

# **SEMESTER 4**

**COMPUTER SCIENCE AND ENGINEERING**

## SEMESTER S4

### COURSE NAME: Mathematics for Computer and Information Science – 4 (Group A)

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

#### Course Objectives:

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

## SYLLABUS

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

|          |                                                                                                                                                                                                                                                                                                                                                   |              |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
|          | <b>[Text 1: Relevant topics from sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.10, 11.5. Proofs of theorems 3.10, 3.16 are excluded.]</b>                                                                                                                                                                                                         |              |
| <b>4</b> | Cut Set and its properties Connectivity, Edge connectivity, Vertex connectivity, Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix,<br><br><b>[Text 1: Relevant topics from sections 4.1,4.2,4.3,4.4,4.5,7.1, 7.3, 7.8, 7.9. Proofs of theorems 4.5,4.6,4.11,4.12,7.4, 7.7, 7.8 are excluded.]</b> | <b>9 hrs</b> |

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

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

| <b>Attendance</b> | <b>Assignment/<br/>Microproject</b> | <b>Internal<br/>Examination-1<br/>(Written)</b> | <b>Internal<br/>Examination- 2<br/>(Written )</b> | <b>Total</b> |
|-------------------|-------------------------------------|-------------------------------------------------|---------------------------------------------------|--------------|
| <b>5</b>          | <b>15</b>                           | <b>10</b>                                       | <b>10</b>                                         | <b>40</b>    |

**End Semester Examination Marks (ESE)**

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

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

### Course Outcomes (COs)

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

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

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

### CO-PO Mapping Table:

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    |
| <b>CO2</b> | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 2    |
| <b>CO3</b> | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    |
| <b>CO4</b> | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    |

| Text Books |                                                                    |                      |                                              |                  |
|------------|--------------------------------------------------------------------|----------------------|----------------------------------------------|------------------|
| Sl. No     | Title of the Book                                                  | Name of the Author/s | Name of the Publisher                        | Edition and Year |
| <b>1</b>   | Graph Theory with Applications to Engineering and Computer Science | Narsingh Deo         | Prentice Hall India Learning Private Limited | 1974             |

| Reference Books |                                 |                      |                         |                   |
|-----------------|---------------------------------|----------------------|-------------------------|-------------------|
| Sl. No          | Title of the Book               | Name of the Author/s | Name of the Publisher   | Edition and Year  |
| <b>1</b>        | Introduction to Graph Theory 2e | Douglas B. West      | Pearson Education India | 2nd edition, 2015 |
| <b>2</b>        | Introduction to Graph Theory    | Robin J. Wilson      | Longman Group Ltd.      | 5th edition, 2010 |

|          |                                |                             |                                      |      |
|----------|--------------------------------|-----------------------------|--------------------------------------|------|
| <b>3</b> | Graph Theory with Applications | J.A. Bondy and U.S.R. Murty | Elsevier Science Publishing Co., Inc | 1976 |
|----------|--------------------------------|-----------------------------|--------------------------------------|------|

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                         |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| <b>Module No.</b>                     | <b>Link ID</b>                                                                                                          |
| <b>1</b>                              | <a href="https://onlinecourses.nptel.ac.in/noc22_ma10/preview">https://onlinecourses.nptel.ac.in/noc22_ma10/preview</a> |
| <b>2</b>                              | <a href="https://onlinecourses.nptel.ac.in/noc22_ma10/preview">https://onlinecourses.nptel.ac.in/noc22_ma10/preview</a> |
| <b>3</b>                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs48/preview">https://onlinecourses.nptel.ac.in/noc21_cs48/preview</a> |
| <b>4</b>                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs48/preview">https://onlinecourses.nptel.ac.in/noc21_cs48/preview</a> |

## SEMESTER S4

### DATABASE MANAGEMENT SYSTEMS

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

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

#### Course Objectives:

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

### SYLLABUS

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

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

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

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

| <b>Attendance</b> | <b>Assignment/<br/>Micro project</b> | <b>Internal<br/>Examination-1<br/>(Written)</b> | <b>Internal<br/>Examination- 2<br/>(Written )</b> | <b>Total</b> |
|-------------------|--------------------------------------|-------------------------------------------------|---------------------------------------------------|--------------|
| <b>5</b>          | <b>15</b>                            | <b>10</b>                                       | <b>10</b>                                         | <b>40</b>    |

**End Semester Examination Marks (ESE)**

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

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

## Course Outcomes (COs)

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

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

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 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO2</b> | 3   | 3   | 3   | 3   |     |     |     |     |     | 2    | 2    | 3    |
| <b>CO3</b> | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 3    |
| <b>CO4</b> | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 3    |
| <b>CO5</b> | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 3    |

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

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



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

| Video Links (NPTEL, SWAYAM...) |                                                                                                                             |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Module No.                     | Link ID                                                                                                                     |
| 1                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs04/preview">https://onlinecourses.nptel.ac.in/noc21_cs04/preview</a>     |
| 2                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs04/preview">https://onlinecourses.nptel.ac.in/noc21_cs04/preview</a>     |
| 3                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs04/preview">https://onlinecourses.nptel.ac.in/noc21_cs04/preview</a>     |
| 4                              | <a href="https://archive.nptel.ac.in/courses/106/104/106104135/">https://archive.nptel.ac.in/courses/106/104/106104135/</a> |

## SEMESTER S4

### OPERATING SYSTEMS

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

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

#### Course Objectives:

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

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Contact Hours</b> |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <p><b>Introduction to Operating Systems</b> (Book 1 Ch 2 introductory part), Operating System Services (Book 3 Ch 2) Overview of Operating Systems and Kernels, Linux Versus Classic Unix Kernels (Book 2 Ch 1)</p> <p><b>Process concepts:</b> Process Creation, Process States, Data Structures, Process API (Book 1 Ch 4, 5), Sharing processor among processes - user and kernel modes, context switching (Book 1 Ch 6), System boot sequence (Book 3 Ch 2)</p> <p><b>Case study:</b> <i>Linux kernel process management (Book 2, Ch 3)</i></p> <p><b>Threads and Concurrency:</b> Concept of a thread, Multithreading benefits, Multithreading models (Book 3 Ch 4)</p> <p><b>Case study:</b> <i>The Linux Implementation of Threads (Book 2, Ch 3)</i></p> <p><b>Process scheduling:</b> Concepts and basic algorithms (Book 1 Ch 7), The Multilevel Feedback Queue: Basic Rules (Book 1 Ch 8)</p> <p><b>Case study:</b> <i>The Linux Completely Fair Scheduler (CFS) (Book 1 Ch 9, Implementation with RB trees not required), The Linux Scheduling Implementation,</i></p> | <b>11</b>            |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <i>Preemption and Context Switching (Book 2, Ch 4)</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |
| <b>2</b> | <p><b>Concurrency and Synchronization</b> - Basic principles (Book 3 Sections 6.1, 6.2), Mechanisms - Locks: The Basic Idea, Building Spin Locks with Test-And-Set, Compare and Swap, Using Queues: Sleeping Instead Of Spinning (Book 1 Ch 28), Semaphores - Definition, Binary Semaphores, The Producer/Consumer (Bounded Buffer) Problem and its solution using semaphores, Reader-Writer Locks (Book 1 Ch 31)</p> <p><b>Case study:</b> <i>Linux Kernel Synchronization Methods - Spin Locks, Semaphores, Mutexes (Book 2 Ch 10)</i></p> <p><b>Concurrency:</b> Deadlock and Starvation - Deadlock Characterization, Deadlock Prevention and Avoidance, Deadlock Detection and recovery (Book 3 Ch 8), Dining Philosophers Problem and its solution (Book 1 Ch 31)</p> | <b>12</b> |
| <b>3</b> | <p><b>Memory management</b> - Address Space, Memory API, Address Translation - An Example, Dynamic (Hardware-based) Relocation, Segmentation: Generalized Base/Bounds, Address translation in segmentation, Support for Sharing (Book 1 Ch 13 to 16)</p> <p><b>Virtual memory</b> - Paging: Introduction, page tables and hardware support, TLBs, Example: Accessing An Array, - TLB hits and misses, Handling TLB misses, TLB structure, Reducing the page table size (Book 1 Ch 18 to 20)</p> <p><b>Going beyond physical memory</b> - Swap space, page fault and its control flow, page replacement policies, Thrashing (Book 1 Ch 21, 22)</p>                                                                                                                          | <b>11</b> |
| <b>4</b> | <p><b>I/O system:</b> Modern System architecture, Programmed I/O, Interrupts, DMA, Device interaction methods, The Device Driver (Book 1 Ch 36),</p> <p><b>Hard disk:</b> Geometry (Book 1 Ch 37), disk scheduling (Book 3 Section 11.2)</p> <p><b>Case study:</b> <i>Linux I/O schedulers - Elevator, Complete Fair Queuing (Book 2 Ch 14)</i></p> <p><b>Files and Directories:</b> The File System Interface - File descriptor, reading and writing files (sequential and random access), Removing files - Hard links and Symbolic links, Creating, reading and deleting directories, Permission bits and Access Control Lists, Mounting a file system (Book 1 Ch 39)</p>                                                                                                | <b>10</b> |

|  |                                                                                                                                                                                               |  |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  | <b>File Organization:</b> The Inode, The Multi-Level Index (Book 1 Ch 40)<br><br><b>Case study:</b> VFS Objects and Their Data Structures - The Inode Object, Inode Operations (Book 2 Ch 13) |  |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

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

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

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

**End Semester Examination Marks (ESE)**

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

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

**Course Outcomes (COs)**

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

| Course Outcome |                                                                                                           | Bloom's<br>Knowledge<br>Level (KL) |
|----------------|-----------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>CO1</b>     | Apply the concepts of process management and process scheduling mechanisms employed in operating systems. | <b>K3</b>                          |
| <b>CO2</b>     | Choose various process synchronization mechanisms employed in operating systems.                          | <b>K3</b>                          |
| <b>CO3</b>     | Use deadlock prevention and avoidance mechanisms in operating systems.                                    | <b>K3</b>                          |
| <b>CO4</b>     | Select various memory management techniques in operating systems.                                         | <b>K3</b>                          |
| <b>CO5</b>     | Understand the storage management in operating systems.                                                   | <b>K2</b>                          |

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 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO2</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO3</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO4</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO5</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |

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

| <b>Text Books</b> |                                      |                                                   |                              |                         |
|-------------------|--------------------------------------|---------------------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>     | <b>Title of the Book</b>             | <b>Name of the Author/s</b>                       | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| 1                 | Operating Systems: Three Easy Pieces | Andrea Arpaci-Dusseau, Remzi Arpaci-Dusseau       | CreateSpace                  | 1/e, 2018               |
| 2                 | Linux Kernel Development             | Robert Love                                       | Pearson                      | 3/e, 2018               |
| 3                 | Operating System Concepts            | Abraham Silberschatz, Peter B. Galvin, Greg Gagne | Wiley                        | 10/e, 2018              |

| <b>Reference Books</b> |                                         |                                    |                              |                         |
|------------------------|-----------------------------------------|------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>                | <b>Name of the Author/s</b>        | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| 1                      | Modern Operating Systems                | Andrew S. Tanenbaum<br>Herbert Bos | Pearson                      | 5/e, 2012               |
| 2                      | The Design of the UNIX Operating System | Maurice J. Bach                    | Prentice Hall of India       | 1/e, 1994               |
| 3                      | The Little Book of Semaphores           | Allen B. Downey                    | Green Tea Press              | 1/e, 2016               |

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                                                                 |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>No.</b>                            | <b>Link ID</b>                                                                                                                                                  |
| 1                                     | <a href="https://archive.nptel.ac.in/courses/106/105/106105214/">https://archive.nptel.ac.in/courses/106/105/106105214/</a>                                     |
| 2                                     | <a href="https://www.youtube.com/playlist?list=PLDW872573QAb4bj0URobvQTD41IV6gRkx">https://www.youtube.com/playlist?list=PLDW872573QAb4bj0URobvQTD41IV6gRkx</a> |

## SEMESTER S4

### COMPUTER ORGANIZATION AND ARCHITECTURE

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

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

#### Course Objectives

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

#### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Contact Hours</b> |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <b>Basic Structure of computers</b> :- Functional units - Basic operational concepts; Memory map; Endianness.<br><b>CISC vs RISC architectures</b> :- RISC Introduction - Assembly Language, Assembler directives, Assembling.<br><b>Programming concepts</b> - Program flow, Branching, Conditional statements, Loops, Arrays, Function calls; Instruction execution cycle.<br><b>Machine language</b> - Instructions, addressing modes, Stored program concept. Evolution of the RISC Architecture. | <b>11</b>            |
| <b>2</b>          | <b>Microarchitecture</b> - Introduction; Performance analysis; Single-Cycle Processor - Single Cycle Datapath, Single Cycle Control; Pipelined Processor - Pipelined Data Path, Pipelined Control: Hazards, Solving Data/Control Hazards, Performance Analysis.                                                                                                                                                                                                                                       | <b>11</b>            |
| <b>3</b>          | <b>Memory Systems</b> : Introduction; performance analysis; Caches - basic concepts, Cache mapping, Cache replacement, Multiple-Level Caches, Reducing Miss Rate, Write Policy; Virtual Memory - Address Translation; Page Table; Translation Lookaside Buffer; Memory Protection.                                                                                                                                                                                                                    | <b>11</b>            |
| <b>4</b>          | <b>Input / Output</b> - External Devices; I/O Modules; Programmed I/O, Interrupt Driven I/O; Direct Memory Access; Embedded I/O Systems - Embedded I/O, General Purpose I/O, Serial I/O, Other Peripherals.                                                                                                                                                                                                                                                                                           | <b>11</b>            |

### Suggestion on Project Topics

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

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

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

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

#### End Semester Examination Marks (ESE)

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

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

### Course Outcomes (COs)

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

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

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

**CO-PO Mapping Table:**

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO2</b> | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 3    |
| <b>CO3</b> | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 3    |
| <b>CO4</b> | 3   | 3   | 3   | 3   |     |     |     |     |     |      |      | 3    |

| <b>Text Books</b> |                                                                     |                               |                              |                         |
|-------------------|---------------------------------------------------------------------|-------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>     | <b>Title of the Book</b>                                            | <b>Name of the Author/s</b>   | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>          | Digital Design and Computer Architecture - RISC-V Edition           | Sarah L. Harris, David Harris | Morgan Kaufmann              | 1/e, 2022               |
| <b>2</b>          | Computer Organization and Architecture<br>Designing for Performance | William Stallings             | Pearson                      | 9/e, 2013               |

| <b>Reference Books</b> |                                                                                          |                                                                        |                              |                         |
|------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>                                                                 | <b>Name of the Author/s</b>                                            | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>               | Computer Organization and Design :<br>The Hardware/Software Interface:<br>RISC-V Edition | David A. Patterson<br>John L. Hennessy                                 | Morgan Kaufman               | 1/e, 2018               |
| <b>2</b>               | Computer Organization and Embedded Systems                                               | Carl Hamacher,<br>Zvonko Vranesic,<br>Safwat Zaky,<br>Naraig Manjikian | McGraw Hil                   | 6/e, 2012               |
| <b>3</b>               | Modern Computer Architecture and Organization                                            | Jim Ledin                                                              | Packt Publishing             | 1/e, 2020               |

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                             |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>No.</b>                            | <b>Link ID</b>                                                                                                              |
| 1                                     | <a href="https://archive.nptel.ac.in/courses/106/105/106105163/">https://archive.nptel.ac.in/courses/106/105/106105163/</a> |
| 2                                     | <a href="https://archive.nptel.ac.in/courses/106/106/106106166/">https://archive.nptel.ac.in/courses/106/106/106106166/</a> |



## PBL Course Elements

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

## Assessment and Evaluation for Project Activity

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

### 1. Project Planning and Proposal (5 Marks)

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

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

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

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

- Active participation and individual contribution
- Teamwork and collaboration

**4. Execution and Implementation (10 Marks)**

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

**5. Final Presentation (5 Marks)**

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

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

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

## SEMESTER S4

### SOFTWARE ENGINEERING

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

|                                            |                 |                    |                |
|--------------------------------------------|-----------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST411</b> | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0         | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 3               | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | None            | <b>Course Type</b> | 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

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Contact Hours</b> |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <b>Introduction to Software Engineering and Process Models</b> - 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><b>Requirement engineering</b> - Functional, Non-functional, System and User requirements. Requirement elicitation techniques, Requirement validation, Feasibility analysis and its types, SRS document characteristics and its structure.<br><i>Case study:</i> SRS for College Library Management Software | <b>9</b>             |
| <b>2</b>          | <b>Software design</b> - Software architecture and its importance, Software architecture patterns: Component and Connector, Layered, Repository, Client-Server, Publish-Subscribe, Functional independence – Coupling and Cohesion<br><i>Case study:</i> Ariane launch failure<br><b>Object Oriented Software Design</b> - UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram, Sequence diagram<br><i>Case Studies:</i> Voice mail system, ATM Example<br><b>Software pattern</b> - Model View Controller, Creational Design Pattern types –                            | <b>9</b>             |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|          | 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |
| <b>3</b> | <p><b>Coding, Testing and Maintenance:</b></p> <p><b>Coding guidelines</b> - Code review, Code walkthrough and Code inspection, Code debugging and its methods.</p> <p><b>Testing</b> - Unit testing , Integration testing, System testing and its types, Black box testing and White box testing, Regression testing</p> <p><b>Overview of DevOps and Code Management</b> - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD), <i>Case study</i> – Netflix.</p> <p><b>Software maintenance and its types-</b> Adaptive, Preventive, Corrective and Perfective maintenance. Boehm’s maintenance models (both legacy and non-legacy)</p>                                        | <b>9</b> |
| <b>4</b> | <p><b>Software Project Management</b> - Project size metrics – LOC, Function points and Object points. Cost estimation using Basic COCOMO.</p> <p>Risk management: Risk and its types, Risk monitoring and management model</p> <p><b>Software Project Management</b> - Planning, Staffing, Organizational structures, Scheduling using Gantt chart. Software Configuration Management and its phases, Software Quality Management – ISO 9000, CMM, Six Sigma for software engineering.</p> <p><b>Cloud-based Software</b> -Virtualisation and containers, Everything as a service (IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment.</p> | <b>9</b> |

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

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

| Attendance | Assignment/<br>Micro project | Internal<br>Examination-1<br>(Written) | Internal<br>Examination- 2<br>(Written ) | Total     |
|------------|------------------------------|----------------------------------------|------------------------------------------|-----------|
| <b>5</b>   | <b>15</b>                    | <b>10</b>                              | <b>10</b>                                | <b>40</b> |

## End Semester Examination Marks (ESE)

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

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

## Course Outcomes (COs)

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

| Course Outcome |                                                                                               | Bloom's Knowledge Level (KL) |
|----------------|-----------------------------------------------------------------------------------------------|------------------------------|
| <b>CO1</b>     | Plan the system requirements and recommend a suitable software process model                  | K3                           |
| <b>CO2</b>     | Model various software patterns based on system requirements                                  | K3                           |
| <b>CO3</b>     | Apply testing and maintenance strategies on the developed software product to enhance quality | K3                           |
| <b>CO4</b>     | 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 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO2</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO3</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO4</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |

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

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

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

| Video Links (NPTEL, SWAYAM...) |                                                                                                                                 |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Module No.                     | Link ID                                                                                                                         |
| 1                              | <a href="https://www.youtube.com/watch?v=Z6f9ckEElsU">https://www.youtube.com/watch?v=Z6f9ckEElsU</a>                           |
| 2                              | <a href="https://www.youtube.com/watch?v=1xUz1fp23TQ">https://www.youtube.com/watch?v=1xUz1fp23TQ</a>                           |
| 3                              | <a href="http://digimat.in/nptel/courses/video/106105150/L01.html">http://digimat.in/nptel/courses/video/106105150/L01.html</a> |
| 4                              | <a href="https://www.youtube.com/watch?v=v7KtPLhSMkU">https://www.youtube.com/watch?v=v7KtPLhSMkU</a>                           |

## SEMESTER S4

### PATTERN RECOGNITION

(Common to CS/CM/CA/AM/CN/CI)

|                                            |                                              |                    |                |
|--------------------------------------------|----------------------------------------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST412</b>                              | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0                                      | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 3                                            | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | GAMAT101, GAMAT201,<br>GAMAT301,<br>PCCST303 | <b>Course Type</b> | Theory         |

#### Course Objectives:

1. To introduce a foundational understanding of the fundamental principles, theories, and methods used in pattern recognition.
2. To develop practical skills in implementing pattern recognition algorithms and techniques.

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Contact Hours</b> |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <p><b>Foundations of Pattern Recognition</b></p> <p><b>Introduction to Pattern Recognition</b> - Definitions and applications of pattern recognition, Overview of pattern recognition systems (<b>Text 2, Chapter 1</b>)</p> <p><b>Statistical Pattern Recognition</b> - Bayes decision theory, Parametric methods: Maximum likelihood estimation, Bayesian estimation (<b>Text 1, Chapters 1, 2</b>)</p> <p><b>Non-Parametric Methods</b> - k-Nearest neighbors, Parzen windows (<b>Text 2, Chapter 4</b>)</p> | <b>9</b>             |
| <b>2</b>          | <p><b>Feature Extraction and Selection</b></p> <p><b>Feature Extraction</b> - Importance of feature extraction, Techniques for feature extraction: PCA, LDA, Feature extraction in image and signal processing (<b>Text 1, Chapter 3</b>)</p> <p><b>Feature Selection</b> - Importance of feature selection, Techniques for feature</p>                                                                                                                                                                         | <b>9</b>             |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|          | selection: filter methods, wrapper methods, Feature selection criteria ( <b>Text 2, Chapter 6</b> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |
| <b>3</b> | <p align="center"><b>Supervised and Unsupervised Learning</b></p> <p><b>Supervised Learning</b> - Basics of supervised learning, Linear classifiers: perceptron, logistic regression, Support vector machines (SVM) (<b>Text 1, Chapter 4</b>)</p> <p><b>Unsupervised Learning</b> - Basics of unsupervised learning, Clustering techniques: k-means, hierarchical clustering, Gaussian Mixture Models (GMM) (<b>Text 1, Chapter 9</b>)</p>                                                                                                                                                                        | <b>9</b> |
| <b>4</b> | <p align="center"><b>Advanced Topics and Applications</b></p> <p><b>Hidden Markov Models (HMMs)</b> - Basics of HMMs, HMM for sequence modeling, Applications of HMMs in speech and language processing (<b>Text 1, Chapter 13</b>)</p> <p><b>Ensemble Methods</b> - Basics of ensemble methods, Bagging, boosting, and random forests, Applications and case studies (<b>Text 1, Chapter 14</b>)</p> <p><b>Applications and Case Studies</b> - Real-world applications of pattern recognition, Case studies in image and speech recognition, Future trends in pattern recognition (<b>Text 2, Chapter 10</b>)</p> | <b>9</b> |

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

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

| <b>Attendance</b> | <b>Assignment/<br/>Micro project</b> | <b>Internal<br/>Examination-1<br/>(Written)</b> | <b>Internal<br/>Examination- 2<br/>(Written )</b> | <b>Total</b> |
|-------------------|--------------------------------------|-------------------------------------------------|---------------------------------------------------|--------------|
| <b>5</b>          | <b>15</b>                            | <b>10</b>                                       | <b>10</b>                                         | <b>40</b>    |



## End Semester Examination Marks (ESE)

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

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

### Course Outcomes (COs)

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

| Course Outcome |                                                                                         | Bloom's Knowledge Level (KL) |
|----------------|-----------------------------------------------------------------------------------------|------------------------------|
| <b>CO1</b>     | Understand and Explain fundamental Concepts of Pattern Recognition:                     | <b>K2</b>                    |
| <b>CO2</b>     | Apply Classification and Clustering Techniques:                                         | <b>K3</b>                    |
| <b>CO3</b>     | Implement Feature Extraction and Dimensionality Reduction Techniques                    | <b>K3</b>                    |
| <b>CO4</b>     | Apply Statistical and Non-Parametric Methods for Pattern Recognition                    | <b>K3</b>                    |
| <b>CO5</b>     | Develop Solutions for Real-World Pattern Recognition Problems and Analyze Case Studies: | <b>K3</b>                    |

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

### CO-PO Mapping Table:

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

| <b>Text Books</b> |                                          |                                       |                              |                         |
|-------------------|------------------------------------------|---------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>     | <b>Title of the Book</b>                 | <b>Name of the Author/s</b>           | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>          | Pattern Recognition and Machine Learning | Christopher M. Bishop                 | SPRINGER                     | 1/e, 2009               |
| <b>2</b>          | Pattern Classification                   | Richard Duda, Peter Hart, David Stork | Wiley                        | 2/e, 2007               |

| <b>Reference Books</b> |                                           |                                                   |                               |                         |
|------------------------|-------------------------------------------|---------------------------------------------------|-------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>                  | <b>Name of the Author/s</b>                       | <b>Name of the Publisher</b>  | <b>Edition and Year</b> |
| <b>1</b>               | The Nature of Statistical Learning Theory | Vladimir Vapnik                                   | Springer-Verlag New York Inc. | 2/e, 2010               |
| <b>2</b>               | The Elements of Statistical Learning      | Jerome Friedman, Robert Tibshirani, Trevor Hastie | Springer-Verlag New York Inc  | 9/e, 2017               |
| <b>3</b>               | Pattern Recognition                       | S.Theodoridis and K.Koutroumbas                   | Academic Press                | 4/e, 2009               |

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                             |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Module No.</b>                     | <b>Link ID</b>                                                                                                              |
| <b>1</b>                              | <a href="https://archive.nptel.ac.in/courses/117/105/117105101/">https://archive.nptel.ac.in/courses/117/105/117105101/</a> |
| <b>2</b>                              | <a href="https://archive.nptel.ac.in/courses/117/105/117105101/">https://archive.nptel.ac.in/courses/117/105/117105101/</a> |
| <b>3</b>                              | <a href="https://archive.nptel.ac.in/courses/117/105/117105101/">https://archive.nptel.ac.in/courses/117/105/117105101/</a> |
| <b>4</b>                              | <a href="https://archive.nptel.ac.in/courses/117/105/117105101/">https://archive.nptel.ac.in/courses/117/105/117105101/</a> |

## SEMESTER S4

### FUNCTIONAL PROGRAMMING

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

|                                            |                 |                    |                |
|--------------------------------------------|-----------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST413</b> | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0         | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 3               | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | GYEST204        | <b>Course Type</b> | Theory         |

#### Course Objectives:

1. To enable the learner write programs in a functional style and reason formally about functional programs;
2. To give the concepts of polymorphism and higher-order functions in Haskell to solve the

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                  | <b>Contact Hours</b> |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | Introducing Functional Programming; Getting Started with Haskell and GHCi; Basic Types and Definitions; Designing and Writing Programs; Data Types, Tuples and Lists.<br><br><i>[Text Ch. 1, 2, 3, 4, 5]</i> | <b>9</b>             |
| <b>2</b>          | Programming with Lists; Defining Functions over Lists; Playing the Game: I/O in Haskell; Reasoning about Programs;<br><br><i>[Text Ch. 6, 7, 8, 9]</i>                                                       | <b>9</b>             |
| <b>3</b>          | Generalization: Patterns of Computation; Higher-order Functions; Developing Higher-order Programs; Overloading, Type Classes and Type Checking.<br><br><i>[Text Ch. 10 11, 12, 13]</i>                       | <b>9</b>             |
| <b>4</b>          | Algebraic Types; Case Study - Huffman Codes; Abstract Data Types; Lazy Programming; Time and Space Behaviour.<br><br><i>[Text Ch. 15, 16, 17, 20]</i>                                                        | <b>9</b>             |

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

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

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

**End Semester Examination Marks (ESE)**

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

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

**Course Outcomes (COs)**

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

| Course Outcome |                                                                             | Bloom's<br>Knowledge<br>Level (KL) |
|----------------|-----------------------------------------------------------------------------|------------------------------------|
| <b>CO1</b>     | Write computer programs in a functional style.                              | <b>K2</b>                          |
| <b>CO2</b>     | Reason formally about functional programs and develop programs using lists. | <b>K3</b>                          |
| <b>CO3</b>     | Use patterns of computation and higher-order functions.                     | <b>K3</b>                          |
| <b>CO4</b>     | Reason informally about the time and space complexity of programs.          | <b>K3</b>                          |

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     |
|------------|----------|----------|----------|-----|----------|-----|-----|-----|-----|------|------|----------|
| <b>CO1</b> | <b>3</b> | <b>2</b> |          |     | <b>3</b> |     |     |     |     |      |      | <b>3</b> |
| <b>CO2</b> | <b>3</b> | <b>3</b> | <b>3</b> |     | <b>3</b> |     |     |     |     |      |      | <b>3</b> |
| <b>CO3</b> | <b>3</b> | <b>3</b> | <b>3</b> |     | <b>3</b> |     |     |     |     |      |      | <b>3</b> |
| <b>CO4</b> | <b>3</b> | <b>3</b> | <b>3</b> |     | <b>3</b> |     |     |     |     |      |      | <b>3</b> |

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

| <b>Text Books</b> |                                               |                             |                              |                         |
|-------------------|-----------------------------------------------|-----------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>     | <b>Title of the Book</b>                      | <b>Name of the Author/s</b> | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>          | HASKELL : The Craft of Functional Programming | Simon Thompson              | Addison Wesley               | 3/e, 2023               |

| <b>Reference Books</b> |                                    |                                                            |                              |                         |
|------------------------|------------------------------------|------------------------------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>           | <b>Name of the Author/s</b>                                | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>               | Thinking Functionally with Haskell | Richard Bird                                               | Cambridge University Press   | 1/e, 2015               |
| <b>2</b>               | Programming in Haskell             | Graham Hutton                                              | Cambridge University Press   | 2/e, 2023               |
| <b>3</b>               | Real World Haskell                 | Bryan O'Sullivan,<br>John Goerzen, Donald<br>Bruce Stewart | O'Reilly                     | 1/e, 2008               |

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                             |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>No.</b>                            | <b>Link ID</b>                                                                                                              |
| <b>1</b>                              | <a href="https://archive.nptel.ac.in/courses/106/106/106106137/">https://archive.nptel.ac.in/courses/106/106/106106137/</a> |

## SEMESTER S4

### CODING THEORY

(Common to CS/CM/AM/CI)

|                                            |                 |                    |                |
|--------------------------------------------|-----------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST414</b> | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0         | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 3               | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | None            | <b>Course Type</b> | Theory         |

#### Course Objectives:

1. To introduce students to some of the classical methods in coding theory
2. To give the concept of code construction through the mathematical foundations and examples.

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                 | <b>Contact Hours</b> |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | Binary block codes, Minimum distance, Error-detecting capability and error-correcting capability.<br><br>Introduction to linear block codes, generator matrix and parity check matrix. Properties of linear block codes: Syndrome, error detection. Distance properties of linear block codes. Single parity check codes, Hamming codes, Reed Muller codes. | <b>9</b>             |
| <b>2</b>          | Cyclic Codes : Generator and Parity-Check Matrices of Cyclic Codes. Encoding of Cyclic Codes, Syndrome Computation and Error Detection, Decoding of Cyclic Codes, Cyclic Hamming Codes, Shortened Cyclic Codes                                                                                                                                              | <b>9</b>             |
| <b>3</b>          | Convolutional codes: Encoding, state diagram, trellis diagram, Classification, realization, distance properties. Viterbi algorithm, BCJR algorithm. Performance bounds for convolutional codes                                                                                                                                                              | <b>9</b>             |
| <b>4</b>          | Turbo codes: Turbo decoding, Distance properties of turbo codes, Convergence of turbo codes.<br><br>Automatic repeat request schemes. Applications of linear codes                                                                                                                                                                                          | <b>9</b>             |

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

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

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

**End Semester Examination Marks (ESE)**

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

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

**Course Outcomes (COs)**

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

| Course Outcome |                                                                    | Bloom's<br>Knowledge<br>Level (KL) |
|----------------|--------------------------------------------------------------------|------------------------------------|
| <b>CO1</b>     | Construct the encoder and decoder of linear block codes            | <b>K3</b>                          |
| <b>CO2</b>     | Understand the concept of error correction coding                  | <b>K2</b>                          |
| <b>CO3</b>     | Understand the implementation of cyclic codes                      | <b>K2</b>                          |
| <b>CO4</b>     | Apply Viterbi algorithm for decoding convolutional codes           | <b>K3</b>                          |
| <b>CO5</b>     | Experiment with turbo codes using iterative map and BCJR algorithm | <b>K3</b>                          |

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 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 2    |
| <b>CO2</b> | 3   | 3   | 3   | 2   |     |     |     |     |     |      |      | 2    |
| <b>CO3</b> | 3   | 3   | 3   | 2   |     |     |     |     |     |      |      | 2    |
| <b>CO4</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 2    |
| <b>CO5</b> | 3   | 3   | 3   | 2   |     |     |     |     |     |      |      |      |

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

| <b>Text Books</b> |                          |                                     |                              |                         |
|-------------------|--------------------------|-------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>     | <b>Title of the Book</b> | <b>Name of the Author/s</b>         | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>          | Error Control Coding     | Shu Lin and Daniel J. Costello, Jr. | PHI                          | 2/e, 2004               |
| <b>2</b>          | Error Correction Coding  | Todd K. Moon                        | Wiley-Interscience           | 1/e, 2006               |

| <b>Reference Books</b> |                                        |                                    |                              |                         |
|------------------------|----------------------------------------|------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>               | <b>Name of the Author/s</b>        | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>               | The Theory of Error-Correcting Codes   | F. J. MacWilliams, N. J. A. Sloane | North-Holland, Amsterdam     | 1/e, 1977               |
| <b>2</b>               | Algebraic Codes for Data Transmission  | R. E. Blahut                       | Cambridge University Press   | 1/e, 2003               |
| <b>3</b>               | Fundamentals of Error-Correcting Codes | Cary W. Huffman, Vera Pless        | Cambridge University Press   | 1/e, 2003               |

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                             |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Mod. No.</b>                       | <b>Link ID</b>                                                                                                              |
| <b>1</b>                              | <a href="https://archive.nptel.ac.in/courses/108/104/108104092/">https://archive.nptel.ac.in/courses/108/104/108104092/</a> |
| <b>2</b>                              | <a href="https://nptel.ac.in/courses/108102117">https://nptel.ac.in/courses/108102117</a>                                   |
| <b>3</b>                              | <a href="https://archive.nptel.ac.in/courses/108/104/108104092/">https://archive.nptel.ac.in/courses/108/104/108104092/</a> |
| <b>4</b>                              | <a href="https://archive.nptel.ac.in/courses/108/104/108104092/">https://archive.nptel.ac.in/courses/108/104/108104092/</a> |



## SEMESTER S4

### SIGNALS AND SYSTEMS

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

|                                            |                 |                    |                |
|--------------------------------------------|-----------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST416</b> | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0         | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 3               | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | None            | <b>Course Type</b> | Theory         |

#### Course Objectives:

1. To teach the concept of a Discrete Time (DT) signal
2. To enable the learner to analyze the spectral information of any DT signal and its transformed version.
3. To provide the learner the concepts of a DT system, how it behaves to an arbitrary input, and also to analyze the behaviour of a given DT system based on z-transform

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Contact Hours</b> |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <p><b>1D Signals</b> - A general introduction to real time signals - CT and DT signals, Sinusoids, Spectrum representation, Sampling and Aliasing (Concept only), Analog frequency and Digital frequency.</p> <p>Elementary sequences- Real Sinusoidal Sequences, Complex Exponential Sequences. - Unit impulse, step and ramp sequences, Representation of discrete time signals- (Graphical representation, Functional representation, Sequence representation)</p> <p><b>Properties of DT Signals</b> - Even and Odd, Periodic and non periodic signal, Energy and Power signals. Periodicity and Symmetry property of DT signals, support of sequences, Bounded Sequences.</p> <p><b>Operations on Signals</b> - Time shifting (Translation), Time Reversal (Reflection), Time scaling - Upsampling and downsampling</p> <p><b>DTFS</b> - Determining the Fourier-Series Representation of a Sequence, Properties of Discrete-Time Fourier Series - Linearity, Translation (Time Shifting) , Modulation (Frequency Shifting), Reflection (Time Reversal), Conjugation, Duality, Multiplication, Parseval's Relation, Even/Odd symmetry, Real sequence.</p> | <b>8</b>             |

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

### Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

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

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

**End Semester Examination Marks (ESE)**

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

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

**Course Outcomes (COs)**

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

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

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

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

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

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

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

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

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                             |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>No.</b>                            | <b>Link ID</b>                                                                                                              |
| <b>1</b>                              | <a href="https://archive.nptel.ac.in/courses/108/104/108104100/">https://archive.nptel.ac.in/courses/108/104/108104100/</a> |
| <b>2</b>                              | <a href="https://archive.nptel.ac.in/courses/108/106/108106163/">https://archive.nptel.ac.in/courses/108/106/108106163/</a> |

## SEMESTER S4

### SOFT COMPUTING

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

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

#### Course Objectives:

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

### SYLLABUS

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

|          |                                                                                                                                                                                                                                                                    |          |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|          | selection, cross over, mutation. Stopping condition for genetic algorithm.                                                                                                                                                                                         |          |
| <b>4</b> | Multi-objective optimization problem. Principles of Multi- objective optimization, Dominance and pareto-optimality. Optimality conditions. Collective Systems, Biological Self-Organization, Particle Swarm Optimization, Ant Colony Optimization, Swarm Robotics. | <b>9</b> |

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

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

| <b>Attendance</b> | <b>Assignment/<br/>Microproject</b> | <b>Internal<br/>Examination-1<br/>(Written)</b> | <b>Internal<br/>Examination- 2<br/>(Written)</b> | <b>Total</b> |
|-------------------|-------------------------------------|-------------------------------------------------|--------------------------------------------------|--------------|
| <b>5</b>          | <b>15</b>                           | <b>10</b>                                       | <b>10</b>                                        | <b>40</b>    |

**End Semester Examination Marks (ESE)**

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

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

## Course Outcomes (COs)

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

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

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 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   |     |     |     |     |     |     |      |      | 3    |
| <b>CO2</b> | 3   | 3   | 2   | 2   |     |     |     |     |     |      |      | 3    |
| <b>CO3</b> | 3   | 3   | 3   | 2   |     |     |     |     |     |      |      | 3    |
| <b>CO4</b> | 3   | 3   | 2   | 2   |     |     |     |     |     |      |      | 3    |
| <b>CO5</b> | 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 |
| <b>1</b>   | Principles of Soft Computing                                                                      | S.N.Sivanandam, S.N. Deepa | John Wiley & Sons.      | 3/e, 2018        |
| <b>2</b>   | Multi-objective Optimization using Evolutionary Algorithms                                        | Kalyanmoy Deb,             | John Wiley & Sons       | 1/e, 2009        |
| <b>3</b>   | Computational intelligence: synergies of fuzzy logic, neural networks and evolutionary computing. | Siddique N, Adeli H.       | John Wiley & Sons       | 1/e, 2013        |
| <b>4</b>   | Bio-inspired artificial intelligence: theories, methods, and technologies.                        | Floreano D, Mattiussi C.   | MIT press; 2008 Aug 22. | 1/e, 2023        |

| Reference Books |                                                                              |                                          |                        |                  |
|-----------------|------------------------------------------------------------------------------|------------------------------------------|------------------------|------------------|
| Sl. No          | Title of the Book                                                            | Name of the Author/s                     | Name of the Publisher  | Edition and Year |
| 1               | Fuzzy Logic with Engineering Applications                                    | Timothy J Ross,                          | John Wiley & Sons,     | 3/e, 2011        |
| 2               | Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis and Applications | T.S.Rajasekaran,<br>G.A.Vijaylakshmi Pai | Prentice-Hall India    | 1/e, 2003        |
| 3               | Neural Networks- A Comprehensive Foundation                                  | Simon Haykin                             | Pearson Education      | 2/e, 1997        |
| 4               | Fuzzy Set Theory & Its Applications                                          | Zimmermann H. J,                         | Allied Publishers Ltd. | 4/e, 2001        |

| Video Links (NPTEL, SWAYAM...) |                                                                                                                             |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| No.                            | Link ID                                                                                                                     |
| 1                              | <a href="https://archive.nptel.ac.in/courses/106/105/106105173/">https://archive.nptel.ac.in/courses/106/105/106105173/</a> |



## SEMESTER S4

### COMPUTATIONAL GEOMETRY

(Common to CS/CM)

|                                            |                       |                    |                |
|--------------------------------------------|-----------------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST418</b>       | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0               | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 3                     | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | GAMAT101,<br>PCCST303 | <b>Course Type</b> | Theory         |

#### Course Objectives:

1. To develop a solid understanding of the fundamental principles, techniques, and algorithms used in computational geometry, including geometric data structures, convex hulls, Voronoi diagrams, and Delaunay triangulations.
2. To equip students with the skills to apply computational geometry algorithms and techniques to address real-world problems in areas such as computer graphics, robotics, and geographic information systems (GIS).

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Contact Hours</b> |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <b>Introduction to Computational Geometry:-</b><br><br>Basics of Computational Geometry - Introduction and applications of computational geometry, Geometric objects, and their representations, Basic geometric primitives: points, lines, segments, polygons (Text 1, Chapters 1, 2)<br><br>Convex Hulls - Definition and properties of convex hulls, Graham's scan algorithm, Jarvis's march (gift wrapping) algorithm, Divide and conquer algorithm for convex hulls (Text 2, Section 33.3)<br><br>Line Segment Intersection - Problem definition and applications, Plane | <b>9</b>             |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|          | sweep algorithm, Bentley-Ottmann algorithm (Text 3, Chapter 7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |
| <b>2</b> | <p><b>Polygon Triangulation and Voronoi Diagrams:-</b></p> <p>Polygon Triangulation - Definition and applications, Triangulation of monotone polygons, Ear clipping method, Chazelle's algorithm (Text 1, Chapter 3)</p> <p>Voronoi Diagrams - Definition and properties, Incremental construction algorithm, Fortune's sweep line algorithm (Text 1, Chapter 7)</p> <p>Delaunay Triangulations - Definition and properties, Relationship with Voronoi diagrams, Bowyer-Watson algorithm, Lawson's flip algorithm (Text 1, Chapter 9)</p>                                                             | <b>9</b> |
| <b>3</b> | <p><b>Range Searching and Point Location :-</b></p> <p>Range Searching - Problem definition and applications, 1-dimensional range searching, K-dimensional range trees, Fractional cascading (Text 1, Chapter 5)</p> <p>Point Location - Problem definition and applications, Trapezoidal map and randomized incremental algorithm, Kirkpatrick's point location algorithm (Text 1, Chapter 6)</p> <p>Binary Space Partitioning - Definition and applications, BSP trees construction and properties, Use in computer graphics and collision detection (Text 1, Chapter 12)</p>                       | <b>9</b> |
| <b>4</b> | <p><b>Advanced Topics and Applications :-</b></p> <p>Arrangements of Lines and Duality - Arrangements of lines and complexity, Zone theorem, Duality transform and its applications (Text 1, Chapter 8)</p> <p>Motion Planning and Geometric Optimization - Problem definition and applications, Visibility graphs and shortest path problems, Art gallery problem, Linear programming in geometry (Text 1, Chapters 10, 11)</p> <p>Computational Geometry in Practice - Computational geometry libraries and software, Applications in robotics, computer graphics, GIS (Text 3, Chapters 9, 10)</p> |          |

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

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

| <b>Attendance</b> | <b>Assignment/<br/>Microproject</b> | <b>Internal<br/>Examination-1<br/>(Written)</b> | <b>Internal<br/>Examination- 2<br/>(Written)</b> | <b>Total</b> |
|-------------------|-------------------------------------|-------------------------------------------------|--------------------------------------------------|--------------|
| <b>5</b>          | <b>15</b>                           | <b>10</b>                                       | <b>10</b>                                        | <b>40</b>    |

**End Semester Examination Marks (ESE)**

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

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

## Course Outcomes (COs)

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

| Course Outcome |                                                                            | Bloom's Knowledge Level (KL) |
|----------------|----------------------------------------------------------------------------|------------------------------|
| <b>CO1</b>     | Understand Fundamental Concepts and Applications of Computational Geometry | <b>K2</b>                    |
| <b>CO2</b>     | Apply Algorithms for Convex Hulls and Line Segment Intersection Algorithms | <b>K3</b>                    |
| <b>CO3</b>     | Perform Polygon Triangulation and Understand Voronoi Diagrams              | <b>K3</b>                    |
| <b>CO4</b>     | Build Delaunay Triangulations and Range Searching Techniques               | <b>K3</b>                    |
| <b>CO5</b>     | Apply Advanced Computational Geometry Techniques and Algorithms            | <b>K3</b>                    |

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

### CO-PO Mapping Table:

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

| <b>Text Books</b> |                                                     |                                                                              |                              |                         |
|-------------------|-----------------------------------------------------|------------------------------------------------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>     | <b>Title of the Book</b>                            | <b>Name of the Author/s</b>                                                  | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>          | Computational Geometry: Algorithms and Applications | Mark de Berg, Otfried Cheong, Marc van Kreveld, and Mark Overmars            | Springer India               | 3/e, 2011               |
| <b>2</b>          | Introduction to Algorithms                          | Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein | MIT Press                    | 4/e, 2022               |
| <b>3</b>          | Computational Geometry in C                         | Joseph O'Rourke                                                              | Cambridge University Press   | 2/e, 1998               |

| <b>Reference Books</b> |                                                     |                                                      |                                                    |                         |
|------------------------|-----------------------------------------------------|------------------------------------------------------|----------------------------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>                            | <b>Name of the Author/s</b>                          | <b>Name of the Publisher</b>                       | <b>Edition and Year</b> |
| <b>1</b>               | Discrete and Computational Geometry Hardcover       | Joseph O'Rourke , Satyan L. Devadoss                 | Princeton University Press                         | 1/e, 2011               |
| <b>2</b>               | Computational Geometry: An Introduction             | Franco P. Preparata, Michael I. Shamos               | Springer-Verlag New York Inc                       | 5/e, 1993               |
| <b>3</b>               | Geometric Algorithms and Combinatorial Optimization | Martin Grötschel, Laszlo Lovasz, Alexander Schrijver | Springer-Verlag Berlin and Heidelberg GmbH & Co. K | 2/e, 1993               |

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                             |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Module No.</b>                     | <b>Link ID</b>                                                                                                              |
| <b>1</b>                              | <a href="https://archive.nptel.ac.in/courses/106/102/106102011/">https://archive.nptel.ac.in/courses/106/102/106102011/</a> |
| <b>2</b>                              | <a href="https://archive.nptel.ac.in/courses/106/102/106102011/">https://archive.nptel.ac.in/courses/106/102/106102011/</a> |
| <b>3</b>                              | <a href="https://archive.nptel.ac.in/courses/106/102/106102011/">https://archive.nptel.ac.in/courses/106/102/106102011/</a> |
| <b>4</b>                              | <a href="https://archive.nptel.ac.in/courses/106/102/106102011/">https://archive.nptel.ac.in/courses/106/102/106102011/</a> |

## SEMESTER S4

### CYBER ETHICS, PRIVACY AND LEGAL ISSUES

(Common to CS/CM/CA/AM)

|                                            |                 |                    |                |
|--------------------------------------------|-----------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST419</b> | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0         | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 3               | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | None            | <b>Course Type</b> | Theory         |

#### Course Objectives:

1. To provide a comprehensive understanding of the fundamental concepts of cyberspace and cyber law, enabling them to analyse and address the challenges of regulating and securing the digital world
2. To explain cybercrime, intellectual property, cyber ethics, and ethical issues in emerging technologies, enabling them to tackle related challenges effectively.
3. To give awareness on data protection and privacy in cyberspace, and to learn legal frameworks protecting privacy, enabling them to address and manage privacy-related challenges effectively

## SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Contact Hours</b> |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <b>Fundamentals of Cyber Law and Cyber Space:-</b> Introduction to cyber law, Contract aspects in cyber law, Security aspects of cyber law, Intellectual property aspects in cyber law and Evidence aspects in cyber law, Criminal aspects in cyber law, Need for Indian cyber law<br><br>Cyberspace- Web space, Web hosting and web development agreement, Legal and Technological Significance of domain Names, Internet as a tool for global access.                              | <b>9</b>             |
| <b>2</b>          | <b>Cyber crime and Cyber Ethics:-</b> Cyber crime and Cyber Ethics:- Introduction to cybercrime- Definition and Origins of Cyber crime- Classifications of Cybercrime, Cyber Offences- Strategic Attacks, Types of Attacks, Security Challenges Faced by Mobile Devices. Organizational Measures for Handling Mobile Phones.<br><br>Cyber Ethics: The Importance of Cyber Law, Significance of Cyber Ethics, Need for Cyber regulations Based on Cyber Ethics, Ethics in Information | <b>9</b>             |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                       |          |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|          | society, Artificial Intelligence Ethics- Ethical Issues in AI and core Principles, Block chain Ethics- Definition and Description.                                                                                                                                                                                                                                                                                    |          |
| <b>3</b> | <b>Data Protection and Privacy Concerns in Cyberspace :</b> Need to protect data in cyberspace, Types of data , Legal framework of data protection, Data protection bill -an overview, GDPR, Concept of privacy, Privacy concerns of cyberspace, Constitutional framework of privacy, Judicial interpretation of privacy in India, Privacy Law and Regulation, Organizational Response, Privacy and Data Surveillance | <b>9</b> |
| <b>4</b> | <b>Security Policies and Information Technology Act</b><br><br>Need for an Information Security policy, Information Security Standards- ISO, Introducing various security policies and their review process, Information Technology Act, 2000, Penalties, Adjudication and appeals under the IT Act,2000, Offences under IT Act, 2000, Right to Information Act, 2005, IT Act,2008 and its amendments.                | <b>9</b> |

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

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

| <b>Attendance</b> | <b>Assignment/<br/>Microproject</b> | <b>Internal<br/>Examination-1<br/>(Written)</b> | <b>Internal<br/>Examination- 2<br/>(Written)</b> | <b>Total</b> |
|-------------------|-------------------------------------|-------------------------------------------------|--------------------------------------------------|--------------|
| <b>5</b>          | <b>15</b>                           | <b>10</b>                                       | <b>10</b>                                        | <b>40</b>    |

### End Semester Examination Marks (ESE)

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

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

### Course Outcomes (COs)

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

| Course Outcome |                                                                                                                                                                                                               | Bloom's Knowledge Level (KL) |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| CO1            | Describe the concepts of cyber law and the various components and challenges associated with cyberspace.                                                                                                      | K2                           |
| CO2            | Discuss the concept of cybercrime and computer crime, the challenges faced by law enforcement, and the importance of intellectual property in the digital age.                                                | K2                           |
| CO3            | Explain the importance of cyber law and ethics, the need for regulations, and the ethical considerations in emerging technologies like AI and blockchain.                                                     | K2                           |
| CO4            | Identify data protection and privacy issues in cyberspace and describe various laws and regulations to address these challenges in the digital age, ensuring comprehensive privacy protection and compliance. | K2                           |

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



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

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

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

| Reference Books |                                                                                      |                                                             |                       |                    |
|-----------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------|-----------------------|--------------------|
| Sl. No          | Title of the Book                                                                    | Name of the Author/s                                        | Name of the Publisher | Edition and Year   |
| 1               | Cyber Security and Cyber Laws                                                        | Nilakshi Jain, Ramesh Menon                                 | Wiley                 | 1/e, 2020          |
| 2               | Cyber Security understanding Cyber Crimes, Computer Forensics and Legal Perspectives | Sumit Belapure , Nina Godbole                               | Wiley India Pvt.Ltd.  | 1/e, 2011          |
| 3               | Cyber Ethics 4.0: Serving Humanity with Values                                       | Christoph Stückelberger, Pavan Duggal                       | Globethics            | 1/e, 2018          |
| 4               | Cyber Laws: Intellectual property & E Commerce, Security                             | K. Kumar                                                    | Dominant Publisher    | 1/e,2011           |
| 5               | Introduction to Information Security and Cyber Laws                                  | Surya Prakash Tripathi, Ritendra Goel, Praveen Kumar Shukla | Dreamtech Press       | 1/e, 2014          |
| 6               | Cyber Law: The Law of the Internet and Information Technology                        | Craig B                                                     | Pearson Education     | First Edition,2013 |

| Video Links (NPTEL, SWAYAM...) |                                                                                                                                                                           |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No.                            | Link ID                                                                                                                                                                   |
| 1                              | <a href="https://www.wbnsou.ac.in/NSOU-MOOC/mooc_cyber_security.shtml">https://www.wbnsou.ac.in/NSOU-MOOC/mooc_cyber_security.shtml</a>                                   |
| 2                              | <a href="https://onlinecourses.swayam2.ac.in/cec22_1w07/preview">https://onlinecourses.swayam2.ac.in/cec22_1w07/preview</a>                                               |
| 3                              | <a href="https://www.coursera.org/learn/data-security-privacy#modules">https://www.coursera.org/learn/data-security-privacy#modules</a>                                   |
| 4                              | <a href="https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044">https://jurnal.fh.unila.ac.id/index.php/fiat/article/download/2667/1961/12044</a> |

## SEMESTER S4

### VLSI DESIGN

(Common to CS/CN/CI)

|                                            |                 |                    |                |
|--------------------------------------------|-----------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST415</b> | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0         | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 5/3             | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | GAEST305        | <b>Course Type</b> | Elective       |

#### Course Objectives:

1. To impart the key concepts of MOS technology including characteristics of CMOS and its application in digital VLSI circuits to design basic CMOS logic gates.
2. To impart the key concepts of Integrated Circuit Design and introduce various design flows.
3. To equip the learner to implement both combinational and sequential logic circuits using both semi-custom and FPGA design flow.

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Contact Hours</b> |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <b>CMOS Fundamentals for Digital VLSI Design :</b><br><br>CPN junction, MOS transistor theory and operation, PMOS, NMOS, CMOS, CMOS Inverter, Voltage Transfer Curve, CMOS logic gates, Tristate Inverter, Tristate buffer. Combinational Circuits Timing - Rise Time, Fall time, Propagation Delay. Introduction to sequential logic circuits, flip-flops and latches, Timing analysis - Set-up time, Hold Time, Propagation Delay, Frequency of Operation, Static and Dynamic Timing Analysis, Pipelining | <b>9</b>             |
| <b>2</b>          | <b>Introduction to Integrated Circuits (ICs):</b><br><br>CMOS fabrication process overview- Photolithography, Structure of an Integrated Circuit, Types of Design flow - Custom design, Semi-custom design, array based design. A System Perspective, Hardware – Software Partitioning, example Video compression, Functional Specification to RTL, Behavioural Synthesis.                                                                                                                                  | <b>9</b>             |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                        |          |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>3</b> | <b>Semi-custom Design flow</b><br><br>Abstraction in VLSI Design Flow- Gajski-Kuhn's Y-chart, Hardware design using hardware description Languages, Design Verification- Simulation using Testbench, Property Checking, Equivalence Checking, Static Timing Analysis, Logic Synthesis, Physical Design- Min-cut Partitioning, Floor plan- , Global and Detailed Placement, Global and Detailed Routing, Micro project* | <b>9</b> |
| <b>4</b> | <b>Finite State Machines (FSMs):</b> Mealy and Moore models. Verilog HDL Design and implementation of RISC stored programmed Machine.<br><br><b>Field Programmable Gate Arrays (FPGAs) :</b> FPGA Architecture- Programming Technology, Programmable logical blocks, Programmable Interconnects, Programmable I/O blocks, FPGA Design Flow, SoC Design on FPGA, Micro project*.                                        | <b>9</b> |

\* Micro-project on FPGA / Semi-Custom Flow.

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

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

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

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

- Ability to capture the specification and ability for RTL coding,
- Ability to analyze the circuit for resource utilization such as area consumption and power consumption. Analyze the circuit for timing violations. Optimize performance.

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

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

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

**Course Outcomes (COs)**

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

| Course Outcome |                                                                                        | Bloom's Knowledge Level (KL) |
|----------------|----------------------------------------------------------------------------------------|------------------------------|
| <b>CO1</b>     | Utilize the MOS Circuits and design basic circuits using CMOS.                         | <b>K3</b>                    |
| <b>CO2</b>     | Explain IC design flow and design a system using hardware software co-design strategy. | <b>K3</b>                    |
| <b>CO3</b>     | Design, simulate and implement systems design in HDL using semi-custom flow.           | <b>K4</b>                    |
| <b>CO4</b>     | Design, simulate and implement digital systems using programmable devices.             | <b>K4</b>                    |

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 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   |     | 3   |     |     |     |     |      |      | 3    |
| <b>CO2</b> | 3   | 3   | 3   |     | 3   |     |     |     |     |      |      | 3    |
| <b>CO3</b> | 3   | 3   | 3   |     | 3   |     |     |     |     |      |      | 3    |
| <b>CO4</b> | 3   | 3   | 3   |     | 3   |     |     |     |     |      |      | 3    |

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

| <b>Text Books</b> |                                                    |                                                          |                              |                         |
|-------------------|----------------------------------------------------|----------------------------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>     | <b>Title of the Book</b>                           | <b>Name of the Author/s</b>                              | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>          | Introduction to VLSI Design Flow                   | Sneh Saurabh                                             | Cambridge University Press   | 1/e, 2023               |
| <b>2</b>          | Digital Integrated Circuits: A Design Perspective. | Jan M. Rabaey, Anantha P. Chandrakasan, Borivoje Nikolic | Pearson Education            | 2/e, 2003               |
| <b>2</b>          | Digital Systems Design Using Verilog               | Charles H. Roth Jr., Lizy Kurian John, Beyeong Kil Lee,  | CL Engineering               | 1/e, 2015               |
| <b>3</b>          | Advanced Digital Design with the Verilog HDL       | Micahel D. Ciletti                                       | Pearson                      | 2/e, 2017               |

| <b>Reference Books</b> |                                                           |                                    |                              |                         |
|------------------------|-----------------------------------------------------------|------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>                                  | <b>Name of the Author/s</b>        | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>               | Digital Design and Computer Architecture - RISC-V Edition | Sarah L. Harris, David Harris      | Morgan Kaufmann              | 1/e, 2022               |
| <b>2</b>               | Digital Design: With an Introduction to the Verilog HDL   | M. Morris Mano, Michael D. Ciletti | Pearson India                | 5/e, 2012               |
| <b>3</b>               | Verilog HDL – A guide to digital design & Synthesis       | Samir Palnitkar                    | Pearson                      | 2/e, 2003               |
| <b>4</b>               | FPGA Based System Design                                  | Wayne Wolf                         | Pearson                      | 1/e, 2004               |
| <b>5</b>               | Embedded Core Design with FPGAs                           | Zainalabedin Navabi                | McGraw-Hill                  | 1/e, 2006               |

| <b>Video Links (NPTEL, SWAYAM...)</b> |                                                                                                                                                                                                                       |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>No.</b>                            | <b>Link ID</b>                                                                                                                                                                                                        |
| <b>1</b>                              | Introduction to Digital VLSI Design Flow, Introduction to Digital VLSI Design Flow, IIT Guwahati <a href="https://nptel.ac.in/courses/106103116">https://nptel.ac.in/courses/106103116</a>                            |
| <b>2</b>                              | Introduction to VLSI Design by Prof. S. Srinivasan , IIT Madras, <a href="https://nptel.ac.in/courses/117106092">https://nptel.ac.in/courses/117106092</a>                                                            |
| <b>3</b>                              | VLSI Physical Design by Prof. Indranil Sengupta, IIT Kharagpur, <a href="https://onlinecourses.nptel.ac.in/noc21_cs12/preview">https://onlinecourses.nptel.ac.in/noc21_cs12/preview</a>                               |
| <b>4</b>                              | Digital System Design using PLDs and FPGAs , Prof. Kuruvilla Varghese from IISc Bangalore <a href="https://archive.nptel.ac.in/courses/117/108/117108040/">https://archive.nptel.ac.in/courses/117/108/117108040/</a> |

## SEMESTER S4

### ADVANCED DATA STRUCTURES

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

|                                            |                 |                    |                |
|--------------------------------------------|-----------------|--------------------|----------------|
| <b>Course Code</b>                         | <b>PECST495</b> | <b>CIE Marks</b>   | 40             |
| <b>Teaching Hours/Week<br/>(L: T:P: R)</b> | 3:0:0:0         | <b>ESE Marks</b>   | 60             |
| <b>Credits</b>                             | 5/3             | <b>Exam Hours</b>  | 2 Hrs. 30 Min. |
| <b>Prerequisites (if any)</b>              | PCCST303        | <b>Course type</b> | Theory         |

#### Course Objectives:

1. To equip students with comprehensive knowledge of advanced data structures utilized in cutting-edge areas of computer science, including database management, cyber security, information retrieval, and networked systems.
2. To prepare students to address challenges in emerging fields of computer science by applying advanced data structures to practical, real-world problems.

#### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                          | <b>Contact Hours</b> |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | <b>Foundational Data Structures-</b> Overview of Arrays and Linked Lists, implementation of pointers and objects, Representing rooted trees, Hashing - Hash Tables, Hash functions, Cuckoo Hashing; Bloom Filters - Count-Min Sketch, Applications to Networks - Click Stream Processing using Bloom Filters, Applications to Data Science - Heavy Hitters and count-min structures. | <b>9</b>             |
| <b>2</b>          | <b>Advanced Tree Data Structures</b> - Balanced Trees - AVL Trees (review), Red-Black Trees, Suffix Trees and Arrays, Segment Trees, Heaps and Related Structures – Binomial heap, Fibonacci Heaps, Merkle Trees, Applications to information Retrieval and WWW - AutoComplete using Tries.                                                                                          | <b>9</b>             |

|          |                                                                                                                                                                                                                                                                                                                                                                               |          |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>3</b> | <b>Specialized Data Structures</b> - Spatial Data Structures – Quadtree, K-D Trees (k-dimensional tree); R-trees; Temporal Data Structures- Persistence, Retroactivity; Search and Optimization Trees – Skip List, Tango Trees; Applications to Data Science - Approximate nearest neighbor search, Applications to information Retrieval and WWW, Posting List intersection. | <b>9</b> |
| <b>4</b> | <b>Data Structure applications</b> - Distributed and Parallel Data Structures - Distributed Hash Tables (DHTs); Consistent Hashing; Distributed BST; Data Compression and Transformations - Burrows-Wheeler Transform; Histogram; Wavelet Trees; Cryptographic Applications – Hashing.                                                                                        | <b>9</b> |

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

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

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

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

Implement various real world problems using multiple suitable data structures and compare the performance.

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

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

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



### Course Outcomes (COs)

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

| Course Outcome |                                                                                                               | Bloom's Knowledge Level (KL) |
|----------------|---------------------------------------------------------------------------------------------------------------|------------------------------|
| <b>CO1</b>     | Implement and use arrays, linked lists, rooted trees and hashing techniques in various programming scenarios. | <b>K3</b>                    |
| <b>CO2</b>     | Design and implement advanced tree data structures for information retrieval.                                 | <b>K3</b>                    |
| <b>CO3</b>     | Use spatial and temporal data structures in data science problems.                                            | <b>K3</b>                    |
| <b>CO4</b>     | Analyze data structures in special scenarios such as distributed, parallel and data compression areas.        | <b>K5</b>                    |

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 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   | 2   | 3   |     |     |     |     |      | 2    | 3    |
| <b>CO2</b> | 3   | 3   | 3   | 3   | 3   |     |     |     |     |      | 2    | 3    |
| <b>CO3</b> | 3   | 3   | 3   | 3   | 3   |     |     |     |     |      | 2    | 3    |
| <b>CO4</b> | 3   | 3   | 3   | 3   | 3   |     |     |     |     |      | 2    | 2    |

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

| Reference Books |                                                   |                                                                       |                            |                  |
|-----------------|---------------------------------------------------|-----------------------------------------------------------------------|----------------------------|------------------|
| Sl. No          | Title of the Book                                 | Name of the Author/s                                                  | Name of the Publisher      | Edition and Year |
| 1               | Advanced Data Structures: Theory and Applications | Suman Saha, Shailendra Shukla                                         | CRC Press                  | 1/e, 2019        |
| 2               | Advanced Data Structures                          | Peter Brass                                                           | Cambridge University Press | 1/e, 2008        |
| 3               | Introduction to Algorithms                        | Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein | MIT Press                  | 4/e, 2022        |
| 4               | Fundamentals of Computer Algorithms               | Ellis Horowitz, Satraj Sahani and Rajasekharam                        | University Press           | 2/e, 2009        |
| 5               | Advanced Data Structures                          | Reema Thareja, S. Rama Sree                                           | Oxford University Press    | 1/e, 2018        |
| 6               | Data Structures and Algorithm Analysis in C++,    | Mark Allen Weiss                                                      | Pearson                    | 2/e, 2004.       |
| 7               | Design and Analysis of Algorithms                 | M T Goodrich, Roberto Tamassia                                        | Wiley                      | 1/e, 2021        |

| Video Links (NPTEL, SWAYAM...) |                                                                                           |
|--------------------------------|-------------------------------------------------------------------------------------------|
| Module No.                     | Link ID                                                                                   |
| 1                              | <a href="https://web.stanford.edu/class/cs166/">https://web.stanford.edu/class/cs166/</a> |

## SEMESTER S3/S4

### ECONOMICS FOR ENGINEERS

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

#### Course Objectives:

1. To provide students with an understanding of fundamental economic principles essential for effective decision-making in engineering contexts.
2. To enable students to apply economic analysis to production decisions, cost management, and market strategies in engineering practice.
3. To equip students with the ability to evaluate macroeconomic scenarios, financial methods, and investment decisions relevant to engineering projects.

### SYLLABUS

| <b>Module No.</b> | <b>Syllabus Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Contact Hours</b> |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>1</b>          | Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility –Demand: Factors determining demand – Law of Demand – Demand curve- Price elasticity of demand- measurement of price elasticity and its applications – Supply: factors determining supply - Law of supply – Supply curve- Equilibrium price determination- Changes in demand and supply and its effects on equilibrium price and quantity<br><br>Production: Production function - Law of variable proportion –Returns to scale- Cobb-Douglas Production Function | <b>6</b>             |
| <b>2</b>          | Cost: Cost concepts – Private cost and social cost – Sunk cost – Opportunity cost -Explicit and implicit cost –Short run cost curves –Long run average cost curve -Revenue concepts – Break-even point<br><br>Market: Perfect Competition – Monopoly - Monopolistic Competition (features and equilibrium of a firm) - Oligopoly – Features – Kinked demand model                                                                                                                                                                                                        | <b>6</b>             |

|          |                                                                                                                                                                                                                                                                                                                                                      |          |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>3</b> | National income: Concepts (GDP, GNP and NNP)– Final goods and Intermediate goods - Methods of Estimation –output method – expenditure method-- Difficulties in the measurement of national income.<br><br>Inflation: Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Repo and reverse repo rate                  | <b>6</b> |
| <b>4</b> | Value Analysis and value Engineering: Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure<br><br>Capital Budgeting: Time value of money - Net Present Value Method - Benefit Cost Ratio – Internal Rate of Return – Payback – Accounting Rate of Return. | <b>6</b> |

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

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

| <b>Attendance</b> | <b>Assignment/Case Study/<br/>Microproject</b> | <b>Internal Examination-1<br/>(Written)</b> | <b>Internal Examination- 2<br/>(Written )</b> | <b>Total</b> |
|-------------------|------------------------------------------------|---------------------------------------------|-----------------------------------------------|--------------|
| <b>10</b>         | <b>15</b>                                      | <b>12.5</b>                                 | <b>12.5</b>                                   | <b>50</b>    |

**End Semester Examination Marks (ESE)**

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

| <b>Part A</b>                                                                                                                                                                  | <b>Part B</b>                                                                                                                                                                                   | <b>Total</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <ul style="list-style-type: none"> <li>• Minimum 1 and Maximum 2 Questions from each module.</li> <li>• Total of 6 Questions, each carrying 3 marks (6x3 =18 marks)</li> </ul> | 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks.<br>(4x8 = 32 marks) | <b>50</b>    |

### Course Outcomes (COs)

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

| Course Outcome |                                                                                                                                                                                 | Bloom's Knowledge Level (KL) |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <b>CO1</b>     | Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.                                 | <b>K2</b>                    |
| <b>CO2</b>     | Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations. | <b>K3</b>                    |
| <b>CO3</b>     | Outline the macroeconomic principles of monetary and fiscal systems and national income.                                                                                        | <b>K2</b>                    |
| <b>CO4</b>     | Make use of the possibilities of value analysis and engineering, and take investment decisions through capital budgeting techniques.                                            | <b>K3</b>                    |

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

### CO-PO Mapping Table:

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | -   | -   | -   | -   | -   | 1   | -   | -   | -   | -    | 1    | -    |
| <b>CO2</b> | -   | -   | -   | -   | -   | 1   | 1   | -   | -   | -    | 1    | -    |
| <b>CO3</b> | -   | -   | -   | -   | 1   | -   | -   | -   | -   | -    | 2    | -    |
| <b>CO4</b> | -   | -   | -   | -   | 1   | 1   | -   | -   | -   | -    | 2    | -    |

| Text Books |                       |                                    |                        |                  |
|------------|-----------------------|------------------------------------|------------------------|------------------|
| Sl. No     | Title of the Book     | Name of the Author/s               | Name of the Publisher  | Edition and Year |
| <b>1</b>   | Managerial Economics  | Geetika, Piyali Ghosh and Chodhury | Tata McGraw Hill,      | 2015             |
| <b>2</b>   | Engineering Economy   | H. G. Thuesen, W. J. Fabrycky      | PHI                    | 1966             |
| <b>3</b>   | Engineering Economics | R. Paneerselvam                    | PHI                    | 2012             |
| <b>4</b>   | Financial Management  | I M Pandey                         | Vikas Publishing House | 2015             |

| <b>Reference Books</b> |                                           |                                            |                              |                         |
|------------------------|-------------------------------------------|--------------------------------------------|------------------------------|-------------------------|
| <b>Sl. No</b>          | <b>Title of the Book</b>                  | <b>Name of the Author/s</b>                | <b>Name of the Publisher</b> | <b>Edition and Year</b> |
| <b>1</b>               | Engineering Economy                       | Leland Blank P.E,<br>Anthony Tarquin P. E. | Mc Graw Hill                 | 7 <sup>TH</sup> Edition |
| <b>2</b>               | Indian Financial System                   | Khan M. Y.                                 | Tata McGraw Hill             | 2011                    |
| <b>3</b>               | Engineering Economics and analysis        | Donald G. Newman,<br>Jerome P. Lavelle     | Engg. Press, Texas           | 2002                    |
| <b>4</b>               | Contemporary Engineering Economics        | Chan S. Park                               | Prentice Hall of India Ltd   | 2001                    |
| <b>5</b>               | Financial Management: Theory and Practice | Prasanna Chandra                           | Mc Graw Hill                 | 2007                    |

| MODEL QUESTION PAPER                                                         |        |                                                                                                                                                                                                     |                              |       |
|------------------------------------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------|
| APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY                                     |        |                                                                                                                                                                                                     |                              |       |
| THIRD SEMESTER B. TECH DEGREE EXAMINATION, MONTH AND YEAR                    |        |                                                                                                                                                                                                     |                              |       |
| Course Code: UCHUT346                                                        |        |                                                                                                                                                                                                     |                              |       |
| Course Name: Economics for Engineers                                         |        |                                                                                                                                                                                                     |                              |       |
| Max. Marks: 50                                                               |        |                                                                                                                                                                                                     | Duration: 2 hours 30 minutes |       |
|                                                                              | PART A |                                                                                                                                                                                                     |                              |       |
|                                                                              |        | Answer all questions. Each question carries 3 marks                                                                                                                                                 | CO                           | Marks |
| 1                                                                            |        | What are the central problems of an economy?                                                                                                                                                        | CO1                          | (3)   |
| 2                                                                            |        | Point out any three applications of price elasticity of demand.                                                                                                                                     | CO1                          | (3)   |
| 3                                                                            |        | What is the social cost of production?                                                                                                                                                              | CO2                          | (3)   |
| 4                                                                            |        | What is repo rate?                                                                                                                                                                                  | CO3                          | (3)   |
| 5                                                                            |        | What is esteem value?                                                                                                                                                                               | CO4                          | (3)   |
| 6                                                                            |        | Write a short note on time value of money.                                                                                                                                                          | CO4                          | (3)   |
| PART B                                                                       |        |                                                                                                                                                                                                     |                              |       |
| Answer any one full question from each module. Each question carries 8 marks |        |                                                                                                                                                                                                     |                              |       |
| Module 1                                                                     |        |                                                                                                                                                                                                     |                              |       |
| 9                                                                            | a)     | Suppose a country is producing at a point inside the production possibility curve. Draw a PPC and examine this situation.                                                                           | CO1                          | (5)   |
|                                                                              | b)     | State the law of demand. Point out any two exceptions of this law.                                                                                                                                  | CO1                          | (3)   |
| 10                                                                           | a)     | A consumer purchases 10 units of a commodity when its price is Rs.100. Later when its price falls to Rs.90, he purchases 8 units only. Estimate price elasticity. What type of a commodity is this? | CO1                          | (5)   |
|                                                                              | b)     | State the law of variable proportion.                                                                                                                                                               | CO1                          | (3)   |

| Module 2 |    |                                                                                                                                                                                                                                                                                 |     |     |
|----------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|
| 11       | a) | What is oligopoly? Why price is rigid under oligopoly?                                                                                                                                                                                                                          | CO2 | (5) |
|          | b) | The cost function of a firm is given as $TC=1000+10Q-6Q^2+Q^3$ . Calculate fixed cost, variable cost and marginal cost when output is 10 units.                                                                                                                                 | CO2 | (3) |
| 12       | a) | Suppose a firm is earning super normal profit under monopolistic market condition. Explain this situation by drawing a diagram.                                                                                                                                                 | CO2 | (5) |
|          | b) | Suppose a firm sells its product at a price of Rs.10 per unit and its average variable cost is Rs.6. If the firm spend Ra.10000 as rent and pay Rs. 6000 as interest every month, estimate its break-even level of output.                                                      | CO2 | (3) |
| Module 3 |    |                                                                                                                                                                                                                                                                                 |     |     |
| 13       | a) | What is inflation? How does inflation affect investment and production.                                                                                                                                                                                                         | CO3 | (5) |
|          | b) | How will you obtain $NNP_{fc}$ from $GDP_{mp}$ .                                                                                                                                                                                                                                | CO3 | (3) |
| 14       | a) | From the data given below (In Rs. Crores) estimate $GDP_{mp}$ and national income.<br><br>Private final consumption expenditure = 1000, Government expenditure = 500, Invest expenditure = 700, Net exports = 300, Depreciation = 200, $NFIA=(-200)$ and Net indirect tax = 100 | CO3 | (5) |
|          | b) | What is bank rate? Examine the bank rate policy of the government during inflation.                                                                                                                                                                                             | CO3 | (3) |
| Module 4 |    |                                                                                                                                                                                                                                                                                 |     |     |
| 15       | a) | Examine the procedures of value engineering.                                                                                                                                                                                                                                    | CO4 | (5) |
|          | b) | Examine the application areas of value engineering                                                                                                                                                                                                                              | CO4 | (3) |



|       |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |     |
|-------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|
| 16    | a) | 1. Suppose the initial investment of a project is Rs. 3000 (Crores) and the cost of capital or the opportunity cost of capital is 10 percent. Calculate NPV of the project based on the cash flows given below.<br><br>Year                      1                      2                      3                      4                      5<br><br>Cash flow                1000                900                800                700                600<br><br>(In Crores) | CO4 | (5) |
|       | b) | Point out any three merits of NPV method.                                                                                                                                                                                                                                                                                                                                                                                                                                          | CO4 | (3) |
| ***** |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |     |

## SEMESTER S3/S4

### ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

|                                    |          |             |                |
|------------------------------------|----------|-------------|----------------|
| Course Code                        | UCHUT347 | CIE Marks   | 50             |
| Teaching Hours/Week<br>(L: T:P: R) | 2:0:0:0  | ESE Marks   | 50             |
| Credits                            | 2        | Exam Hours  | 2 Hrs. 30 Min. |
| Prerequisites (if any)             | None     | Course Type | Theory         |

#### Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

### SYLLABUS

| Module No. | Syllabus Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Contact Hours |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1          | <b>Fundamentals of ethics</b> - Personal vs. professional ethics, Civic Virtue, Respect for others, <b>Profession and Professionalism</b> , Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, <b>Technology and digital revolution</b> -Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, <b>High technologies: connecting people and places</b> -accessibility and social impacts, <b>Managing conflict</b> , Collective bargaining, <b>Confidentiality</b> , Role of confidentiality in moral integrity, <b>Codes of Ethics</b> .<br><b>Basic concepts in Gender Studies</b> - sex, gender, sexuality, gender | 6             |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|          | spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, <b>Gender disparity and discrimination in education</b> , employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, <b>Ethical values and practices in connection with gender</b> - equity, diversity & gender justice, <b>Gender policy and women/transgender empowerment initiatives</b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |
| <b>2</b> | <b>Introduction to Environmental Ethics:</b> Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). <b>Sustainable Engineering Principles:</b> Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. <b>Ecosystems and Biodiversity:</b> Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. <b>Landscape and Urban Ecology:</b> Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.                                                                                                                                                              | <b>6</b> |
| <b>3</b> | <b>Hydrology and Water Management:</b> Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. <b>Zero Waste Concepts and Practices:</b> Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. <b>Circular Economy and Degrowth:</b> Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. <b>Mobility and Sustainable Transportation:</b> Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions. | <b>6</b> |
| <b>4</b> | <b>Renewable Energy and Sustainable Technologies:</b> Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>6</b> |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  | <p>energy production and consumption, Challenges and opportunities in renewable energy adoption. <b>Climate Change and Engineering Solutions:</b> Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. <b>Environmental Policies and Regulations:</b> Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. <b>Case Studies and Future Directions:</b> Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.</p> |  |
|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

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

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

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

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

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

\*Can be taken from the given sample activities/projects

#### Evaluation Criteria:

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

### Course Outcomes (COs)

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

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

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

### CO-PO Mapping Table:

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

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

### Suggested Activities/Projects:

#### Module-II

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

### **Module-III**

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

### **Module-IV**

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



## SEMESTER S4

### OPERATING SYSTEMS LAB

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

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

#### Course Objectives:

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

| Expt. No. | Experiments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1         | Familiarisation with basic Linux programming commands: ps, strace, gdb, strings, objdump, nm, file, od, xxd, time, fuser, top                                                                                                                                                                                                                                                                                                                                                                 |
| 2         | Use <b>/proc</b> file system to gather basic information about your machine:<br><br>(a) Number of CPU cores<br>(b) Total memory and the fraction of free memory<br>(c) Number of processes currently running.<br>(d) Number of processes in the running and blocked states.<br>(e) Number of processes forked since the last bootup. How do you compare this value with the one in (c) above?<br>(f) The number of context switches performed since the last bootup for a particular process. |
| 3         | Write a simple program to print the system time and execute it. Then use the <b>/proc</b> file system to determine how long this program (in the strict sense, the corresponding process) ran in user and kernel modes.                                                                                                                                                                                                                                                                       |
| 4         | Create a new process using a <b>fork</b> system call. Print the parent and child process IDs. Use the <b>ps</b> command to find the process tree for the child process starting from the <b>init</b>                                                                                                                                                                                                                                                                                          |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | process.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 5 | Write a program to add two integers (received via the command line) and compile it to an executable named “ <b>myadder</b> ”. Now write another program that creates a new process using a <b>fork</b> system call. Make the child process add two integers by replacing its image with the “ <b>myadder</b> ” image using <b>execvp</b> system call.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 6 | Create a new process using a <b>fork</b> system call. The child process should print the string “ <b>PCCSL407</b> ” and the parent process should print the string “ <b>Operating Systems Lab</b> ”. Use a <b>wait</b> system call to ensure that the output displayed is “ <b>PCCSL407 Operating Systems Lab</b> ”                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 7 | <p><b>Inter-process Communication (<a href="https://www.linuxdoc.org/LDP/lpg/node7.html">https://www.linuxdoc.org/LDP/lpg/node7.html</a>)</b></p> <p>(a) Using Pipe – Evaluate the expression <math>\sqrt{b^2 + 4ac}</math>. The first process evaluates <math>b^2</math>. The second process evaluates <math>4ac</math> and sends it to the first process which evaluates the final expression and displays it.</p> <p>(b) Using Message Queue - The first process sends a string to the second process. The second process reverses the received string and sends it back to the first process. The first process compares the original string and the reversed string received from the second one and then prints whether the string is a palindrome or not.</p> <p>(c) Using Shared Memory - The first process sends three strings to the second process. The second process concatenates them to a single string (with whitespace being inserted between the two individual strings) and sends it back to the first process. The first process prints the concatenated string in the flipped case, that is if the concatenated string is “<b>Hello S4 Students</b>”, the final output should be “<b>hELLO s4 sTUDENTS</b>”</p> |
| 8 | Write a multithreaded program that calculates the mean, median, and standard deviation for a list of integers. This program should receive a series of integers on the command line and will then create three separate worker threads. The first thread will determine the mean value, the second will determine the median and the third will calculate the standard deviation of the integers. The variables representing the mean, median, and standard deviation values will be stored globally. The worker threads will set these values, and the parent thread will output the values once the workers have exited.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9 | Input a list of processes, their CPU burst times (integral values), arrival times, and priorities. Then simulate FCFS, SRTF, non-preemptive priority (a larger priority number implies a higher priority), and RR (quantum = 3 units) scheduling algorithms on the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | process mix, determining which algorithm results in the minimum average waiting time (over all processes).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 10 | Use semaphores to solve the readers-writers problem with writers being given priority over readers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11 | Obtain a (deadlock-free) process mix and simulate the banker's algorithm to determine a safe execution sequence.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 12 | Obtain a process mix and determine if the system is deadlocked.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 13 | Implement the deadlock-free semaphore-based solution for the dining philosopher's problem.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 14 | <p>Simulate the address translation in the paging scheme as follows: The program receives three command line arguments in the order</p> <ul style="list-style-type: none"> <li>• size of the virtual address space (in megabytes)</li> <li>• page size (in kilobytes)</li> <li>• a virtual address (in decimal notation)</li> </ul> <p>The output should be the physical address corresponding to the virtual address in &lt;frame number, offset&gt; format. You may assume that the page table is implemented as an array indexed by page numbers. (NB: If the page table has no index for the page number determined from the virtual address, you may just declare a page table miss!)</p> |
| 15 | Simulate the FIFO, LRU, and optimal page-replacement algorithms as follows: First, generate a random page-reference string where page numbers range from 0 to 9. Apply the random page-reference string to each algorithm, and record the number of page faults incurred by each algorithm. Assume that demand paging is used. The length of the reference string and the number of page frames (varying from 1 to 7) are to be received as command line arguments.                                                                                                                                                                                                                            |
| 16 | Simulate the SSTF, LOOK, and CSCAN disk-scheduling algorithms as follows: Your program will service a disk with 5,000 cylinders numbered 0 to 4,999. The program will generate a random series of 10 cylinder requests and service them according to each of the algorithms listed earlier. The program will be passed the initial position of the disk head (as a parameter on the command line) and will report the total number of head movements required by each algorithm.                                                                                                                                                                                                               |

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

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

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

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

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

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

**Course Outcomes (COs)**

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

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

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

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

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

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

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

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

| Video Links (NPTEL, SWAYAM...) |                                                                                                                                                                 |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Module No.                     | Link ID                                                                                                                                                         |
| 1                              | <a href="https://archive.nptel.ac.in/courses/106/105/106105214/">https://archive.nptel.ac.in/courses/106/105/106105214/</a>                                     |
| 2                              | <a href="https://www.youtube.com/playlist?list=PLDW872573QAb4bj0URobvQTD41IV6gRkx">https://www.youtube.com/playlist?list=PLDW872573QAb4bj0URobvQTD41IV6gRkx</a> |

## Continuous Assessment (25 Marks)

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

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

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

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

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

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

### 4. Viva Voce (5 Marks)

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

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

## **Evaluation Pattern for End Semester Examination (50 Marks)**

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

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

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

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

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

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

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

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

### **5. Record (5 Marks)**

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

## SEMESTER S4

### DBMS LAB

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

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

#### Course Objectives:

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

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

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



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

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

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

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

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

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

**Course Outcomes (COs)**

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

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

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

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

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

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

| Text Books |                                  |                      |                       |                  |
|------------|----------------------------------|----------------------|-----------------------|------------------|
| Sl. No     | Title of the Book                | Name of the Author/s | Name of the Publisher | Edition and Year |
| 1          | Fundamentals of Database Systems | Elmasri, Navathe     | Pearson               | 7/e, 2017        |
| 2          | Professional NoSQL               | Shashank Tiwari      | Wiley                 | 1/e, 2011        |

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

| Video Links (NPTEL, SWAYAM...) |                                                                                                                             |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Module No.                     | Link ID                                                                                                                     |
| 1                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs04/preview">https://onlinecourses.nptel.ac.in/noc21_cs04/preview</a>     |
| 2                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs04/preview">https://onlinecourses.nptel.ac.in/noc21_cs04/preview</a>     |
| 3                              | <a href="https://onlinecourses.nptel.ac.in/noc21_cs04/preview">https://onlinecourses.nptel.ac.in/noc21_cs04/preview</a>     |
| 4                              | <a href="https://archive.nptel.ac.in/courses/106/104/106104135/">https://archive.nptel.ac.in/courses/106/104/106104135/</a> |

## **Continuous Assessment (25 Marks)**

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

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

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

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

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

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

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

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

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

## **Evaluation Pattern for End Semester Examination (50 Marks)**

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

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

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

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

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

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

- Accuracy of Results: Precision and correctness of the obtained results.
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## **5. Record (5 Marks)**

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