# SEMESTER 7

## COMPUTER SCIENCE AND ENGINEERING

## SEMESTER S7

# FORMAL METHODS IN SOFTWARE ENGINEERING

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

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

**Course Objectives:**

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

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction :-**<br>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 :-**<br>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 :-**<br>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:-**<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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 **Asynchronous JavaScript and XML -** AJAX : Making Asynchronous | **9** |

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

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

**Continuous Internal Evaluation Marks (CIE):**

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

**End Semester Examination Marks (ESE)**

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

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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)**<br>Genes, DNAs, RNAs, Proteins, Genomics, Sequencing techniques, Bioinformatics overview and scope<br>**Sequence Alignment (6 hours)**<br>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)**<br>Genomic and Sequence Data Formats, GenBank, EMBL-Bank, and DDBJ, PROSITE, NCBI- Database Searching: BLAST, FASTA<br>**Phylogenetics (6 hours)**<br>Phylogenetic Tree basics and Construction Methods, UPGMA, Neighbour joining, Parsimonous trees, Additive trees, Bootstrapping | 9 |
| 3 | **Combinatorial Pattern Matching (9 hours)**<br>Combinatorial Pattern Matching, Repeat finding, Keyword Trees, Suffix Trees, Heuristic similarity search algorithms, Approximate Pattern Matching | 9 |

| | | |
|---|---|---|
| **4** | **R FOR BIOINFORMATICS**<br>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.)<br>**Indicative Laboratory/Microproject Tasks**<br>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.<br>● Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | ● Each question carries 9 marks.<br>● Two questions will be given from each module, out of which 1 question should be answered.<br>● Each question can have a maximum of 3 sub divisions.<br>**(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;<br>Access Control Mechanisms - Access Control, Access control matrix, Access control in OS-Discretionary and Mandatory access control, Role-based access control. | **9** |
| **2** | Software Vulnerabilities - Buffer and Stack Overflow, Cross-site Scripting (XSS) and vulnerabilities, SQL Injection and vulnerabilities, Phishing; Malwares - Viruses, Worms and Trjans, Topological worms, Trapdoors, Salami attack, Man-in-the-middle attacks, Covert channels. | **9** |
| **3** | Introduction to security of information storage - Processing, and Transmission. Information Security Management - The ISO Standards relating to Information Security - Other Information Security Management Frameworks - Security Policies - Security Controls - The Risk Management Process - Regulations and legal frameworks; Authentication - User Authentication, Token Based, Biometric Authentication, Remote User Authentication, Multifactor Authentication. | **9** |
| **4** | Security in Networks - Threats in networks, Network Security Controls - | **9** |

| | | |
|---|---|---|
| | Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP, S/MIME. | |

## 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.<br>● Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | ● Each question carries 9 marks.<br>● Two questions will be given from each module, out of which 1 question should be answered.<br>● Each question can have a maximum of 3 subdivisions.<br>**(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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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**<br>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**<br>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.<br>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**<br>Bitcoin: Components, Nodes in Bitcoin network, Transactions and memory | 10 |

| | | |
|---|---|---|
| | pools, Proof of Work-Mining Cryptocurrencies, Hard and Soft Forks, Tracking Bitcoins-Unspent Transaction Outputs.<br>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 :-**<br>Solidity Language - Remix IDE, Structure of a Smart Contract Program, Modifiers, Events, Functions, Inheritance, External Libraries, Error Handling.<br>Permissioned Blockchains, Introduction to Hyperledger Foundation, Hyperledger Distributed Ledger frameworks, Hyperledger Fabric.<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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)<br>Greedy Algorithms - Introduction to greedy algorithms, Set cover problem, Vertex cover problem. (Chapter 2)<br>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)<br>Rounding Techniques - Randomized rounding, Deterministic rounding, Applications to various problems. (Chapter 5)<br>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)<br>Approximation Schemes - Polynomial-time approximation schemes (PTAS), | **9** |

| | | |
|---|---|---|
| | Fully polynomial-time approximation schemes (FPTAS), Examples: knapsack problem, Euclidean TSP. (Chapter 9) | |
| **4** | Inapproximability Results - Introduction to inapproximability, Reductions and hardness of approximation, PCP theorem and its implications. (Chapter 10)<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(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 S7

# COMPUTER VISION

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

**Course Objectives:**

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

## SYLLABUS

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

| | | |
|---|---|---|
| **3** | **Machine Learning for Computer Vision :-**<br>Machine Learning - Introduction, Dataset for Machine Perception- Labelled and Unlabelled Data, Basics of Classification and Clustering, Multi-Class Perspective.<br>Machine Learning for Computer Vision -Machine Learning -Deep Learning Use Cases.<br>Machine Learning Models for Vision - Image Vision-Pretrained Model, Transfer Learning, Fine-Tuning, Convolutional Networks, Convolutional Filters, Stacking Convolutional Layers, Pooling Layers - AlexNet, VGG19, , Modular architecture - ResNet, Neural Architecture Search Design - NASNet | **9** |
| **4** | **Segmentation and Object detection :-**<br>Segmentation Using Clustering Methods - Human vision- Grouping and Gestalt, Applications- Shot Boundary Detection, Background Subtraction, Image Segmentation by Clustering Pixels- Simple Clustering Methods, Clustering and Segmentation by K-means<br>Object detection - YOLO, Segmentation-Mask R-CNN and Instance Segmentation, U-Net and Semantic Segmentation, Model Quality Metrics<br>***A case study to compare performance of various models on a suitable dataset.*** | **9** |

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

**Continuous Internal Evaluation Marks (CIE):**

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

**End Semester Examination Marks (ESE)**

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

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

**Course Outcomes (COs)**

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

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

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

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

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

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

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

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

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | Computer Vision and Image Processing - Fundamentals and Applications by Prof. M. K. Bhuyan at IIT Guwahati https://onlinecourses.nptel.ac.in/noc23_ee39/preview |
| **2** | Computer Vision by Prof. Jayanta Mukhopadhyay at IIT Kharagpur https://onlinecourses.nptel.ac.in/noc19_cs58/preview |
| **3** | |
| **4** | Deep Learning for Computer Vision by Prof. Vineeth N Balasubramanian at IIT Hyderabad https://onlinecourses.nptel.ac.in/noc21_cs93/preview |
| | COVID-Net Open Source Initiative - COVIDx CT-3 Dataset https://www.kaggle.com/datasets/hgunraj/covidxct |

## SEMESTER S7

# TOPICS IN THEORETICAL COMPUTER SCIENCE

| | | | |
|---|---|---|---|
| **Course Code** | **PECST795** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 5/3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | PCCST303<br>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.<br>**Assignments:**<br>1. Implement Cheeger's inequality for a set of sample graphs. Compare the theoretical results with empirical data to analyze the effectiveness of different partitioning algorithms. Use a set of sample graphs such as Erdős-Rényi Random Graphs, Barabási-Albert Model: Known for scale-free properties, and Regular Graphs. Compare theoretical results with empirical data using different partitioning algorithms such as Spectral Clustering - Uses the eigenvectors of the Laplacian matrix, K-means Clustering - Applied to spectral embeddings of the graph, Normalized Cut - Minimizes the normalized cut criterion. Measure how close the empirical conductance is to the theoretical lower bound provided by Cheeger's inequality. Analyze which algorithms produce cuts with conductance values closer to the | 9 |

| | | |
|---|---|---|
| | theoretical bounds.<br>Real-world Application: Apply Cheeger's inequality to social network analysis to detect community structures.<br>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.<br>**Assignment:**<br>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.<br>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.<br>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.<br>**Assignments:**<br>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.<br>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 | **9** |

| | | |
|---|---|---|
| | added noise and measure the performance of the expander code in correcting errors. Evaluate the BER, code rate, and error correction capability by comparing the number of errors corrected versus the total number of errors introduced. | |
| **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.<br>**Assignments:**<br>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.<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br><br>**(8x3 =24 marks)** | • 2 questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>• Each question carries 9 marks.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

## SEMESTER S7

# ADVANCED COMPUTER NETWORKS

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

**Course Objectives:**

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

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Review of Computer Networking Fundamentals - OSI and TCP/IP Models, Layers and Protocols, IP Addressing and Subnetting, Routing Protocols - RIP, OSPF, BGP;<br>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;<br>Data Center Network Architectures - Traditional vs. Modern Data Center Designs (Spine-Leaf, Clos Networks), Ethernet Fabrics and TRILL;<br>Data Center Design Considerations - Scalability, Redundancy, and Latency. | 9 |
| 3 | SDN Architecture and Components - Control Plane, Data Plane, and Application Plane; OpenFlow Protocol and its Role in SDN; SDN Controllers - Ryu, OpenDaylight, and ONOS; SDN Use Cases - Traffic | 9 |

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

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

**Continuous Internal Evaluation Marks (CIE):**

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

**End Semester Examination Marks (ESE)**

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

| Part A | Part B | Total |
|---|---|---|
| ● 2 Questions from each module.<br>● Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | ● Each question carries 9 marks.<br>● Two questions will be given from each module, out of which 1 question should be answered.<br>● Each question can have a maximum of 3 subdivisions.<br>**(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 :-**<br>Introduction to Responsible AI- Overview of AI and its societal impact;<br>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:-**<br>Interpretability - Interpretability through simplification and visualization, Intrinsic interpretable methods, Post Hoc interpretability, Explainability through causality, Model agnostic Interpretation.<br>Interpretability Tools - SHAP (SHapley Additive exPlanation), LIME(Local Interpretable Model-agnostic Explanations) | 10 |
| 3 | **Ethics, Privacy and Security :-**<br>Ethics and Accountability -Auditing AI models, fairness assessment, Principles for ethical practices.<br>Privacy preservation - Attack models, Privacy-preserving Learning, Differential privacy- Working, The Laplace Mechanism, Introduction to | 10 |

| | | |
|---|---|---|
| | Federated learning.<br>Security - Security in AI Systems, Strategies for securing AI systems and protecting against adversarial attacks | |
| **4** | **Future of Responsible AI and Case Studies : -**<br>Future of Responsible AI - Emerging trends and technologies in AI ethics and responsibility.<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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]<br>https://c3.ai/glossary/data-science/lime-local-interpretable-model-agnostic-explanations/<br>https://shap.readthedocs.io/en/latest/<br>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<br>Case Studies<br>https://www.kaggle.com/code/teesoong/explainable-ai-on-a-nlp-lstm-model-with-lime<br>https://www.kaggle.com/code/victorcampelo/using-lime-to-explaining-the-preditions-from-ml |

## SEMESTER S7

# FUZZY SYSTEMS

(Common to CS/CA)

| | | | |
|---|---|---|---|
| **Course Code** | **PECST753** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

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

## SYLLABUS

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

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

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

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

**End Semester Examination Marks (ESE)**

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

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

## Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

## SEMESTER 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.<br>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.<br>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<br>***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.<br>***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.<br>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.<br>***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.<br>***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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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** | **PECST753** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

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

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| **1** | Introduction to Game Theory - Competitive equilibrium, Rationality; Strategic Games - Dominance, Nash equilibrium, Maxmin strategies, elimination of dominated strategies, preservation of pure Nash equilibrium (PSNE), matrix games, relation between maxmin and PSNE in matrix games Mixed strategies, mixed strategy Nash equilibrium (MSNE), finding MSNE, MSNE characterization theorem, algorithm to find MSNE | **8** |
| **2** | Correlated equilibrium (CE) - Computing CE, extensive form games, subgame perfection, limitations of subgame perfect Nash equilibrium;<br>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;<br>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;<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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/ |
| **3** | |
| **4** | |

## SEMESTER S7

# HIGH PERFORMANCE COMPUTING

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

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

**Course Objectives:**

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

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Modern processors:** Stored-program computer architecture- *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**:-<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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<br>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<br>Yuliana Zamora | Manning Publications | 1/e, 2021 |
| 2 | High-Performance Computing | Charles Severance<br>Kevin Dowd | O'Reilly Media | 2/e, 1998 |
| 3 | Computer Architecture And Parallel Processing | Kai Hwang<br>Faye Alaye Briggs | McGraw-Hill | 1/e, 1984 |
| 4 | Computer Architecture: A Quantitative Approach | John L. Hennessy<br>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.<br>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.<br>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.<br>● Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | ● Each question carries 9 marks.<br>● Two questions will be given from each module, out of which 1 question should be answered.<br>● Each question can have a maximum of 3 subdivisions.<br>**(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<br>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<br>Parallel Programming with MPI - Introduction to MPI, Message passing model and MPI basics, Advanced MPI features and applications<br>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.<br>● Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | ● Each question carries 9 marks.<br>● Two questions will be given from each module, out of which 1 question should be answered.<br>● Each question can have a maximum of 3 subdivisions.<br>**(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/<br>https://nptel.ac.in/courses/106104120 |
| **3** | https://archive.nptel.ac.in/courses/106/106/106106112/<br>https://nptel.ac.in/courses/106104120 |
| **4** | https://archive.nptel.ac.in/courses/106/106/106106112/<br>https://nptel.ac.in/courses/106104120 |

## SEMESTER S7

# INTERNET OF THINGS

(Common to CS/CM/CA)

| | | | |
|---|---|---|---|
| **Course Code** | **PECST755** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 5/3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | | |

**Course Objectives:**

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

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| **1** | Introduction - Why IoT? Trends in IT Space, Internet of Things Era, Device-to-Device/Machine-to-Machine Integration, Device-to-Cloud (D2C) Integration, IoT Platform as a Service (PaaS), Cloud-to-Cloud (C2C) Integration, IoT Key Application Domains, Emerging IoT Flavors; IoT Ecosystem - Architecture for IoT, Mobile Technologies, Mobile Application Development Platforms, LPWAN. | **8** |
| **2** | Infrastructure and Service Discovery Protocols - Layered Architecture for IoT, Protocol Architecture of IoT, Infrastructure Protocols, Device or Service Discovery for IoT, Protocols & products for IoT Service Discovery; Integration Technologies and Tools - Smart Enterprises and Environments, Sensor and Actuator Networks, The IoT Device Integration Concepts, Standards, and Implementations, The Device Integration Protocols and Middleware, The Protocol Landscape. | **10** |
| **3** | Platforms for IoT Applications and Analytics - The IoT Building Blocks, Usecases, M2M Application Platform, IoT Architectural Building Blocks, Data Analytics Platforms, IoT Data Virtualization Platforms and capabilities, The IoT Edge Data Analytics; Clouds for IoT Applications and Analytics - | **8** |

| | | |
|---|---|---|
| | Reflecting the Cloud Journey, The Key Motivations for Cloud-Enabled Environments, IoT and Cloud-Inspired Smarter Environments, Hybrid, Federated, and Special-purpose cloud, The Emergence of Edge/Fog Clouds, SDN and SDS. | |
| **4** | Introduction to Raspberry Pi, Creating your first project, Creating a Sensor to Measure Ambient Light, Creating an Actuator for Controlling Illumination, Publishing Information Using MQTT & HTTP, Creating Web Pages for Your Devices. | **10** |

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

### Continuous Internal Evaluation Marks (CIE):

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

**Criteria for Evaluation(Evaluate and Analyse): 20 marks**

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

**End Semester Examination Marks (ESE):**

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

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

## Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

## SEMESTER S7

# ALGORITHMS FOR DATA SCIENCE

**(Common to CS/AM/CM)**

| | | | |
|---|---|---|---|
| **Course Code** | **PECST785** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 5/3 | **Exam Hours** | 2 Hrs. 30 Mins. |
| **Prerequisites (if any)** | PCCST303<br>PCCST502 | **Course Type** | Theory |

**Course Objectives:**

1. To equip students with the ability to design, analyze, and implement advanced algorithms that are fundamental to data science, enabling them to process and analyze large-scale datasets efficiently and effectively.
2. To provide hands-on experience through real-world projects that require students to apply algorithmic techniques to solve data science problems, strengthen the development of practical skills in data manipulation, analysis, and interpretation.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Foundations of Data Science Algorithms**<br>Introduction to Data Science and Algorithms - Overview of data science and its significance, Role of algorithms in data science; Data Preprocessing Techniques - Data cleaning, transformation, and normalization, Handling missing data, outliers, and data imputation techniques; Dimensionality reduction techniques - Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE); Algorithmic Approaches to Data Sampling - Random sampling, stratified sampling, and bootstrapping, Importance of representative sampling in data analysis.<br><br>**Project 1**: Data Cleaning and Preprocessing - Develop a pipeline for cleaning and preprocessing a large, messy dataset like UCI Machine Learning Repository - Adult Data Set<br>**Tasks:** Handle missing values, outliers, and noisy data. Apply | **9** |

| | | |
|---|---|---|
| | dimensionality reduction techniques to simplify the dataset. Implement data transformation and normalization processes. | |
| **2** | **Algorithms for Data Summarization and Visualization :-**<br>Data Summarization Techniques - Central tendency measures: mean, median, mode; Dispersion measures - variance, standard deviation, Interquartile range (IQR), Quantiles, percentiles, and outlier detection; Visualization Algorithms - Basics of data visualization, histograms, bar charts, scatter plots; Advanced visualization techniques - heatmaps, correlation matrices, and pair plots; Visualization tools and libraries - Matplotlib, Seaborn, Plotly; Algorithmic Approaches to Data Grouping - Clustering: k-means, hierarchical clustering, DBSCAN; Association rule learning - Apriori, FP-Growth.<br><br>**Project 2**: Exploratory Data Analysis and Visualization Perform exploratory data analysis (EDA) and create visualizations to uncover patterns and insights in the dataset like Kaggle - Titanic Dataset<br>***Tasks:*** Summarize the dataset using statistical measures. Create various visualizations to explore relationships and patterns in the data. Implement clustering algorithms to identify natural groupings within the data. | **9** |
| **3** | **Algorithms for Data Modeling :-**<br>Regression Algorithms - Linear regression and polynomial regression; Regularization techniques - Ridge, Lasso, Elastic Net; Evaluation metrics - RMSE, MAE, $R^2$; Classification Algorithms - Logistic regression, decision trees, and k-Nearest Neighbors (k-NN); Performance metrics - accuracy, precision, recall, F1-score, ROC-AUC; Algorithmic Optimization Techniques - Gradient descent and its variants: stochastic, mini-batch; Hyperparameter tuning - grid search, random search, Bayesian optimization.<br><br>**Project 3**: Predictive Modeling and Evaluation - Build and evaluate predictive models using regression and classification algorithms using datasets like Kaggle - House Prices: Advanced Regression Techniques<br>***Tasks:*** Implement linear and polynomial regression models to predict house prices. Apply classification algorithms to classify houses into different categories. Evaluate the models using appropriate performance metrics and fine-tune them for better accuracy. | **9** |
| **4** | **Algorithms for Big Data and Scalability :-**<br>Introduction to Big Data Algorithms - Overview of big data challenges and | **9** |

| | | |
|---|---|---|
| | processing techniques; Distributed computing frameworks - Hadoop, Spark; MapReduce paradigm - concepts and applications; Scalable Data Processing Algorithms - Algorithms for large-scale data processing : sorting, searching, filtering; Data partitioning and shuffling techniques in distributed systems; Handling data with memory constraints - external memory algorithms.<br><br>**Project 4**: Scalable Data Processing with Spark - Implement scalable algorithms using Apache Spark to process large datasets efficiently using datasets like Kaggle - Google Analytics Customer Revenue Prediction<br>***Tasks:*** Set up a Spark environment for large-scale data processing. Implement scalable algorithms for sorting, searching, and filtering the dataset. Analyze the performance of your algorithms on different dataset sizes and optimize for scalability. | |

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

### Continuous Internal Evaluation Marks (CIE):

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

**Criteria for Evaluation(Evaluate and Analyse): 20 marks**

**Assignment evaluation pattern:**

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

**End Semester Examination Marks (ESE):**

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

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

## Course Outcomes (COs)

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

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Implement data preprocessing and cleaning techniques to prepare raw data for analysis, ensuring the quality and reliability of the datasets. | **K3** |
| **CO2** | Perform exploratory data analysis (EDA) and create insightful visualizations that help in understanding the underlying patterns and trends in the data. | **K4** |
| **CO3** | Develop predictive models using various regression and classification algorithms, and optimize them for better performance, applying appropriate evaluation metrics. | **K5** |
| **CO4** | Implement scalable algorithms using distributed computing frameworks like Apache Spark to process large datasets efficiently. | **K6** |

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

## CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

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

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

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Algorithms for Data Science Hardcover | Brian Steele, John Chandler, Swarna Reddy | Springer International | 1/e, 2016 |
| 2 | Mining of Massive Datasets | Jure Leskovec, Anand Rajaraman, Jeff Ullman | Cambridge University Press | 2/e, 2020 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Foundations of Data Science | Avrim Blum, John Hopcroft and Ravi Kannan | Cambridge University Press | 1/e, 2020 |
| 2 | The Elements Of Statistical Learning: Data Mining, Inference, And Prediction | Trevor Hastie, Robert Tibshirani and Jerome Friedman | Springer | 9/e, 2017 |
| 3 | Data Mining: Concepts and Techniques | Jiawei Han, Micheline Kamber and Jian Pei Professor | Morgan Kaufmann | 3/e, 2011 |
| 4 | Data Mining and Predictive Analytics | Daniel T. Larose | Wiley | 2/e, 2015 |
| 5 | Hadoop for Dummies | Dirk Deroos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss | Wiley | 1/e, 2014 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/106/104/106104189/<br>https://onlinecourses.nptel.ac.in/noc20_cs92/preview |
| **2** | https://archive.nptel.ac.in/courses/106/104/106104189/<br>https://onlinecourses.nptel.ac.in/noc20_cs92/preview |
| **3** | https://archive.nptel.ac.in/courses/106/104/106104189/<br>https://onlinecourses.nptel.ac.in/noc20_cs92/preview |
| **4** | https://archive.nptel.ac.in/courses/106/104/106104189/<br>https://nptel.ac.in/courses/106105186<br>https://archive.nptel.ac.in/courses/106/106/106106142/ |

## SEMESTER S7

# CYBER SECURITY

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

**Course Objectives:**

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

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to Cyber Security :-**<br>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 :-**<br>Cybercrime, Classification of Cybercrimes, The legal perspectives- Indian perspective, Global perspective, Categories of Cybercrime.<br>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 :-**<br>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 :-**<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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/<br>https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044<br>https://www.coursera.org/learn/data-security-privacy#modules<br>https://nptel.ac.in/courses/106105217<br>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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(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.<br>**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.<br>*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<br>*Case study:* Ariane launch failure<br>**Object Oriented Software Design -** UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram, | 10 |

| | | |
|---|---|---|
| | Sequence diagram<br>*Case Studies*: Voice mail system, ATM Example<br>**Software pattern -** Model View Controller, Creational Design Pattern types – Factory method, Abstract Factory method, Singleton method, Prototype method, Builder method. Structural Design Pattern and its types – Adapter, Bridge, Proxy, Composite, Decorator, Façade, Flyweight. Behavioral Design Pattern | |
| **3** | **Coding, Testing and Maintenance:**<br>**Coding guidelines** - Code review, Code walkthrough and Code inspection, Code debugging and its methods.<br>**Testing** - Unit testing , Integration testing, System testing and its types, Black box testing and White box testing, Regression testing<br>**Overview of DevOps and Code Management** - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD), *Case study* – Netflix.<br>**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.<br>Risk management: Risk and its types, Risk monitoring and management model<br>**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.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

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

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

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

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

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

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

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

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

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

## SEMESTER S7

# COMPUTER NETWORKS

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

**Course Objectives:**

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

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| **1** | Introduction to Computer Networks:-<br>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:-<br>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:-<br>Logical Addressing- IPv4 and IPv6 Addresses; Internet Protocol- IPV4 and IPv6; Unicast Routing Protocols- Distance Vector Routing, Link State Routing<br>Multicast Routing Protocols. | **9** |
| **4** | Transport Layer:-<br>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<br><br>**(8x3 =24 marks)** | Each question carries 9 marks.<br>Two questions will be given from each module, out of which 1 question should be answered.<br>Each question can have a maximum of 3 subdivisions.<br>**(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<br>M. Ajaykumar<br>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<br>Data Persistence: SQLite, SharedPreferences, Hive<br>Asynchronous Programming with Dart: Futures, async/await, and Streams | |
| **4** | **Industry Practices and App Deployment:**<br>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.<br>● Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | ● Each question carries 9 marks.<br>● Two questions will be given from each module, out of which 1 question should be answered.<br>● Each question can have a maximum of 3 subdivisions.<br>**(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 |