SEMESTER 7

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

SEMESTER S7

FORMAL METHODS IN SOFTWARE ENGINEERING

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

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

Course Objectives:

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

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

WEB PROGRAMMING

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

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

BIOINFORMATICS

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

INFORMATION SECURITY

(Common to CS/CM/CA/AM)

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

EMBEDDED SYSTEMS

(Common to CS/CM/AM)

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

BLOCKCHAIN AND CRYPTOCURRENCIES

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

Course Objectives:

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

SYLLABUS

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

	Bitcoin: Components, Nodes in Bitcoin network, Transactions and memory pools, Proof of Work-Mining Cryptocurrencies, Hard and Soft Forks, Tracking Bitcoins-Unspent Transaction Outputs. Ethereum: Transition from Bitcoin to Ethereum, Concept of Ethereum World Computer, Ethereum Virtual Machine, Ethereum Network, Transition from PoW to PoS- Working of PoS, Smart Contracts in Ethereum, Decentralised Applications in Ethereum, Tools used in Ethereum.	
4	**Blockchain Ethereum Platform using Solidity and Use Cases in Blockchain :-** Solidity Language - Remix IDE, Structure of a Smart Contract Program, Modifiers, Events, Functions, Inheritance, External Libraries, Error Handling. Permissioned Blockchains, Introduction to Hyperledger Foundation, Hyperledger Distributed Ledger frameworks, Hyperledger Fabric. Use Cases in Blockchain - Finance, Education, Government, Healthcare and Supply Chain Management.	**10**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

REAL TIME SYSTEMS

(Common to CS/CM/CA/AM)

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

Course Objectives:

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

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S7

APPROXIMATION ALGORITHMS

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S6

REINFORCEMENT LEARNING

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

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction:**Deep Reinforcement Learning, Suitability of Reinforcement Learning, Components of Reinforcement Learning - Agent, Environment, Observations, Actions.Examples - The Bandit Walk Environment, Agent-Environment interaction cycle. **Markov Decision Process (MDP):**The Engine of the Environment - States, Actions, Transition Function, Reward Signal.	8
2	**Planning:**Objective of a decision making agent-environment, Plan, Optimal policy, Comparison of Policies, Bellman Equation/State-Value Function, Action-Value Function, Action-Advantage Function, Optimality. **Exploitation and Exploration of Reinforcement Learning:**Bandits- Single State Decision Problem (Multi-Armed Bandit(MAB) problem), The cost of exploration, Approaches to solve MAB environments, Greedy Strategy, Random Strategy, Epsilon-Greedy Strategy, Decaying Epsilon-Greedy Strategy, Optimistic Initialization Strategy, Strategic Exploration, Softmax Exploration Strategy, Upper Confidence Bound (UCB) Equation Strategy, Thompson Sampling Strategy.	10
3	**Model Free Reinforcement Learning:**Monte Carlo Prediction (MC), First-Visit MC (FVMC), Every-Visit MC (EVMC), Temporal Difference Learning (TD), Learning to Estimate from Multiple Steps, N-step TD Learning, Forward-View TD(λ), Backward-View TD(λ), Generalized Policy Iteration(GPI), Monte Carlo Control, SARSA: On-Policy TD control, Q-	10

	learning: Off-Policy TD control, Double Q-learning, SARSA(λ), Watkins's Q(λ). **Model Based Reinforcement Learning:**Dyna-Q, Trajectory sampling	
4	**Value Based Reinforcement Learning:**Deep Reinforcement Learning Agents with Sequential Feedback, Evaluative Feedback, Sampled Feedback, Function Approximation for Reinforcement Learning - High-Dimensional State and Action Spaces, Continuous State and Action Spaces, State-Value Function and Action-Value Function with and without Function Approximation, Neural Fitted Q (NFQ), Deep Q-Network (DQN), Double Deep-Q Networks (DDQN), Duelling DDQN, Prioritized Experience Replay (PER).	**8**

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Ways of assessing at

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate various Components of Reinforcement Learning	K2
CO2	Make use of various exploration and exploitation strategies.	K3
CO3	Apply Model based and Model Free Prediction techniques	K3
CO4	Evaluate different value based Reinforcement Learning Algorithms.	K5

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

CO-PO Mapping Table:

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

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Reinforcement learning: An Introduction	Richard S. Sutton and Andrew G. Barto	MIT Press	2/e, 2019
2	Reinforcement Learning, State-of-the-Art, Adaptation	Marco Wiering and Martijn van Otterlo(Eds.)	Springer	1/e, 2012

3	Foundations of Deep Reinforcement Learning: Theory and Practice in Python	Laura Graesser and Wah Loon Keng	Pearson India	1/e, 2022

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

SEMESTER S7

ADVANCED COMPUTER NETWORKS

Course Code	**PECST751**	**CIE Marks**	40
Teaching Hours/Week (L:T:P:R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To give a comprehensive understanding of advanced networking concepts, including MPLS, VPNs, Data Center Networks, and Software-Defined Networking (SDN).
2. To impart the skills necessary to analyze, design, and evaluate complex networking architectures, addressing the challenges and emerging trends.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Review of Computer Networking Fundamentals - OSI and TCP/IP Models, Layers and Protocols, IP Addressing and Subnetting, Routing Protocols - RIP, OSPF, BGP; QoS in IP networks - Random Early Detection, Protocols for QoS support - RSVP, RTP, Multiprotocol Label Switching (MPLS): Overview and Use Cases; Network Security Basics - Firewalls, ACLs, and NAT; Working of NAT; Virtual Private Networks (VPNs) - Types and Architectures; Overview of Data Center Networks: Key Components and Topologies;	8
2	DLL switching - Overview, VLANs, Inter-VLAN Routing; Spanning Tree Protocol (STP) - IEEE 802.1D, Rapid Spanning Tree Protocol (RSTP) - IEEE 802.1w, Multiple Spanning Tree Protocol (MSTP) - IEEE 802.1s, STP Enhancements - BPDU Guard, Root Guard, and Loop Guard; Data Center Network Architectures - Traditional vs. Modern Data Center Designs (Spine-Leaf, Clos Networks), Ethernet Fabrics and TRILL; Data Center Design Considerations - Scalability, Redundancy, and Latency.	9
3	SDN Architecture and Components - Control Plane, Data Plane, and Application Plane; OpenFlow Protocol and its Role in SDN; SDN Controllers - Ryu, OpenDaylight, and ONOS; SDN Use Cases - Traffic Engineering,	9

	Network Function Virtualization (NFV) - NFV Concepts, Virtualizing Network Functions and Services; NFV Infrastructure (NFVI) and Management (MANO); Service Function Chaining (SFC); NFV in Telecom Networks.	
4	Data Center Interconnect (DCI) - Technologies for Data Center Interconnection(VPLS, OTV, and VXLAN), DCI Design and Deployment Considerations; Intent-Based Networking (IBN) - Introduction to Intent-Based Networking; Content Distribution on the Internet - Architectures for Information-Centric Networking; Content Naming, Routing and Caching, Security in Named Data Networking; Network Automation and Orchestration; Automation Tools - Ansible, Terraform; Orchestration Frameworks - Kubernetes.	**10**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain and critically analyze advanced networking protocols and technologies, including MPLS, VPNs, and SDN, and their applications in modern networks	**K3**
CO2	Demonstrate an understanding of data center network architectures, including the design considerations and protocols that ensure scalability, redundancy, and efficiency.	**K3**
CO3	Use Software-Defined Networking (SDN) and Network Function Virtualization (NFV) to automate and optimize network operations.	**K3**
CO4	Explain emerging trends such as Intent-Based Networking (IBN) and network automation, applying this knowledge to modernize and innovate networking solutions.	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Networking: A Top-Down Approach	James F. Kurose, Keith W. Ross	Pearson	8/e, 2022
2	Data Center Virtualization Fundamentals: Understanding Techniques and Designs for Highly Efficient Data Centers with Cisco Nexus, UCS, MDS, and Beyond	Gustavo A. A. Santana	CISCO Press	1/e, 2013
3	MPLS and VPN Architectures	Jim Guichard, Ivan Pepelnjak, Jeff Apcar	CISCO Press	1/e, 2000
4	High-speed networks and Internet: Performance and Quality of Service	William Stallings	Pearson	2/e, 2002
5	Software Defined Networks: A Comprehensive Approach	Paul Goransson, Chuck Black, Timothy Culver	Morgan Kaufman	2/e, 2016
6	Information-Centric Networking (ICN): Content-Centric Networking (CCNx) and Named Data Networking (NDN) Terminology	B. Wissingh, C. Wood, A. Afanasyev, L. Zhang, D. Oran, C. Tschudin	RFC 8793	2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Cloud Networking: Understanding Cloud-based Data Centre Networks	Gary Lee	Morgan Kaufman	1/e, 2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106243/

SEMESTER S7

RESPONSIBLE ARTIFICIAL INTELLIGENCE

Course Code	**PECST752**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To impart the ideas of fairness, accountability, bias, and privacy as fundamental aspects of responsible AI.
2. To teach the principles of interpretability techniques including simplification, visualization, intrinsic interpretable methods, and post hoc interpretability for AI models.
3. To give the learner understanding of the ethical principles guiding AI development, along with privacy concerns and security challenges associated with AI deployment.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Foundations of Responsible AI :-** Introduction to Responsible AI- Overview of AI and its societal impact; Fairness and Bias - Sources of Biases, Exploratory data analysis, limitation of a dataset, Preprocessing, inprocessing and postprocessing to remove bias.	7
2	**Interpretability and explainability:-** Interpretability - Interpretability through simplification and visualization, Intrinsic interpretable methods, Post Hoc interpretability, Explainability through causality, Model agnostic Interpretation. Interpretability Tools - SHAP (SHapley Additive exPlanation), LIME(Local Interpretable Model-agnostic Explanations)	10
3	**Ethics, Privacy and Security :-** Ethics and Accountability -Auditing AI models, fairness assessment, Principles for ethical practices.	10

	Privacy preservation - Attack models, Privacy-preserving Learning, Differential privacy- Working, The Laplace Mechanism, Introduction to Federated learning. Security - Security in AI Systems, Strategies for securing AI systems and protecting against adversarial attacks	
4	**Future of Responsible AI and Case Studies : -** Future of Responsible AI - Emerging trends and technologies in AI ethics and responsibility. Case Studies - Recommendation systems, Medical diagnosis, Computer Vision, Natural Language Processing.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify and describe key aspects of responsible AI such as fairness, accountability, bias, and privacy.	**K2**
CO2	Describe AI models for fairness and ethical integrity.	**K2**
CO3	Understand interpretability techniques such as simplification, visualization, intrinsic interpretable methods, and post hoc interpretability.	**K2**
CO4	Comprehend the ethical principles, privacy concerns, and security challenges involved in AI development and deployment.	**K3**
CO5	Understand responsible AI solutions for practical applications, balancing ethical considerations with model performance.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way	Virginia Dignum	Springer Nature	1/e, 2019
2	Interpretable Machine Learning	Christoph Molnar	Lulu	1/e, 2020

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

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/3-xhMXeYIcg?si=x8PXrnk0TabaWxQV
2	https://youtu.be/sURHNhBMnFo?si=Uj0iellJs3oLOmDL [SHAP and LIME] https://c3.ai/glossary/data-science/lime-local-interpretable-model-agnostic-explanations/ https://shap.readthedocs.io/en/latest/ https://www.kaggle.com/code/bextuychiev/model-explainability-with-shap-only-guide-u-need
3	https://www.youtube.com/live/DA7ldX6OIG4?si=Dk4nW1R1zi_UMG_4
4	https://youtu.be/XlYhKwRLerc?si=IeU7C0BLhwn9Pvmi Case Studies https://www.kaggle.com/code/teesoong/explainable-ai-on-a-nlp-lstm-model-with-lime https://www.kaggle.com/code/victorcampelo/using-lime-to-explaining-the-preditions-from-ml

SEMESTER S7

COMPUTATIONAL LINGUISTICS

Course Code	PECMT753	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	anaphora and discourse relations.Pragmatic Enrichment - Integrating context and world knowledge into computational models.	
4	**Natural Language Applications:-** Machine Translation, Sentiment analysis, Chatbots and dialogue systems, Text extraction and summarization. Natural language user interfaces - Text-based question answering, knowledge-based question answering, Voice-based web services and assistants.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Grasp the foundational concepts, scope, and linguistic subfields essential to computational linguistics.	**K2**
CO2	Examine and utilize linguistic theories and Chomsky's Hierarchy in computational language processing.	**K3**
CO3	Construct and assess models for syntactic and semantic tasks, addressing linguistic ambiguities.	**K3**
CO4	Design and develop NLP applications like machine translation, sentiment analysis, and chatbots using advanced techniques.	**K3**

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

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

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

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

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

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

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

SEMESTER S7

DIGITAL FORENSICS

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

Course Code	**PECST754**	**CIE Marks**	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To impart the fundamental knowledge on incident management and reporting.
2. To provide a good understanding on devices, operating systems, network and mobile forensics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Digital Forensics - Principles in Digital Forensics; Stages in Digital Forensics Investigation- Forensics Imaging & Cloning, Concept of Chain of Custody, Digital Evidence Handling at Crime Scene, Collection/Acquisition and Preservation of Digital Evidence, Processing & Analysis, Compilation of Findings & Reporting; Expansion of Stages in Digital Investigation. Types of Storage Media - Hard Disk Drives (HDD), Solid State Drives (SSD), USB Flash Drives, Optical Discs, Memory Cards, Cloud Storage, Drive Geometry, Cylinders, Heads, and Sectors, Logical Block Addressing (LBA); Expansion of Types of Storage Medium. Overview of File Systems - Introduction to File Systems, File Systems in Digital Forensics, FAT (File Allocation Table), Structure and Characteristics : FAT12, FAT16, FAT32, NTFS (New Technology File System), Structure and Characteristics, Master File Table (MFT), EXT (Extended File System), EXT2, EXT3, EXT4, Journaling in EXT3 and EXT4, HFS (Hierarchical File System), HFS and HFS+ Structure and Characteristics, Metadata and Attributes ***Tools suggested*** : Hex Viewer , FTK Imager , OS Forensics	**10**

2	Windows Forensics - OS Artefacts, Registry Analysis, Analysis of USB Connections, Event Logs, Applications, Slack Space, Overwritten Files, Data Recovery Techniques, Volatile and Non-Volatile Data, Hibernation file analysis, Pagefile analysis, prefetch files, thumbnails, Timestamps, File Signatures, File System Analysis Tools, Techniques for Recovering Deleted Files, File Carving; Memory Forensics - RAM dump and analysis; Linux and MAC Forensics; Anti Forensics Methods - Steganography, Encryption, Alternate Data Streams. ***Tools suggested*** : Hex Viewer, FTK Imager, Autopsy, RegRipper, Volatility, Dumpit	**9**
3	Mobile Forensics - Introduction to Mobile Forensics, Mobile Forensics Fundamentals, Understanding Mobile Device Storage, Android, iOS, Windows OS Artifacts, ADB (Android Debug Bridge), APK Files, Techniques for Acquiring Data from Mobile Devices, Rooting, Jailbreaking. Analysis of Application Files - Social Media Files, Understanding and Analyzing APK Files, Messages, Malware Analysis, Cloud Data in Mobile Forensics, Analyzing Backups and Cloud Data, Advanced Data Recovery Techniques (Bypassing Encryption, Password Cracking), Challenges in Mobile Forensics. ***Tools suggested*** : MobileCheck, BlueStacks(Android Emulator), SQLite Database viewer	**9**
4	Network Forensics - Introduction to Network Forensics, Overview of Network Architectures and Protocols, Capturing and Analyzing Network Traffic using Wireshark/Tcpdump, Log Analysis, Email and Web Forensics, Email Header Analysis; Endpoint Security systems - Intrusion Detection Systems, Firewall, Router Forensics, NAS, Proxy, VPN; Public Key Infrastructure Systems; Digital Signature - Concepts of Public Key and Private Key, Certification Authorities and Their Role, Creation and Authentication of Digital Signature. ***Tools Suggested :*** Wireshark , Apache Log Viewer	**8**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Perform forensics analysis of hard disk, Network, and mobile phones.	**K3**
CO2	Experiment with the network traffic dump.	**K3**
CO3	Examine the analyse logs of the systems and identify the anomalies.	**K3**
CO4	Plan an onsite triage in case of an incident.	**K3**

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

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

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

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Forensics and Incident Response	Gerard Johansen	Packt	2/e, 2020
2	Guide to Computer Forensics and Investigations	Bill Nelson, Amelia Phillips, Christopher Steuart	Cengage	6/e, 2020
3	Practical Mobile Forensics	Rohit Tamma, Oleg Skulkin , Heather Mahalik, Satish Bommisetty	Packt	4/e, 2020
4	Mobile Forensics - Advanced Investigative Strategies	Oleg Afonin, Vladimir Katalov	Packt	1/e, 2016
5	Network Forensics : Tracking Hackers Through Cyberspace	Sherri Davidoff, Jonathan Ham	Pearson	1/e, 2013
6	File system forensic analysis	Brian Carrier	Addison-Wesley	1/e, 2005
7	Windows Forensics: The Field Guide for Corporate Computer Investigations	Chad Steel	Wiley	1/e, 2006
8	Android Forensics: Investigation, Analysis and Mobile Security for Google Android	Andrew Hoog	Syngress	1/e, 2011

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
2	https://www.swgde.org/documents/published-by-committee/quality-standards/
3	https://csrc.nist.gov/pubs/sp/800/101/r1/final

SEMESTER S7

GAME THEORY AND MECHANISM DESIGN

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

Course Objectives:

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

SYLLABUS

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

4	Introduction to VCG mechanism, VCG in Combinatorial allocations, applications to Internet advertising, slot allocation and payments in position auctions, pros and cons of VCG mechanism; Affine maximizers, single object allocation, Myerson's lemma, optimal mechanism design; Single and multi-agent optimal mechanism design, examples of optimal mechanisms	**8**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Differentiate between different types of games Identify various equilibria within games	**K3**
CO2	Identify strategic interactions.	**K3**
CO3	Describe the basic concepts of non-cooperative and cooperative games.	**K2**
CO4	Apply the concepts in different game scenarios.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	An Introduction to Game Theory	Martin Osborne	Cambridge University Press	1/e, 2004
2	Game Theory and Mechanism Design	Y. Narahari	World Scientific and IISc Press	1/e, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Game Theory 101: The Complete Textbook	William Spaniel	Self	1/e,
2	Game Theory - An Introduction	Steven Tadelis	Princeton University Press	1/e, 2013

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/101/106101237/
2	https://www.masfoundations.org/

SEMESTER S7

HIGH PERFORMANCE COMPUTING

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

Course Code	**PECST757**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To Gain an understanding of the modern processor architectures.
2. To Give an introduction to parallel programming using OpenMP and MPI.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Modern processors:** Stored-program computer architecture- *General-purpose cache-based microprocessor architecture* - Performance metrics and benchmarks -Moore's Law - Pipelining - Super scalarity - SIMD - *Memory hierarchies* - Cache , Cache mapping, Prefetch, Multicore processors - Multithreaded processors - *Vector processors* - Design principles - Maximum performance estimates - Programming for vector architectures.	**9**
2	**Parallel computers** - Taxonomy of parallel computing paradigms - *Shared-memory computers* - Cache coherence - UMA, ccNUMA, Distributed-memory computers - Hierarchical (hybrid) systems - *Networks* - Basic performance characteristics of networks, Buses, Switched and fat-tree networks - Mesh networks - Hybrids.	**9**
3	**Shared-memory parallel programming with OpenMP**:- *Short introduction to OpenMP* - Parallel execution - Data scoping - OpenMP worksharing for loops - Synchronization, Reductions, Loop scheduling, Tasking,Miscellaneous, Case study: OpenMP-parallel Jacobi algorithm	**9**

4	**Distributed-memory parallel programming with MPI**:- Message passing - *A short introduction to MPI*, A simple example, Messages and point-to-point communication, Collective communication, Nonblocking point-to-point communication, Virtual topologies. *Example- MPI parallelization of a Jacobi solver* - MPI implementation - Performance properties.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe parallel computing architectures supported by modern processors.	**K2**
CO2	Classify parallel computing paradigms and network topologies.	**K2**
CO3	Implement shared-memory parallel programming with OpenMP.	**K3**
CO4	Design and implement parallel algorithms using distributed-memory parallel programming with MPI	**K3**

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

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

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

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

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Parallel and High-Performance Computing	Robert Robey Yuliana Zamora	Manning Publications	1/e, 2021
2	High-Performance Computing	Charles Severance Kevin Dowd	O'Reilly Media	2/e, 1998
3	Computer Architecture And Parallel Processing	Kai Hwang Faye Alaye Briggs	McGraw-Hill	1/e, 1984
4	Computer Architecture: A Quantitative Approach	John L. Hennessy David A. Patterson	Morgan Kaufman	6/e, 2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/106108055
2	https://nptel.ac.in/courses/106108055
3	https://nptel.ac.in/courses/106108055
4	https://nptel.ac.in/courses/128106014

SEMESTER S7

PROGRAMMING LANGUAGES

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

Course Code	**PECST758**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To enable the students understand various constructs and their respective comparisons in different high-level languages so that he can choose a suitable programming language for solving a particular problem
2. To develop the student's ability to understand the salient features and paradigms in the landscape of programming languages.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - The Origins of Programming Languages, Abstractions in Programming Languages, Computational Paradigms, Language Definition, Language Translation, The Future of Programming Languages; Language Design Criteria - Historical Overview, Efficiency, Regularity, Security, Extensibility, C++: An Object-Oriented Extension of C, Python: A General-Purpose Scripting Language; Syntax and Analysis Parsing: Lexical Structure of Programming Languages, Context-Free Grammars and BNFs, Parse Trees and Abstract Syntax Trees, Ambiguity, Associativity, and Precedence, EBNFs and Syntax Diagrams, Parsing Techniques and Tools, Lexics vs. Syntax vs. Semantics, Case Study: Building a Syntax Analyzer for TinyAda;	9
2	Basic Semantics- Attributes, Binding, and Semantic Functions, Declarations, Blocks, and Scope, The Symbol Table, Name Resolution and Overloading, Allocation, Lifetimes, and the Environment, Variables and Constants, Aliases, Dangling References, and Garbage, Case Study: Initial Static Semantic Analysis of TinyAda. Data Types - Data Types and Type Information, Simple Types, Type Constructors, Type Nomenclature in Sample Languages, Type Equivalence,	9

	Type Checking, Type Conversion, Polymorphic Type Checking, Explicit Polymorphism, Case Study: Type Checking in TinyAda.	
3	Expressions and Statements - Expressions, Conditional Statements and Guards, Loops and Variations on WHILE, The GOTO Controversy and Loop Exits, Exception Handling, Case Study: Computing the Values of Static Expressions in TinyAda. Procedures and Environments- Procedure Definition and Activation, Procedure Semantics, Parameter-Passing Mechanisms, Procedure Environments, Activations, and Allocation, Dynamic Memory Management, Exception Handling and Environments, Case Study: Processing Parameter Modes in TinyAda.	9
4	Abstract Data Types and Modules- The Algebraic Specification of Abstract Data Types, Abstract Data Type Mechanisms and Modules, Separate Compilation in C, C++ Namespaces, and Java Packages, Ada Packages, Modules in ML, Modules in Earlier Languages, Problems with Abstract Data Type Mechanisms, The Mathematics of Abstract Data Types.	9

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the history of programming languages and introduce abstraction, the concept of different language paradigms, and an overview of language design criteria.	**K1**
CO2	Describe how the syntactic structure of a language can be precisely specified using context-free grammar rules in Backus-Naur form (BNF).	**K2**
CO3	Explain the abstractions of the operations that occur during the translation and execution of programs.	**K2**
CO4	Apply the data types in various languages	**K3**
CO5	Apply procedure activation and parameter passing; and exceptions and exception handling.	**K4**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programming languages: principles and practices.	Kenneth C Louden	Cengage Learning	3/e, 2011
2	Concepts of programming languages.	Sebesta R W.	Pearson	12/e, 2023
3	Programming languages: concepts and constructs.	Sethi R	Pearson	2/e, 2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Programming Languages: Principles and Paradigms	Allen Tucker, Robert Noonan	McGraw-Hill	2/e, 2017
2	Principles of programming languages.	Gilles Dowek.	Springer	1/e, 2009.
3	Principles of Programming Languages	Rajiv Chopra	Wiley	1/e, 2019

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

SEMESTER S7

PARALLEL ALGORITHMS

(Common to CS/CM/CD/AM)

Course Code	**PECST759**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST303 PCCST502	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

	Parallel Search Algorithms - Parallel search algorithms: parallel binary search, parallel search trees, Applications and analysis.	
4	Parallel Programming with OpenMP - Introduction to OpenMP, Parallel programming constructs in OpenMP, Performance tuning and optimization Parallel Programming with MPI - Introduction to MPI, Message passing model and MPI basics, Advanced MPI features and applications Parallel Numerical Algorithms - Solving linear systems: parallel Gaussian elimination, parallel LU decomposition, Parallel algorithms for eigenvalue problems, Applications and analysis.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and articulate the fundamental principles and architectures of parallel computing.	**K2**
CO2	Implement and evaluate parallel algorithms for basic operations such as sorting and searching.	**K3**
CO3	Develop and analyze parallel algorithms for complex problems, including graph and numerical algorithms.	**K3**
CO4	Apply parallel programming techniques to real-world problems and assess the efficiency and performance of parallel solutions.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Parallel Computing	Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar	Addison-Wesley	2/e, 2003
2	Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers	Barry Wilkinson and Michael Allen	Pearson India	2/e, 2006
3	An Introduction to Parallel Algorithms	Joseph Jaja	Addison-Wesley Professional	1/e, 1992
4	Parallel Algorithms	Henri Casanova, Arnaud Legrand, Yves Robert	Chapman and Hall/CRC	1/e, 2020
5	Parallel Scientific Computing in C++ and MPI	George Em Karniadakis and Robert M. Kirby II	Cambridge University Press	1/e, 2003

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

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

SEMESTER S7

TIME SERIES MODELLING

Course Code	PEADT755	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 help the students in understanding the usability of time series data and its analysis and time series models that can be used in different time series models that can be used in scientific/business application.

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation (Evaluate and Analyse): 20 marks

Assess the students with questions of the following nature

Time Series Decomposition:

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

ACF and PACF Analysis:

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

Model Selection for Forecasting:

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

Dynamic Regression Models:

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain different types of forecasting, fundamental principles of time series data, analyse various time series processes and gain proficiency in preparing and wrangling time series data.	**K3**
CO2	Apply and interpret a variety of time series models and determine the most suitable model for various types of time series data.	**K4**
CO3	Apply exponential smoothing methods for forecasting and analyse time series patterns.	**K3**
CO4	Implement dynamic regression models and develop proficiency in advanced forecasting methods.	**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						3	3
CO2	3	3	3	3	3						3	3
CO3	3	3	3	3	3						3	3
CO4	3	3	3	3	3						3	3

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

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Time series Analysis and its Applications.	Shumway, R. H and Stoffer	Springer	1/e, 2006
2	Time Series Analysis and Its Applications: With R Examples	Robert H. Shumway and David S. Stoffer	Springer	4/e, 2017
3	Time Series Analysis: Forecasting and Control	George E. P. Box, Gwilym M. Jenkins, and Gregory C. Reinsel	Wiley	5/e, 2015
4	Applied Time Series Analysis	Wayne A. Woodward, Henry L. Gray, and Alan C. Elliott	CRC Press	7/e, 2017

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

SEMESTER S7

TOPICS IN THEORETICAL COMPUTER SCIENCE

Course Code	**PECST795**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST303 PCCST502	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

	correcting errors. Evaluate the BER, code rate, and error correction capability by comparing the number of errors corrected versus the total number of errors introduced.	
4	LP- and SDP-based Approximation Algorithms for NP-Hard Problems - Linear Programming (LP) Relaxations and their Use in Approximation: Vertex Cover and Set Cover, Semidefinite Programming (SDP) and its Applications: Max-Cut Problem. **Assignments:** 1. Implement and evaluate LP relaxations for vertex cover and set cover problems (use Erdős-Rényi Graphs). Compare the results with exact solutions and analyze the quality of the approximations. 2. Develop and test approximation algorithms for Max-cut problem using SDP relaxations. Assess the performance and efficiency of your algorithms on various datasets. To assess the performance and efficiency of the SDP-based Max-Cut approximation, test the algorithm on various types of graphs, including: Erdős-Rényi Graphs, Barabási-Albert Graphs, and Real-world Graphs. Compare the cut values obtained from the SDP relaxation and rounding with known or exact solutions if available. For large graphs, use heuristics or bounds for comparison. Measure the time taken to solve the SDP relaxation and perform the rounding. This includes the time for solving the SDP problem and the time for eigen-decomposition.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Assignment evaluation pattern:

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and explain fundamental concepts of Spectral Graph Theory, including Laplacian matrices and their applications.	**K2**
CO2	Apply spectral clustering techniques to real-world data and evaluate clustering performance using appropriate metrics.	**K5**
CO3	Construct and analyze expander graphs, and assess their applications in network design and error-correcting codes.	**K4**
CO4	Develop and implement LP- and SDP-based approximation algorithms for solving NP-Hard problems, and compare their performance.	**K5**
CO5	Demonstrate the ability to solve complex theoretical problems using advanced algorithms and techniques covered in the course.	**K4**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Spectral Graph Theory (CBMS Regional Conference Series)	Fan R. K. Chung	American Mathematical Society	1/e, 1997
2	Algebraic Graph Theory	Norman Biggs	Cambridge India	2/e, 2016
3	Approximation Algorithms	Vijay V. Vazirani	Springer Nature	2/e, 2013
4	Convex Optimization	Stephen Boyd, Lieven Vandenberghe	Cambridge University Press	1/e, 2004

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

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

SEMESTER S7

CYBER SECURITY

Course Code	**OECST721**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	**Course Type**	Theory

Course Objectives:

1. To teach the basic attacks, threats and vulnerabilities related to cyber security
2. To make the learner aware of cyber crimes and cyber laws
3. To give concepts of the malwares and its protection mechanisms in systems and mobile devices

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Cyber Security :-** Basic Cyber Security Concepts, Layers of Security, Vulnerability, Threats, Computer Criminals, CIA Triad, Motive of Attackers, Active attacks, Passive attacks, Software attacks, Hardware attacks, Cyber Threats and its Classifications- Malware, Social Engineering, DoS/DDoS, Insider Threats, Advanced Persistent Threats (APTs), Data Breaches and Information Theft.	9
2	**Cybercrime and CyberLaw :-** Cybercrime, Classification of Cybercrimes, The legal perspectives- Indian perspective, Global perspective, Categories of Cybercrime. Fundamentals of cyber law, Outline of legislative framework for cyber Law, History and emergence of cyber law, Outreach and impact of cyber law, Major amendments in various statutes.	9
3	**Malwares and Protection against Malwares :-** Virus, Worms, Trojans, Spyware, Adware, Key-logger, Ransomware, Common Methods of Malware Propagation- Email Attachments, Malicious Websites, Removable Media, File Sharing Networks, Malvertising, Protection against Malware- Antivirus/Antimalware Software, Regular Software Updates, Email Filtering, Web Filtering, Data Backup and Recovery, Strong Passwords and Multi-Factor Authentication (MFA).	9

4	**Mobile App Security :-** Security Implications of Mobile Apps, Mobile App Permission Management and Best Practices, Risks of Location-Based Social Networks, Data Security on Mobile Devices- Importance of Data Security on Mobile Devices to Protect Sensitive Information, Risks of Unencrypted Data Storage and Communication on Mobile Platforms, Benefits of Device Encryption, Secure Messaging Apps, and Encrypted Storage Solutions.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the attacks, security mechanisms and services to user information	**K2**
CO2	Identify the cybercrimes and discuss the cyber laws against the crimes	**K2**
CO3	Discuss the malwares and the protection mechanisms against malwares	**K3**
CO4	Describe the issues and solutions related with mobile applications	**K2**

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

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

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

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computer Security: Principles and Practices	William Stallings	Pearson	5/e, 2011
2	Cyber Security- Understanding Cyber Crimes, Computer Forensics and Legal Perspectives	Nina Godbole, Sunit Belapure	Wiley	1/e, 2011
3	Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives	B.B.Gupta, D.P Agrawal, Haoxiang Wang.	CRC Press	1/e, 2018
4	Cyber Security Essentials	James Graham, Richard Howard, Ryan Otson	Auerbach	1/e, 2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/111/101/111101137/ https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044 https://www.coursera.org/learn/data-security-privacy#modules https://nptel.ac.in/courses/106105217 https://archive.nptel.ac.in/courses/106/106/106106156/
2	
3	
4	

SEMESTER S7

CLOUD COMPUTING

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

Course Objectives:

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

SYLLABUS

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

CO3	2	2	2	2								2
CO4	2	2	2	2								2

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

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

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

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

SEMESTER S7

SOFTWARE ENGINEERING

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

	Reusable Object Oriented Software	Helm, Ralph Johnson,John Vlissides	Addison-Wesley	

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 https://archive.nptel.ac.in/courses/106/105/106105182/
3	http://digimat.in/nptel/courses/video/106105150/L01.html
4	

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:-	**9**

	Logical Addressing- IPv4 and IPv6 Addresses; Internet Protocol- IPV4 and IPv6; Unicast Routing Protocols- Distance Vector Routing, Link State Routing Multicast Routing Protocols.	
4	Transport Layer:- Transport Layer Protocols- UDP, TCP; Congestion Control- Open Loop Vs Closed Loop Congestion Control, Congestion Control in TCP; Application Layer - Application Layer Paradigms, Client-server applications, World Wide Web and HTTP, FTP. Electronic Mail, DNS; Peer-to-peer paradigm - P2P Networks.	**8**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)
In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Comprehend the OSI and TCP/IP models, the functioning of different network layers, and the protocol stack used in computer networks.	**K2**
CO2	Evaluate various transmission media (copper, fiber, wireless), error detection/correction methods, and medium access control mechanisms in both wired and wireless LANs.	**K2**

CO3	Demonstrate a working knowledge of IPv4 and IPv6 addressing schemes, routing protocols (unicast and multicast), and apply them to network scenarios.	**K3**
CO4	Summarize UDP and TCP protocols, explain congestion control mechanisms, and understand client-server and peer-to-peer applications like HTTP, FTP, DNS, and P2P networks.	**K3**

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

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

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

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

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

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

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

SEMESTER S7

MOBILE APPLICATION DEVELOPMENT

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

Course Code	**OECST725**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	0	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST204 OR OECST615	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the basics of mobile application development and different mobile platforms and the environment setup.	**K2**
CO2	Apply principles of effective mobile UI/UX design, develop responsive user interfaces using Flutter widgets.	**K3**
CO3	Experiment effectively with state in Flutter applications. networking and data persistence in Flutter apps.	**K3**
CO4	Apply security best practices in mobile app development and debug Flutter applications effectively.	**K3**

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

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

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

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

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

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Flutter in Action	Eric Windmill	Manning	1/e, 2019
2	Flutter and Dart: Up and Running	Deepti Chopra, Roopal Khurana	BPB	1/e, 2023

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

SEMESTER 8

ARTIFICIAL INTELLIGENCE &

MACHINE LEARNING

SEMESTER S8

SOFTWARE ARCHITECTURES

Course Code	**PECST861**	**CIE Marks**	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To develop a comprehensive understanding of software architecture principles and patterns.
2. To provide the ability to design and analyze software architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Software Architecture:** Definition and Importance, Architecture in the Life Cycle, Role of the Architect vs. Engineer, Requirements engineering: Stakeholders, Concerns, and Types of Requirements, Use Cases and Tactics.	**8**
2	**Architectural Patterns and Styles:** Architectural Patterns- Overview of Patterns and Styles, Applying Patterns and Choosing a Style. Patterns for Enterprise Applications: Enterprise Applications and Layered Patterns, Concurrency Problems.	**8**
3	**Components, Contracts, and Service-Oriented Architectures:** Component Software- Nature of Components and Reuse, UML and Components Design by Contract- Contracts, Polymorphism, Inheritance, and Delegation Service-Oriented Architectures- Standards, Technologies, and Security.	**9**
4	**Architecture Evaluation and Description:** Describing Architectures and Viewpoints, Evaluating Architectures. Architectural Description Languages (ADLs)- Overview and Applications.	**7**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the foundational concepts of software architecture, including the roles of stakeholders and the importance of requirements engineering.	**K2**
CO2	Apply architectural patterns and styles to design software systems, particularly in enterprise contexts.	**K3**
CO3	Understand the principles of component-based software design and the use of contracts in ensuring reliable software systems.	**K2**
CO4	Apply architectural description techniques to document and evaluate software architectures.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Software Architecture	A.Bijlsma, B.J.Heeren, E.E.Roubtsova,S. Stuurman	Free Technology Academy	1/e, 2011
2	Software Architecture 1	Mourad Chabane Oussalah	Wiley	1/e, 2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Head First Software Architecture: A Learner's Guide to Architectural Thinking	Raju Gandhi, Mark Richards, Neal Ford	Oreilly	1/e, 2024

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://www.youtube.com/playlist?list=PL4JxLacgYgqTgS8qQPC17fM-NWMTr5GW6

SEMESTER S8

LARGE LANGUAGE MODELS

Course Code	**PECMT862**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCCMT503, PCCMT602	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

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

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER 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	**10**

	Learning Security Requirements of Databases, Reliability and Integrity of Databases, Database Disclosure	
4	**Security policies and models**: Confidentiality Policies, Bell- LaPadula model, Integrity policies, Biba model, Clark-Wilson models, Chinese wall model, waterfall model. **Management and Incidents**- Security Planning, Business Continuity Planning, Handling Incidents, Risk Analysis, Dealing with Disaster	**8**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the fundamentals of threat management, web security and privacy	**K2**
CO2	Identify the significance of network security and IDS	**K2**
CO3	Apply machine learning algorithms for database security	**K3**
CO4	Explain the policies and models for data integrity along with managements and incidents associated with data	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Security in Computing	Charles P. Pfleeger, Shari Lawrence Pfleeger Jonathan Margulies	Pearson	5/e, 2015
2	Data mining and machine learning in cybersecurity	Dua, Sumeet, Xian Du	Auerbach Publications	1/e, 2011
3	Machine learning and security: Protecting systems with data and algorithms.	Chio, Clarence, David Freeman	O'Reilly	1/e, 2018
4	Network Security and Cryptography	Bernard Menezes	Cengage Learning	1/e, 2010
5	Computer Security: Art and Science	M Bishop	Addison - Wesley	2/e, 2019

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

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

SEMESTER S8

COMPUTATIONAL COMPLEXITY

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

Course Code	**PECST864**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST302, PCCST502	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Complexity Theory - Basic concepts and motivations, Deterministic and nondeterministic models, Turing machines, and computational models. (Text 2 - Ch 7) Complexity Classes P and NP - Definitions and examples of P and NP, Polynomial-time algorithms, NP-completeness and the Cook-Levin theorem. (Text 2 - Ch 7, 8) Reductions and Completeness - Polynomial-time reductions, NP-complete problems, and their significance, Examples of NP-complete problems (Text 1 - Ch 2)	**9**
2	Space Complexity - Space complexity classes: L, NL, PSPACE, Savitch's theorem and NL-completeness, PSPACE-completeness. (Text 2 - Ch 8)	**9**

	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)	
3	Interactive Proofs - Definition and examples of interactive proofs, IP = PSPACE theorem, Zero-knowledge proofs. (Text 1 - Ch 8) Probabilistically Checkable Proofs (PCPs) - Introduction to PCPs, PCP theorem and implications, Applications in hardness of approximation. (Text 1 - Ch 9)	**9**
4	Circuit Complexity - Boolean circuits and circuit complexity, Circuit lower bounds, Complexity of specific functions. (Text 2 - Ch 9) Quantum Complexity - Basics of quantum computation, Quantum complexity classes: BQP, QMA, Quantum algorithms and their complexity. (Text 3 - Ch 10, 11)	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe and interpret different computational models, including deterministic and nondeterministic Turing machines.	**K2**
CO2	Recall and categorize complexity classes such as P, NP, and PSPACE, and explain their fundamental properties.	**K2**
CO3	Use polynomial-time reductions to demonstrate problem completeness and analyze the computational difficulty of problems.	**K3**
CO4	Evaluate problems based on their space complexity and apply theories like Savitch's theorem to assess space-bounded algorithms.	**K4**
CO5	Examine advanced topics in complexity theory, including interactive proofs, PCPs, and quantum complexity, and their implications for computational theory.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computational Complexity: A Modern Approach	Sanjeev Arora, Boaz Barak	Cambridge University Press	1/e, 2019
2	Introduction to the Theory of Computation	Michael Sipser	Cengage	3/e, 2014
3	Quantum Computing: A Gentle Introduction	Eleanor Rieffel, Wolfgang Polak	MIT Press	1/e, 2014

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

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

SEMESTER S8

SPEECH AND AUDIO PROCESSING

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

Course Code	**PECST866**	**CIE Marks**	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PECST636	**Course Type**	Theory

Course Objectives:

1. To get familiarised with speech processing and audio processing concepts.
2. To equip the student to apply speech processing techniques in finding solutions to day-to-day problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Speech Production :- Acoustic theory of speech production; Source/Filter model - Pitch, Formant; Spectrogram- Wide and narrow band spectrogram; Discrete model for speech production; Short-Time Speech Analysis; Windowing; STFT; Time domain parameters (Short time energy, short time zero crossing Rate, ACF); Frequency domain parameters - Filter bank analysis; STFT Analysis.	**9**
2	Mel-frequency cepstral coefficient (MFCC)- Computation; Pitch Estimation ACF/AMDF approaches; Cepstral analysis - Pitch and Formant estimation using cepstral analysis; *LPC Analysis* - LPC model; Auto correlation method - Levinson Durbin Algorithm	**9**
3	Speech Enhancement :- Spectral subtraction and Filtering, Harmonic filtering, Parametric resynthesis; Speech coding - fundamentals, class of coders : Time domain/spectral domain/vocoders, Sub band coding, adaptive transform coding, phase vocoder; Speaker Recognition :- Speaker	**9**

	verification and speaker identification, log-likelihood; Language identification - Implicit and explicit models; Machine learning models in Speaker Recognition.	
4	Signal Processing models of audio perception - Basic anatomy of hearing System, Basilar membrane behaviour; Sound perception - Auditory Filter Banks, Critical Band Structure, Absolute Threshold of Hearing; Masking - Simultaneous Masking, Temporal Masking; Models of speech perception.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To recall various steps in the speech production process	**K2**
CO2	To summarise various speech processing approaches	**K2**
CO3	To develop speech-processing applications in various domains	**K3**
CO4	To analyse the speech processing model for audio perception	**K4**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Speech Communications: Human & Machine	Douglas O'Shaughnessy	IEEE Press	2/e, 1999
2	Discrete-Time Speech Signal Processing: Principles and Practice	Thomas F. Quatieri	Prentice Hall	1/e, 2001
3	Fundamentals of Speech Recognition	Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana	Pearson	1/e, 2008

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

Video Links (NPTEL, SWAYAM…)	
No.	**Link ID**
1	https://youtu.be/Xjzm7S__kBU?si=j11bk3F7gocYjhfg

SEMESTER S8

STORAGE SYSTEMS

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

Course Code	**PECST867**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To provide a comprehensive understanding of storage technologies and architectures.
2. To empower students to design and implement effective storage solutions.

SYLLABUS

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

	Replication, Backup Methods- Hot Backups, Offline Backups, LAN-Based Backups, LAN-Free Backups (SAN Based), Serverless Backups, NDMP, Backup Types- Full Backups, Incremental Backups, Differential Backups , Synthetic Full Backups, Application-Aware Backups	
4	**Storage Management:-** Capacity Management- Capacity Reporting, Thin Provisioning Considerations, Deduplication and Compression, Quotas and Archiving, Showback and Chargeback, Performance Management- Latency/Response Time, IOPS,MBps and Transfer Rate, Factors Affecting Storage Performance Management Protocols and Interfaces.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe emerging storage technologies.	**K2**
CO2	Compare and contrast different storage networking technologies.	**K2**
CO3	Understand the importance of business continuity.	**K2**
CO4	Develop a comprehensive backup and recovery strategy	**K3**
CO5	Utilize management tools and best practices to monitor, optimize, and secure storage resources, ensuring optimal performance and data integrity.	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Storage Networking	Nigel Poulton	WILEY	2/e, 2015
2	Computer Storage Fundamentals	Susanta Dutta	BPB Publication	1/e, 2018

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

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

SEMESTER S8

PROMPT ENGINEERING

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

Course Code	PECST868	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

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

SYLLABUS

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

	Techniques: Prompt Chaining, Iterative Prompting. ***Handson :*** Crafting and optimizing prompts for specific tasks (e.g., text generation, summarization, Q&A); Using prompt engineering to fine-tune pre-trained models on specific datasets or tasks.	
3	**Applications of Prompt Engineering :-** Prompt Engineering in Chatbots and Conversational AI; Content Generation: Creative Writing, Code Generation, and Data Augmentation; Prompt Engineering for Sentiment Analysis, Classification, and Translation; Integration of Prompt Engineering with Other AI Technologies (e.g., Computer Vision, Data Science); Real-World Case Studies and Industry Applications ***Handson :*** Developing a simple chatbot using prompt engineering techniques, Case study analysis and reproduction of real-world prompt engineering applications	**9**
4	**Challenges, Future Trends, and Research in Prompt Engineering :-** Challenges in Prompt Engineering: Ambiguity, Bias, and Misinterpretation; Evaluating and Improving Prompt Performance: Metrics and Benchmarks; Future Trends: Emerging Techniques and the Evolution of Language Models; ***Handson :*** Working on a capstone project to solve a real-world problem using prompt engineering	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the core principles of NLP, language models, and the role of prompts in influencing AI behavior.	**K2**
CO2	Demonstrate the ability to design and fine-tune prompts for specific tasks, optimizing language models for desired outputs	**K3**
CO3	Apply prompt engineering techniques to develop functional AI applications, such as chatbots, content generation tools, and automated systems.	**K3**
CO4	Compare the ethical implications of prompt engineering, addressing challenges such as bias, ambiguity, and misuse, and propose solutions to mitigate these issues.	**K3**
CO5	Apply prompt engineering techniques to a variety of assigned tasks	**K3**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Speech and Language Processing	Daniel Jurafsky and James H. Martin	Pearson	2/e, 2013
2	Unlocking the Secrets of Prompt Engineering	Gilbert Mizrahi	Packt	1/e, 2023
3	Prompt Engineering	Ian Khan	Wiley	1/e, 2024

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

SEMESTER S8

COMPUTATIONAL NUMBER THEORY

(Common to CS/CM)

Course Code	**PECST869**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST205 PCCST303 PCCST502	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

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

3	Public Key Cryptography - RSA algorithm and its implementation, Security aspects and cryptanalysis; Elliptic Curve Cryptography - Basics of elliptic curves, Elliptic curve cryptosystems; Cryptographic Protocols - Key exchange protocols, Digital signatures and authentication	**9**
4	Algebraic Number Theory - Algebraic integers and number fields, Factorization in number fields; Computational Methods - Algorithms for solving Diophantine equations, Applications in computational algebra; Recent Developments and Applications - Applications in modern cryptography and coding theory	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand basic number theory concepts and algorithms.	**K2**
CO2	Apply factorization algorithms to solve computational problems.	**K3**
CO3	Analyze and evaluate cryptographic systems based on number theory.	**K4**
CO4	Synthesize algebraic number theory concepts into computational methods.	**K4**
CO5	Create and present a project on recent advances and applications in computational number theory.	**K4**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A Computational Introduction to Number Theory and Algebra	Victor Shoup	Cambridge University Press	2/e, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Computational Number Theory and Modern Cryptography	Song Y. Yan	John Wiley & Sons	1/e, 2013
2	A course in computational algebraic number theory	Henri Cohen	Springer-Verlag	4/e, 2000
3	Computational Number Theory	Abhijit Das	CRC	1/e, 2013
4	Modern Computer Algebra	Joachim von zur Gathen and Jürgen Gerhard	Cambridge University Press	4/e, 2013
5	An Introduction to the Theory of Numbers	G. H. Hardy, Edward M. Wright, Roger Heath- Brown and Joseph Silverman	Oxford University Press	6/e, 2008

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

SEMESTER S8

NEXT GENERATION INTERACTION DESIGN

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

Course Code	**PECST865**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Interaction Design and AR/VR :-** Fundamentals of Interaction Design - Principles of interaction design, Human-computer interaction (HCI) basics, User experience (UX) design principles; Introduction to AR and VR - Overview of AR and VR technologies (Key differences and Application), Overview of AR/VR hardware (headsets, controllers, sensors), Software tools and platforms for AR/VR development.	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,	11

	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; Microinteraction; Motion capture and tracking technologies; Natural Language Interaction and conversational interfaces; Type of IoT sensors and uses.	
4	**Implementation, Evaluation, and Future Trends :-** Developing AR/VR Projects - Project planning and management, Collaborative design and development, Case studies of successful AR/VR projects; Evaluating AR/VR Experiences - Evaluation methods and metrics, Analyzing user feedback, Refining and improving AR/VR applications; Future Trends and Ethical Considerations- Emerging technologies in AR/VR, Ethical implications of AR/VR, Future directions in interaction design for AR/VR.	**9**

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

Continuous Internal Evaluation Marks (CIE):

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

Criteria for Evaluation(Evaluate and Analyse): 20 marks

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

End Semester Examination Marks (ESE):

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

SEMESTER S8

INTRODUCTION TO ALGORITHM

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

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

Course Objectives:

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

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Algorithm Analysis Time and Space Complexity- Asymptotic notation, Elementary operations and Computation of Time Complexity-Best, worst and Average Case Complexities- Complexity Calculation of simple algorithms Recurrence Equations: Solution of Recurrence Equations – Iteration Method and Recursion Tree Methods	9
2	Trees - Binary Trees – level and height of the tree, complete-binary tree representation using array, tree traversals (Recursive and non-recursive), applications. Binary search tree – creation, insertion and deletion and search operations, applications; Graphs – representation of graphs, BFS and DFS (analysis not required), Topological Sorting.	9

	Divide and Conquer - Control Abstraction, Finding Maximum and Minimum, Costs associated element comparisons and index comparisons, Binary Search, Quick Sort, Merge Sort - Refinements; Greedy Strategy - Control Abstraction, Fractional Knapsack Problem, Minimum Cost Spanning Trees – PRIM's Algorithm, Kruskal's Algorithm, Single Source Shortest Path Algorithm - Dijkstra's Algorithm.	**9**
4	Dynamic Programming - The Control Abstraction- The Optimality Principle - 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.	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S8

WEB PROGRAMMING

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

Course Objectives:

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

SYLLABUS

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

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

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S8

SOFTWARE TESTING

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

Course Objectives:

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

SYLLABUS

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

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

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

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

Video Links (NPTEL, SWAYAM…)

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

SEMESTER S8

INTERNET OF THINGS

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

Course Objectives:

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

SYLLABUS

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

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

SEMESTER S8

COMPUTER GRAPHICS

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

Course Objective:

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

SYLLABUS

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

	algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm.	

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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

End Semester Examination Marks (ESE)

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

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

Course Outcomes (COs)

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

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

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

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

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

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

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

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

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