in Action	Eric Windmill	Manning	1/e, 2019
2	Flutter and Dart: Up and Running	Deepti Chopra, Roopal Khurana	BPB	1/e, 2023

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://www.youtube.com/watch?v=VPvVD8t02U8

SEMESTER 8

COMPUTER SCIENCE AND ENGINEERING

SEMESTER S8

SOFTWARE ARCHITECTURES

Course Code	PECST861	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To develop a comprehensive understanding of software architecture principles and patterns.
2. To provide the ability to design and analyze software architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Software Architecture: Definition and Importance, Architecture in the Life Cycle, Role of the Architect vs. Engineer, Requirements engineering: Stakeholders, Concerns, and Types of Requirements, Use Cases and Tactics.	8
2	Architectural Patterns and Styles: Architectural Patterns- Overview of Patterns and Styles, Applying Patterns and Choosing a Style. Patterns for Enterprise Applications: Enterprise Applications and Layered Patterns, Concurrency Problems.	8
3	Components, Contracts, and Service-Oriented Architectures: Component Software- Nature of Components and Reuse, UML and Components Design by Contract- Contracts, Polymorphism, Inheritance, and Delegation Service-Oriented Architectures- Standards, Technologies, and Security.	9
4	Architecture Evaluation and Description: Describing Architectures and Viewpoints, Evaluating Architectures. Architectural Description Languages (ADLs)- Overview and Applications.	7

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks <p align="center">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> • Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. <p align="center">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the foundational concepts of software architecture, including the roles of stakeholders and the importance of requirements engineering.	K2
CO2	Apply architectural patterns and styles to design software systems, particularly in enterprise contexts.	K3
CO3	Understand the principles of component-based software design and the use of contracts in ensuring reliable software systems.	K2
CO4	Apply architectural description techniques to document and evaluate software architectures.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2									3
CO2	3	3	3		2							3
CO3	3	2	2		2							3
CO4	3	3	3		2							3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Software Architecture	A.Bijlsma, B.J.Heeren, E.E.Roubtsova,S. Stuurman	Free Technology Academy	1/e, 2011
2	Software Architecture 1	Mourad Chabane Oussalah	Wiley	1/e, 2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Head First Software Architecture: A Learner's Guide to Architectural Thinking	Raju Gandhi, Mark Richards, Neal Ford	Oreilly	1/e, 2024

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://www.youtube.com/playlist?list=PL4JxLacgYgqTgS8qQPC17fM-NWMTr5GW6

SEMESTER S8

NATURAL LANGUAGE PROCESSING

(Common to CS/CA/CD)

Course Code	PECST862	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of natural language processing (NLP) and language models, focusing on the principles and techniques of prompt engineering to effectively guide and optimize AI-driven outputs.
2. practical skills necessary to design, implement, and evaluate prompt engineering strategies across various applications, while considering the ethical implications and challenges associated with AI-generated content.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to NLP: Introduction to Natural Language Processing - Various stages of traditional NLP – Challenges - Basic Text Processing techniques - Common NLP Tasks. N-gram Language Models - Naive Bayes for Text Classification, and Sentiment Analysis – Evaluation-Precision, Recall and F-measure-Test sets and cross validation.	7
2	Traditional NLP Techniques: Annotating Linguistic Structures - Context-Free Grammars, Constituency Parsing, Ambiguity, CYK Parsing, Dependency Parsing - Transition-Based Dependency Parsing, Graph-Based Dependency Parsing, Evaluation.	7
3	Neural Networks for NLP: Word representations - Lexical Semantics, Vector Semantics, TF-IDF, Pointwise Mutual Information (PMI), Neural Word embeddings - Word2vec, GloVe, Contextual Word Embeddings. Evaluating Vector Models - Feedforward Neural Networks for Text Classification	10

4	<p>Advanced NLP and Applications:</p> <p>Sequence Modelling - Recurrent Neural Networks, RNNs as Language Models, RNNs for NLP tasks, Stacked and Bidirectional RNN architectures, Recursive Neural Networks, LSTM & GRU, Common RNN NLP Architectures, Encoder-Decoder Model with RNNs, Attention models, Transformers.</p> <p>NLP Applications - Machine Translation, Question Answering and Information Retrieval, Introduction to Large Language Models.</p>	12
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**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the foundational concepts of NLP and apply that to do text processing.	K3
CO2	Utilize word representations and evaluate vector models for NLP	K3
CO3	Analyse and implement advanced linguistic annotation and parsing techniques	K4
CO4	Apply advanced sequence modeling techniques using Neural Networks	K3
CO5	Apply NLP techniques in machine translation, question answering, and information retrieval.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3								3		
CO2	3	3			3							
CO3	3	3									3	
CO4	3	3	3		3							
CO5	3	3	3			3						

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition	Dan Jurafsky and James H. Martin.	Pearson	2006
2	Introduction to Natural Language Processing	Jacob Eisenstein	MIT Press	2019
3	Natural Language Processing with Transformers	Lewis Tunstall, Leandro von Werra, and Thomas Wolf	O'Reilly	2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Deep learning for Natural Language Processing	Stephan Raaijmakers	Manning	2022
2	Natural Language Processing with PyTorch	Delip Rao and Brian McMahan	O'Reilly	2019
3	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	2016

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc19_cs56

SEMESTER S8

TOPICS IN SECURITY

(Common to CS/CM/AM/CB/CN/CU/CI)

Course Code	PECST863	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To explore various web security and privacy concerns
2. To impart security policies and models for data integrity.
3. To enable the learners to protect databases and introduce IDS

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Security and Threat Management: Computer Security, Threats, Harm, Vulnerabilities, Authentication, Access Control Web Security- Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data Privacy- Privacy Concepts, Principles and Policies, Privacy on the Web, Privacy Principles and Policies, Email Security.	9
2	Cryptography in Network Security- Network Encryption, Browser Encryption, Onion Routing, IPSEC, VPN Intrusion Detection and Prevention Systems- Types of IDSs, Other Intrusion Detection Technology, Intrusion Prevention Systems, Intrusion Response, Goals for Intrusion Detection Systems, IDS Strengths and Limitations	9
3	Database Security: -Machine Learning for Malware detection, Supervised Learning for Misuse/Signature Detection, Anomaly Detection using ML, Spam detection based on Machine Learning approach, Adversarial Machine Learning Security Requirements of Databases, Reliability and Integrity of Databases, Database Disclosure	10

4	<p>Security policies and models: Confidentiality Policies, Bell- LaPadula model, Integrity policies, Biba model, Clark-Wilson models, Chinese wall model, waterfall model.</p> <p>Management and Incidents- Security Planning, Business Continuity Planning, Handling Incidents, Risk Analysis, Dealing with Disaster</p>	8
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**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamentals of threat management, web security and privacy	K2
CO2	Identify the significance of network security and IDS	K2
CO3	Apply machine learning algorithms for database security	K3
CO4	Explain the policies and models for data integrity along with managements and incidents associated with data	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Security in Computing	Charles P. Pfleeger, Shari Lawrence Pfleeger Jonathan Margulies	Pearson	5/e, 2015
2	Data mining and machine learning in cybersecurity	Dua, Sumeet, Xian Du	Auerbach Publications	1/e, 2011
3	Machine learning and security: Protecting systems with data and algorithms.	Chio, Clarence, David Freeman	O'Reilly	1/e, 2018
4	Network Security and Cryptography	Bernard Menezes	Cengage Learning	1/e, 2010
5	Computer Security: Art and Science	M Bishop	Addison - Wesley	2/e, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of information security	E Whiteman, J Mattord	Cengage Learning	4/e, 2011
2	Network Security Essentials: Applications and Standards	William Stallings	McGraw Hill	6/e, 2018
3	Network security: the complete reference.	Bragg, Roberta	McGraw-Hill	1/e, 2004
4	Database Security	Basta A., Zgola M,	Cengage Learning	3/e, 2011

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc24_cs121 https://nptel.ac.in/courses/106106093 https://archive.nptel.ac.in/courses/106/106/106106129/

SEMESTER S8

COMPUTATIONAL COMPLEXITY

(Common to CS/CM/AD/CB/CN/CU/CR/CI)

Course Code	PECST864	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST302, PCCST502	Course Type	Theory

Course Objectives:

1. To develop an understanding of various computational models, including deterministic and nondeterministic models, Turing machines, and other computational models, and analyze their capabilities and limitations, focusing on how these models influence the classification of problems into complexity classes.
2. To explore key complexity classes such as P, NP, and PSPACE, and apply polynomial-time reductions to prove the NP-completeness of various problems, and also investigate space complexity, polynomial hierarchy, and advanced topics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Complexity Theory - Basic concepts and motivations, Deterministic and nondeterministic models, Turing machines, and computational models. (Text 2 - Ch 7) Complexity Classes P and NP - Definitions and examples of P and NP, Polynomial-time algorithms, NP-completeness and the Cook-Levin theorem. (Text 2 - Ch 7, 8) Reductions and Completeness - Polynomial-time reductions, NP-complete problems, and their significance, Examples of NP-complete problems (Text 1 - Ch 2)	9
2	Space Complexity - Space complexity classes: L, NL, PSPACE, Savitch's theorem and NL-completeness, PSPACE-completeness. (Text 2 - Ch 8) Polynomial Hierarchy and Alternation - Definition of the polynomial hierarchy (PH), Complete problems for each level of PH, Relationship between PH and other classes. (Text 1 - Ch 5)	9
3	Interactive Proofs - Definition and examples of interactive proofs, IP =	9

	PSPACE theorem, Zero-knowledge proofs. (Text 1 - Ch 8) Probabilistically Checkable Proofs (PCPs) - Introduction to PCPs, PCP theorem and implications, Applications in hardness of approximation. (Text 1 - Ch 9)	
4	Circuit Complexity - Boolean circuits and circuit complexity, Circuit lower bounds, Complexity of specific functions. (Text 2 - Ch 9) Quantum Complexity - Basics of quantum computation, Quantum complexity classes: BQP, QMA, Quantum algorithms and their complexity. (Text 3 - Ch 10, 11)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe and interpret different computational models, including deterministic and nondeterministic Turing machines.	K2
CO2	Recall and categorize complexity classes such as P, NP, and PSPACE, and explain their fundamental properties.	K2
CO3	Use polynomial-time reductions to demonstrate problem completeness and analyze the computational difficulty of problems.	K3
CO4	Evaluate problems based on their space complexity and apply theories like Savitch's theorem to assess space-bounded algorithms.	K4
CO5	Examine advanced topics in complexity theory, including interactive proofs, PCPs, and quantum complexity, and their implications for computational theory.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	3	3	3									2
CO3	3	3	3									2
CO4	3	3	3									2
CO5	3	3	3									2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computational Complexity: A Modern Approach	Sanjeev Arora, Boaz Barak	Cambridge University Press	1/e, 2019
2	Introduction to the Theory of Computation	Michael Sipser	Cengage	3/e, 2014
3	Quantum Computing: A Gentle Introduction	Eleanor Rieffel, Wolfgang Polak	MIT Press	1/e, 2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Randomized Algorithms	Rajeev Motwani and Prabhakar Raghavan	Cambridge University Press	1/e, 2004
2	Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis	Michael Mitzenmacher and Eli Upfal	Cambridge University Press	3/e, 2017
3	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	The MIT Press Cambridge	4/e, 2023
4	The Probabilistic Method	Noga Alon and Joel H. Spencer	Wiley-Blackwell	4/e, 2016
5	Approximation Algorithms	Vijay V. Vazirani	Springer	4/e, 2013
6	Theory of Computation : Classical And Contemporary Approaches	Dexter C Kozen	Springer	6/e, 2006
7	Computational Complexity: A Conceptual Perspective,	Oded Goldreich	Cambridge University Press	1/e, 2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview
3	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview
4	https://onlinecourses.nptel.ac.in/noc21_cs90/preview https://onlinecourses.nptel.ac.in/noc21_cs49/preview https://archive.nptel.ac.in/courses/106/104/106104241/

SEMESTER S8

SPEECH AND AUDIO PROCESSING

(Common to CS/CA/CM/CD/CR/AD/CC/CG)

Course Code	PECST866	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PECST636	Course Type	Theory

Course Objectives:

1. To get familiarised with speech processing and audio processing concepts.
2. To equip the student to apply speech processing techniques in finding solutions to day-to-day problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Speech Production :- Acoustic theory of speech production; Source/Filter model - Pitch, Formant; Spectrogram- Wide and narrow band spectrogram; Discrete model for speech production; Short-Time Speech Analysis; Windowing; STFT; Time domain parameters (Short time energy, short time zero crossing Rate, ACF); Frequency domain parameters - Filter bank analysis; STFT Analysis.	9
2	Mel-frequency cepstral coefficient (MFCC)- Computation; Pitch Estimation ACF/AMDF approaches; Cepstral analysis - Pitch and Formant estimation using cepstral analysis; <i>LPC Analysis</i> - LPC model; Auto correlation method - Levinson Durbin Algorithm	9
3	Speech Enhancement :- Spectral subtraction and Filtering, Harmonic filtering, Parametric resynthesis; Speech coding - fundamentals, class of coders : Time domain/spectral domain/vocoders, Sub band coding, adaptive transform coding, phase vocoder; Speaker Recognition :- Speaker verification and speaker identification, log-likelihood; Language identification - Implicit and explicit models; Machine learning models in Speaker Recognition.	9

4	Signal Processing models of audio perception - Basic anatomy of hearing System, Basilar membrane behaviour; Sound perception - Auditory Filter Banks, Critical Band Structure, Absolute Threshold of Hearing; Masking - Simultaneous Masking, Temporal Masking; Models of speech perception.	9
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**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To recall various steps in the speech production process	K2
CO2	To summarise various speech processing approaches	K2
CO3	To develop speech-processing applications in various domains	K3
CO4	To analyse the speech processing model for audio perception	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2		2	2					3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3	2			2					3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Speech Communications: Human & Machine	Douglas O'Shaughnessy	IEEE Press	2/e, 1999
2	Discrete-Time Speech Signal Processing: Principles and Practice	Thomas F. Quatieri	Prentice Hall	1/e, 2001
3	Fundamentals of Speech Recognition	Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana	Pearson	1/e, 2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory and Application of Digital Processing of Speech Signals	Rabiner and Schafer	Prentice Hall	1/e, 2010
2	Speech and Audio Signal Processing: Processing and Perception Speech and Music	Nelson Morgan and Ben Gold	John Wiley & Sons	2/e, 2011

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://youtu.be/Xjzm7S_kBU?si=j11bk3F7gocYjhfg

SEMESTER S8

STORAGE SYSTEMS

(Common to CS/CM/CR/CD/AM/AD)

Course Code	PECST867	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of storage technologies and architectures.
2. To empower students to design and implement effective storage solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Storage technologies:- Computer storage technologies-Magnetic bubble memories, Charged Coupled Devices - CCDs, Micro-Electro-Mechanical Systems - MEMS, Flash memories, Processing In Memory - PIM, Optical storage - Data deduplication in storage systems. Storage Arrays- Architectural Principles, Replication, Local Snapshot Redundant Arrays of Independent Disks (RAID) - RAID0,RAID2,RAID3, RAID4, RAID5, RAID6, Hybrid RAID.	9
2	Data Storage Networking:- Fibre Channel SAN- FC SAN Components,SAN Topologies, iSCSI SAN- iSCSI names, Sessions, iSNS, Network Attached Storage - NAS Protocols, NAS Arrays, NAS Performance Object Storage - Objects and Object IDs, metadata, API Access	9
3	Business Continuity, Backup and Recovery:- Replication- Synchronous Replication, Asynchronous Replication Application, Layer Replication, Logical Volume Manager-Based Replication, Backup Methods- Hot Backups, Offline Backups, LAN-Based Backups, LAN-Free Backups (SAN Based), Serverless Backups, NDMP, Backup Types- Full Backups, Incremental Backups, Differential Backups ,	9

	Synthetic Full Backups, Application-Aware Backups	
4	Storage Management:- Capacity Management- Capacity Reporting, Thin Provisioning Considerations, Deduplication and Compression, Quotas and Archiving, Showback and Chargeback, Performance Management- Latency/Response Time, IOPS,MBps and Transfer Rate, Factors Affecting Storage Performance Management Protocols and Interfaces.	9

**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p align="center">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. <p align="center">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe emerging storage technologies.	K2
CO2	Compare and contrast different storage networking technologies.	K2
CO3	Understand the importance of business continuity.	K2
CO4	Develop a comprehensive backup and recovery strategy	K3
CO5	Utilize management tools and best practices to monitor, optimize, and secure storage resources, ensuring optimal performance and data integrity.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									3
CO2	3	3	2									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Storage Networking	Nigel Poulton	WILEY	2/e, 2015
2	Computer Storage Fundamentals	Susanta Dutta	BPB Publication	1/e, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Storage Systems : Organization, Performance, Coding, Reliability, and Their Data Processing	Alexander Thomasian	Morgan Kaufmann	1/e, 2021
2	Information Storage and Management	Somasundaram Gnanasundaram Alok Shrivastava	Wiley	2/e, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/108/106108058/

SEMESTER S8

PROMPT ENGINEERING (Common to CS/CM/CR/CD/AD/AM)

Course Code	PECST868	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To develop students' practical skills in applying prompt engineering techniques to real-world applications, while fostering an awareness of the ethical considerations and challenges in the field
2. To give an understanding of contextual cues to mitigating biases with techniques for seamless interaction with AI systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Prompt Engineering and Language Models :- Fundamentals of Natural Language Processing (NLP) - Overview of Language Models: From Rule-Based Systems to Transformer Architectures (e.g., GPT, BERT) - Understanding Prompts: Definition, Importance, and Applications - Introduction to Prompt Engineering: Techniques and Use Cases - Ethical Considerations in Prompt Engineering Handson : Explore various language models using platforms like OpenAI, Hugging Face, or Google Colab; Experimenting with basic prompts to understand the impact of phrasing and context on model outputs.	9
2	Techniques and Strategies in Prompt Engineering :- Designing Effective Prompts - Best Practices and Common Pitfalls; Prompt Tuning and Fine-Tuning Language Model; Using Zero-Shot, Few-Shot, and Multi-Shot Learning in Prompts; Exploring the Role of Context, Repetition, and Specificity in Prompt Responses; Advanced Prompt Engineering Techniques: Prompt Chaining, Iterative Prompting. Handson : Crafting and optimizing prompts for specific tasks (e.g., text generation, summarization, Q&A); Using prompt engineering to fine-tune pre-	9

	trained models on specific datasets or tasks.	
3	<p>Applications of Prompt Engineering :-</p> <p>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</p> <p>Handson : Developing a simple chatbot using prompt engineering techniques, Case study analysis and reproduction of real-world prompt engineering applications</p>	9
4	<p>Challenges, Future Trends, and Research in Prompt Engineering :-</p> <p>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;</p> <p>Handson : Working on a capstone project to solve a real-world problem using prompt engineering</p>	9

**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the core principles of NLP, language models, and the role of prompts in influencing AI behavior.	K2
CO2	Demonstrate the ability to design and fine-tune prompts for specific tasks, optimizing language models for desired outputs	K3
CO3	Apply prompt engineering techniques to develop functional AI applications, such as chatbots, content generation tools, and automated systems.	K3
CO4	Compare the ethical implications of prompt engineering, addressing challenges such as bias, ambiguity, and misuse, and propose solutions to mitigate these issues.	K3
CO5	Apply prompt engineering techniques to a variety of assigned tasks	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Speech and Language Processing	Daniel Jurafsky and James H. Martin	Pearson	2/e, 2013
2	Unlocking the Secrets of Prompt Engineering	Gilbert Mizrahi	Packt	1/e, 2023
3	Prompt Engineering	Ian Khan	Wiley	1/e, 2024

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Natural Language Processing with Python	Steven Bird, Ewan Klein, and Edward Loper	Oreilly	1/e, 2009
2	Transformers for Natural Language Processing	Denis Rothman	Packt	1/e, 2021

SEMESTER S8

COMPUTATIONAL NUMBER THEORY

(Common to CS/CM)

Course Code	PECST869	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST205 PCCST303 PCCST502	Course Type	Theory

Course Objectives:

1. To develop proficiency in key algorithms for number-theoretic operations, including primality testing, integer factorization, and modular exponentiation and to analyze and implement these algorithms efficiently to solve problems in number theory and cryptography.
2. To apply advanced computational techniques, such as elliptic curve cryptography and lattice-based methods, to address complex problems in cryptographic systems and gain practical skills to implement and evaluate these techniques within real-world security applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Number Theory - Basic concepts and definitions, Greatest common divisor (GCD) and Euclidean algorithm; Modular Arithmetic - Congruences and modular arithmetic, Applications of modular arithmetic; Integer Factorization - Prime numbers and factorization, Algorithms for integer factorization; Basic Algorithms - Algorithms for modular arithmetic, Fast exponentiation techniques	9
2	Advanced Factorization Algorithms - Pollard's rho algorithm, Elliptic curve factorization; Public-Key Cryptography - RSA algorithm, Security analysis of RSA; Elliptic Curve Cryptography - Introduction to elliptic curves, Algorithms for elliptic curve cryptosystems	9
3	Public Key Cryptography - RSA algorithm and its implementation, Security aspects and cryptanalysis; Elliptic Curve Cryptography - Basics of elliptic curves, Elliptic curve cryptosystems; Cryptographic Protocols - Key	9

	exchange protocols, Digital signatures and authentication	
4	Algebraic Number Theory - Algebraic integers and number fields, Factorization in number fields; Computational Methods - Algorithms for solving Diophantine equations, Applications in computational algebra; Recent Developments and Applications - Applications in modern cryptography and coding theory	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand basic number theory concepts and algorithms.	K2
CO2	Apply factorization algorithms to solve computational problems.	K3
CO3	Analyze and evaluate cryptographic systems based on number theory.	K4
CO4	Synthesize algebraic number theory concepts into computational methods.	K4
CO5	Create and present a project on recent advances and applications in computational number theory.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									2
CO2	3	3	3									2
CO3	3	3	3	3	3							2
CO4	3	3	3	3	3					2	2	2
CO5	3	3	3									2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Computational Introduction to Number Theory and Algebra	Victor Shoup	Cambridge University Press	2/e, 2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computational Number Theory and Modern Cryptography	Song Y. Yan	John Wiley & Sons	1/e, 2013
2	A course in computational algebraic number theory	Henri Cohen	Springer-Verlag	4/e, 2000
3	Computational Number Theory	Abhijit Das	CRC	1/e, 2013
4	Modern Computer Algebra	Joachim von zur Gathen and Jürgen Gerhard	Cambridge University Press	4/e, 2013
5	An Introduction to the Theory of Numbers	G. H. Hardy, Edward M. Wright, Roger Heath-Brown and Joseph Silverman	Oxford University Press	6/e, 2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/
2	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/
3	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/
4	https://archive.nptel.ac.in/courses/111/104/111104138/ https://archive.nptel.ac.in/courses/106/103/106103015/

SEMESTER S8

NEXT GENERATION INTERACTION DESIGN

(Common to CS/CR/CM/CA/CD/AM/AD/CN/CC/CI/CG)

Course Code	PECST865	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None		

Course Objectives:

1. To provide a comprehensive understanding of the principles of interaction design and their application in augmented reality (AR) and virtual reality (VR) environments.
2. To equip learners with practical skills in developing, prototyping, and evaluating AR/VR applications, focusing on user-centered design and advanced interaction techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Interaction Design and AR/VR :- Fundamentals of Interaction Design - Principles of interaction design, Human-computer interaction (HCI) basics, User experience (UX) design principles; Introduction to AR and VR - Overview of AR and VR technologies (Key differences and Application), Overview of AR/VR hardware (headsets, controllers, sensors), Software tools and platforms for AR/VR development.	8
2	User-Centered Design and Prototyping :- Understanding User Needs and Context - User research methods, Personas and user journey mapping, Contextual inquiry for AR/VR, Designing for AR/VR Environments, Spatial design principles, Immersion and presence in AR/VR, User interface (UI) design for AR/VR; Prototyping and Testing - Rapid prototyping technique, Usability testing methods, Iterative design and feedback loops.	8
3	Advanced Interaction Techniques :- Gesture - Designing for gesture-based interaction, Implementing gesture controls in AR/VR applications; Voice - Voice recognition technologies, Integrating voice commands in AR/VR; Haptic Feedback and Sensory Augmentation - Understanding haptic feedback and tactile interactions; Eye Gaze - Designing and integrating Eye Gaze in VR; Spatial Audio;	11

	Microinteraction; Motion capture and tracking technologies; Natural Language Interaction and conversational interfaces; Type of IoT sensors and uses.	
4	Implementation, Evaluation, and Future Trends :- Developing AR/VR Projects - Project planning and management, Collaborative design and development, Case studies of successful AR/VR projects; Evaluating AR/VR Experiences - Evaluation methods and metrics, Analyzing user feedback, Refining and improving AR/VR applications; Future Trends and Ethical Considerations- Emerging technologies in AR/VR, Ethical implications of AR/VR, Future directions in interaction design for AR/VR.	9

**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

- The students must be directed to measure the quality of the interfaces / GUI based on various techniques such as user testing.
- The students may be assessed based on their ability to analyze various performance of the interfaces /GUIs.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	<ul style="list-style-type: none"> • 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. • Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply fundamental interaction design principles and human-computer interaction (HCI) concepts to create effective and intuitive user experiences in AR/VR applications.	K3
CO2	Demonstrate proficiency in using AR/VR hardware and software tools for the development and prototyping of immersive environments.	K3
CO3	Conduct user research and apply user-centered design methodologies to tailor AR/VR experiences that meet specific user needs and contexts.	K4
CO4	Implement advanced interaction techniques such as gesture controls, voice commands, haptic feedback, and eye gaze in AR/VR applications to enhance user engagement and immersion.	K3
CO5	Evaluate AR/VR projects, utilizing appropriate evaluation methods and metrics, and propose improvements based on user feedback and emerging trends in the field.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								3
CO2	3	3	3	3	3							3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	3							3
CO5	3	3	3	3								3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Augmented Reality - Theory, Design and Development	Chetankumar G Shetty	McGraw Hill	1/e, 2023
2	Virtual Reality and Augmented Reality: Myths and Realities	Ralf Doerner, Wolfgang Broll, Paul Grimm, and Bernhard Jung	Wiley	1/e, 2018
3	Augmented Reality: Principles and Practice	Dieter Schmalstieg and Tobias Hollerer	Pearson	1/e, 2016
4	Human-Computer Interaction	Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale	Pearson	3/e, 2004
5	Evaluating User Experience in Games: Concepts and Methods	Regina Bernhaupt	Springer	1/e, 2010
6	Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics	Bill Albert, Tom Tullis	Morgan Kaufman	2/e, 2013
7	The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything	Robert Scoble and Shel Israel	Patrick Brewster	1/e, 2016
8	Augmented Reality and Virtual Reality: The Power of AR and VR for Business	M. Claudia tom Dieck and Timothy Jung	Springer	1/e, 2019

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	Interaction Design https://archive.nptel.ac.in/courses/107/103/107103083/
2	Virtual Reality https://archive.nptel.ac.in/courses/106/106/106106138/
3	Augmented Reality https://www.youtube.com/watch?v=WzfDo2Wpxks

SEMESTER S8

INTRODUCTION TO ALGORITHM

(Common to CS/CA/CM/CD/CR/AD/AM)

Course Code	OECS831	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To give proficiency in analysing algorithm efficiency and solve a variety of computational problems, including sorting, graph algorithms.
2. To provide an understanding in algorithmic problem-solving techniques, including Divide and Conquer, Greedy Strategy, Dynamic Programming, Backtracking, and Branch & Bound algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Algorithm Analysis Time and Space Complexity- Asymptotic notation, Elementary operations and Computation of Time Complexity-Best, worst and Average Case Complexities- Complexity Calculation of simple algorithms Recurrence Equations: Solution of Recurrence Equations – Iteration Method and Recursion Tree Methods	9
2	Trees - Binary Trees – level and height of the tree, complete-binary tree representation using array, tree traversals (Recursive and non-recursive), applications. Binary search tree – creation, insertion and deletion and search operations, applications; Graphs – representation of graphs, BFS and DFS (analysis not required), Topological Sorting.	9
	Divide and Conquer - Control Abstraction, Finding Maximum and Minimum, Costs associated element comparisons and index comparisons, Binary Search, Quick Sort, Merge Sort - Refinements; Greedy Strategy - Control Abstraction, Fractional Knapsack Problem, Minimum Cost Spanning Trees – PRIM's Algorithm, Kruskal's Algorithm, Single Source Shortest Path Algorithm - Dijkstra's Algorithm.	9
4	Dynamic Programming - The Control Abstraction- The Optimality Principle	9

	- Matrix Chain Multiplication, Analysis; All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm; The Control Abstraction of Backtracking – The N-Queens Problem. Branch and Bound Algorithm for Travelling Salesman Problem.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify algorithm efficiency using asymptotic notation, compute complexities, and solve recurrence equations	K3
CO2	Use binary trees and search trees, and apply graph representations, BFS, DFS, and topological sorting	K3
CO3	Use divide and conquer to solve problems like finding maximum/minimum, binary search, quick sort, and merge sort	K3
CO4	Apply greedy strategies to solve the fractional knapsack problem, minimum cost spanning trees using Prim's and Kruskal's algorithms, and shortest paths with Dijkstra's algorithm.	K3
CO5	Understand the concepts of Dynamic Programming, Backtracking and Branch & Bound	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									1
CO2	2	3	2	2								2
CO3	3	3	3	2								2
CO4	2	2										2
CO5	2	3	2									2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Algorithms	T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein	Prentice-Hall India	4/e, 2022
2	Fundamentals of Computer Algorithms	Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran	Universities Press	2/e, 2008

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Algorithm Design	Jon Kleinberg, Eva Tardos	Pearson	1/e, 2005
2	Algorithms	Robert Sedgwick, Kevin Wayne	Pearson	4/e, 2011
3	The Algorithm Design Manual	Steven S. Skiena	Springer	2/e, 2008

Video Links (NPTEL, SWAYAM...)

No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105164/

SEMESTER S8

WEB PROGRAMMING

Course Code	OECST832	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST203	Course Type	Theory

Course Objectives:

1. To equip students with the knowledge and skills required to create, style, and script web pages using HTML5, CSS, JavaScript, and related technologies.
2. To provide hands-on experience with modern web development tools and frameworks such as React, Node.js, JQuery, and databases, enabling students to design and build dynamic, responsive, and interactive web applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Creating Web Page using HTML5 - Introduction, First HTML5 example, Headings, Linking, Images, Special Characters and Horizontal Rules, Lists, Tables, Forms, Internal Linking, meta Elements, HTML5 Form input Types, Input and datalist Elements and autocomplete Attribute, Page-Structure Elements; Styling Web Page using CSS - Introduction, Inline Styles, Embedded Style Sheets, Linking External Style Sheets, Positioning Elements:, Absolute Positioning, z-index, Positioning Elements: Relative Positioning, span, Backgrounds, Element Dimensions, Box Model and Text Flow, Media Types and Media Queries, Drop-Down Menus; Extensible Markup Language - Introduction, XML Basics, Structuring Data, XML Namespaces, Document Type Definitions (DTDs), XML Vocabularies	9
2	Scripting language - Client-Side Scripting, Data Types, Conditionals, Loops, Arrays , Objects , Function Declarations vs. Function Expressions , Nested Functions , The Document Object Model (DOM) - Nodes and NodeLists, Document Object, Selection Methods, Element Node Object, Event Types Asynchronous JavaScript and XML - AJAX : Making Asynchronous Requests , Complete Control over AJAX , Cross-Origin Resource Sharing	9

	JavaScript library - jQuery - jQuery Foundations - Including jQuery, jQuery Selectors, Common Element Manipulations in jQuery, Event Handling in jQuery	
3	JavaScript runtime environment : Node.js - The Architecture of Node.js, Working with Node.js, Adding Express to Node.js; Server-side programming language : PHP - What Is Server-Side Development? Quick tour of PHP, Program Control , Functions , Arrays , Classes and Objects in PHP , Object-Oriented Design ; Rendering HTML : React - ReactJS Foundations : The Philosophy of React, What is a component? Built- in components, User- defined components - Types of components, Function Components, Differences between Function and Class Components	9
4	SPA – Basics, Angular JS; Working with databases - Databases and Web Development, SQL, Database APIs, Accessing MySQL in PHP; Web Application Design - Real World Web Software Design, Principle of Layering , Software Design Patterns in the Web Context, Testing; Web services - Overview of Web Services - SOAP Services, REST Services, An Example Web Service, Web server - hosting options	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop structured web pages with HTML5 and style them using CSS techniques, including positioning, media queries, and the box model.	K3
CO2	Write client-side scripts using JavaScript and utilize jQuery for DOM manipulation, event handling, and AJAX requests to create responsive and interactive user interfaces.	K3
CO3	Build and deploy server-side applications using Node.js, Express, and PHP, and integrate databases using SQL to store and retrieve data for dynamic content generation.	K3
CO4	Utilize React for building component-based single-page applications (SPAs), understanding the fundamental principles of component architecture, and leveraging AngularJS for web application development.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3							3
CO2	3	3	3		3							3
CO3	3	3	3		3							3
CO4	3	3	3		3							3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Web Development	Randy Connolly, Ricardo Hoar	Pearson	1/e, 2017
2	Building User Interfaces with ReactJS - An Approachable Guide	Chris Minnick	Wiley	1/e, 2022
3	Internet & World Wide Web - How to Program	Paul J. Deitel, Harvey M. Deitel, Abbey Deitel	Pearson	1/e, 2011
4	SPA Design and Architecture: Understanding Single Page Web Applications	Emmit Scott	Manning Publications	1/e, 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Hand Book On Web Development : From Basics of HTML to JavaScript and PHP	Pritma Jashnani	Notion press	1/e, 2022
2	Advanced Web Development with React	Mohan Mehul	BPB	1/e, 2020
3	JavaScript Frameworks for Modern Web Development	Tim Ambler, Sufyan bin Uzayr, Nicholas Cloud	Apress	1/e, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106222/
2	https://archive.nptel.ac.in/courses/106/106/106106156/

SEMESTER S8
SOFTWARE TESTING

Course Code	OECST833	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To Cultivate proficiency in software testing methodologies and techniques.
2. To Foster expertise in software testing tools and technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>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.</p>	8
2	<p>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.</p>	8

3	<p>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.</p>	10
4	<p>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.</p>	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
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the ability to apply a range of software testing techniques, including unit testing using JUnit and automation tools.	K2
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	K3
CO3	Explain and apply graph coverage criteria in terms of control flow and data flow graphs to improve code quality.	K2
CO4	Demonstrate the importance of black-box approaches in terms of Domain and Functional Testing	K3
CO5	Illustrate the importance of security, compatibility, and performance testing across devices.	K3
CO6	Use advanced tools like PEX to perform symbolic execution and optimize test case generation and also leverage AI tools for automated test case prediction and symbolic execution with PEX.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3	3	3							3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3		3							3
CO6	3	3	3	3	3							3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Software Testing.	Paul Ammann, Jeff Offutt	Cambridge University Press	2/e, 2016
2	Software Testing and Quality Assurance: Theory and Practice	Kshirasagar Naik, Priyadarshi Tripathy	Wiley	1/e, 2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Software Testing	Ron Patten	Pearson	2/e, 2005
2	Software Testing: A Craftsman's Approach	Paul C. Jorgensen	CRC Press	4/e, 2017
3	Foundations of Software Testing	Dorothy Graham, Rex Black, Erik van Veenendaal	Cengage	4/e, 2021
4	The Art of Software Testing	Glenford J. Myers, Tom Badgett, Corey Sandler	Wiley	3/e, 2011

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/101/106101163/
2	https://archive.nptel.ac.in/courses/106/101/106101163/
3	https://archive.nptel.ac.in/courses/106/101/106101163/
4	https://archive.nptel.ac.in/courses/106/101/106101163/

SEMESTER S8
INTERNET OF THINGS

Course Code	OECST834	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. To give an understanding in the Internet of Things, including the components, tools, and analysis through its fundamentals and real-world applications.
2. To enable the students to develop IoT solutions including the softwares and programming of Raspberry Pi hardware.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to IoT - Physical Design of IoT, Logical Design of IoT, IoT levels and Deployment templates, Domain Specific IoT- Home automation, Energy, Agriculture, Health and lifestyle.	9
2	IoT and M2M-M2M, Difference between IoT and M2M, Software Defined Networking, Network Function virtualization, Need for IoT System Management, Simple Network Management Protocol (SNMP), NETCONF, YANG; LPWAN - LPWAN applications, LPWAN technologies, Cellular (3GPP) and Non 3GPP standards, Comparison of various protocols like Sigfox, LoRA, LoRAWAN, Weightless, NB-IoT, LTE-M.	9
3	Developing IoT - IoT design methodology, Case study on IoT system for weather monitoring, Motivations for using python, IoT-system Logical design using python, Python Packages of Interest for IoT - JSON, XML, HTTPLib & URLLib, SMTPLib	9
4	Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi, Interfacing an LED and switch with Raspberry Pi, Other IoT devices- PcDino, Beagle bone Black, Cubieboard, Data Analytics for IoT	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course, students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand domain-specific applications and apply the principles of IoT, including physical and logical design and deployment templates	K2
CO2	Use the principles of IoT and M2M, their differences, and key concepts like SDN, NFV, and essential management protocols.	K3
CO3	Develop and apply IoT design methodology, utilize Python for logical system design, and leverage key Python packages through practical case studies.	K3
CO4	Experiment using Raspberry Pi with Python to control LEDs and switches, interface with other IoT devices.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3							2		3
CO2	3	3	3							2		3
CO3	3	3	3	2						2		3
CO4	3	3	3	2						2		3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Internet of Things - a Hands On Approach.	Arshdeep Bahga, Vijay Madiseti	Universities Press	1/e, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Internet of Things : Architecture and Design Principles	Rajkamal	McGraw Hill	2/e, 2022
2	The Internet of Things –Key applications and Protocols	Olivier Hersent, David Boswarthick, Omar Elloumi	Wiley	1/e, 2012
3	IoT fundamentals : Networking technologies, Protocols and use cases for the Internet of things	David Hanes Gonzalo. Salgueiro, Grossetete, Robert Barton	Cisco Press	1/e, 2017

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/106/105/106105166/
2	https://archive.nptel.ac.in/courses/108/108/108108179/

SEMESTER S8

COMPUTER GRAPHICS

Course Code	OECST835	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objective:

1. To provide strong technological concepts in computer graphics including the three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Computer graphics - Basics of Computer Graphics and its applications. Video Display devices - LED, OLED, LCD, PDP and FED and reflective displays. Random and Raster scan displays and systems. Line and Circle drawing Algorithms - Line drawing algorithms- Bresenham's algorithm, Liang-Barsky Algorithm, Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's Circle drawing algorithm.	10
2	Geometric transformations - 2D and 3D basic transformations - Translation, Rotation, Scaling, Reflection and Shearing, Matrix representations and homogeneous coordinates. Filled Area Primitives - Scan line polygon filling, Boundary filling and flood filling.	10
3	Transformations and Clipping Algorithms - Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms.	8
4	Three dimensional graphics - Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p align="center">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. <p align="center">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles of computer graphics and displays	K2
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	K3
CO3	Illustrate 2D and 3D basic transformations and matrix representation	K3
CO4	Demonstrate different clipping algorithms and 3D viewing pipeline.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Graphics : Algorithms and Implementations	D. P. Mukherjee, Debasish Jana	PHI	1/e, 2010
2	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4/e, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Flat Panel Displays	Jiun-Haw Lee, I-Chun Cheng, Hong Hua, Shin-Tson Wu	Wiley	1/e, 2020
2	Computer Graphics and Multimedia	ITL ESL	Pearson	1/e, 2013
3	Computer Graphics	Zhigang Xiang and Roy Plastock	McGraw Hill	2/e, 2000
4	Principles of Interactive Computer Graphics	William M. Newman and Robert F. Sproull	McGraw Hill	1/e, 2001
5	Procedural Elements for Computer Graphics	David F. Rogers	McGraw Hill	1/e, 2017
6	Computer Graphics	Donald D Hearn, M Pauline Baker	Pearson	2/e, 2002

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1.	Computer Graphics By Prof. Samit Bhattacharya at IIT Guwahati https://onlinecourses.nptel.ac.in/noc20_cs90/preview