

**B. TECH. FOUR YEAR DEGREE**

**PROGRAM CURRICULUM**

(Applicable for the batches admitted from A.Y 2025-26)

**ELECTRONICS AND  
COMMUNICATION ENGINEERING**



**A D I T Y A**  
**U N I V E R S I T Y**

Aditya Nagar, ADB Road, Surampalem - 533 437



## Department of Electronics and Communication Engineering

### **Vision:**

To be a recognized centre of excellence in Electronics and Communication Engineering through quality education, innovation, and research to meet societal and industrial needs.

### **Mission:**

**M1:** Delivering a robust industry aligned curriculum that empowers students to achieve global excellence.

**M2:** Providing state-of-the-art infrastructure that fosters innovation, critical thinking, and interdisciplinary research.

**M3:** Inculcating technical and entrepreneurial skills to provide socially relevant and sustainable solutions.

### **Program Educational Objectives:**

Graduates will

**PEO1:** Design and develop modern electronic and communication systems with professional ethics, environmental sustainability, and social responsibility.

**PEO2:** Pursue successful professional careers and higher studies by cultivating a learning mindset, engaging in innovative research, and embracing lifelong learning.

**PEO3:** Demonstrate effective communication, leadership, and adaptability to excel in diverse, multidisciplinary, and collaborative environments.

### **Program Specific Outcomes:**

**PSO 1:** Design and implement sustainable and energy-efficient solutions in Communication and Signal Processing to address societal and industrial needs.

**PSO 2:** Apply advanced technologies in VLSI Design and Embedded Systems to develop innovative solutions and enhance professional competence.

## PROGRAM OUTCOMES (PO's)

The 11 Program Outcomes are described as below.

After successful completion of the program, the graduates will be able to

- PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
- PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
- PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
- PO5 **Engineering tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
- PO6 **The Engineer and the world :** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
- PO7 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
- PO8 **Individual and collaborative teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
- PO9 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO10 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO11 **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## **Department Electronics and Communication Engineering**

### **B. Tech (ECE) Program Curriculum -2025** **(Applicable for the Batches admitted from A.Y 2025-26)**

#### **UG Programs Offered**

- B. Tech in (Electronics and Communication Engineering)
- B. Tech in (Electronics and Communication Engineering) with
  - Minor degree in Civil Engineering
  - Minor degree in Electrical and Electronics Engineering
  - Minor degree in Mechanical Engineering
  - Minor degree in Computer Science and Engineering
  - Minor degree in Data Science
  - Minor degree in Artificial Intelligence and Machine Learning
  - Minor degree in Mining Engineering
  - Minor degree in Petroleum Technology
  - Minor degree in Agricultural Engineering
  - Minor degree in Entrepreneurship Development and Incubation
  - Minor degree in Quantum Technologies
- Minor Streams offered in B. Tech (Electronics and Communication Engineering)
  - Minor Stream in VLSI
  - Minor Stream in Embedded Systems
  - Minor Stream in Signal Processing and Communication Technology
  - Minor Stream in Space Technology
  - Minor Stream in Technology for Digital Resilience Industry Integrated Program- L & T
  - Minor Stream in Smart Infrastructure (Electronics) Industry Integrated Program- L & T
  - Minor Stream in Semiconductor Design Framework for Industrial ICs
  - Minor Stream in Embedded AI Association with NASSCOM

### Credit Division Category-wise

| S.No                                                | Broad Category of Courses                                                                                                                    | UGC        | Credits    |
|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|
| 1                                                   | Major Core Courses (MCC)                                                                                                                     | 80         | 80         |
| 2                                                   | Minor Stream Courses (MSC)<br>Or<br>Minor Stream Courses (Min 20 credits) and<br>University Open Elective Courses (UEC)<br>(upto 12 Credits) | 32         | 32         |
| 3                                                   | Multidisciplinary Courses (MDC)                                                                                                              | 9          | 7          |
| 4                                                   | Ability Enhancement Courses (AEC)                                                                                                            | 8          | 9          |
| 5                                                   | Skill Enhancement Courses (SEC)                                                                                                              | 9          | 10         |
| 6                                                   | Value Added Courses (VAC)                                                                                                                    | 6-8        | 6          |
| 7                                                   | Summer Internships (SI)                                                                                                                      | 2-4        | 4          |
| 8                                                   | Full Semester Internship (PROJ)                                                                                                              | 12         | 12         |
| 9                                                   | Mandatory Courses (MC)                                                                                                                       |            | 0          |
| <b>Total Credits to be earned for B.Tech Degree</b> |                                                                                                                                              | <b>160</b> | <b>160</b> |

**Foundation Courses – FC**

**Intermediate-level Courses - IC**

**Advanced Courses - AC**

### Major Core Courses (MCC)

| Course Code         | Course Name                                                                       | Level | L | T | P | C | CIE | SE<br>E | Total | Pre-requisite |
|---------------------|-----------------------------------------------------------------------------------|-------|---|---|---|---|-----|---------|-------|---------------|
| 2501MA01            | Linear Algebra & Calculus                                                         | FC    | 2 | 1 |   | 3 | 50  | 50      | 100   | -             |
| 2501MA02            | Differential Equations & Vector Calculus                                          | FC    | 2 | 1 |   | 3 | 50  | 50      | 100   | -             |
| 2501MA07            | Transform Calculus                                                                | FC    | 2 | 1 |   | 3 | 50  | 50      | 100   | LAC, DEVC     |
| 2501CH02            | Applied Chemistry                                                                 | FC    | 2 |   | 1 | 3 | 50  | 50      | 100   | -             |
| 2501PH02            | Modern Physics                                                                    | FC    | 2 |   | 1 | 3 | 50  | 50      | 100   | -             |
| 2501CS01 / 2601DS01 | Programming for Problem Solving Using C* / Problem Solving Through C Programming# | FC    | 2 |   | 2 | 4 | 50  | 50      | 100   | -             |
| 2501IT01/ 2601AI01  | Business Intelligence Lab* / Business Intelligence & AI Tools Lab#                | FC    |   |   | 2 | 2 | 50  | 50      | 100   | -             |
| 2501ME01            | Engineering Graphics                                                              | FC    | 1 |   | 2 | 3 | 50  | 50      | 100   | -             |
| 2501ME03            | Engineering Workshop                                                              | FC    |   |   | 1 | 1 | 100 | -       | 100   | -             |
| 2501EE01            | Basic Electrical & Electronics Engineering                                        | FC    | 2 |   | 2 | 4 | 50  | 50      | 100   | -             |
| 2501EC02            | Network Analysis                                                                  | FC    | 3 | 1 |   | 4 | 50  | 50      | 100   | -             |
| 2501EC01            | Digital Electronics                                                               | FC    | 2 |   | 2 | 4 | 50  | 50      | 100   | -             |
| 2501EC03            | Electronic Devices & Circuits                                                     | FC    | 2 |   | 2 | 4 | 50  | 50      | 100   | BEEE          |
| 2501EC04            | Random Variables & Stochastic Processes                                           | FC    | 3 | 1 |   | 4 | 50  | 50      | 100   | -             |
| 2501EC14            | Signals & Systems                                                                 | FC    | 2 | 1 | 1 | 4 | 50  | 50      | 100   | -             |

|              |                                            |    |           |          |           |           |    |    |     |      |
|--------------|--------------------------------------------|----|-----------|----------|-----------|-----------|----|----|-----|------|
| 2501EC05     | Electromagnetic Waves & Transmission Lines | IC | 2         | 1        |           | 3         | 50 | 50 | 100 | DEVC |
| 2501EC06     | Analog Electronics                         | IC | 2         |          | 2         | 4         | 50 | 50 | 100 | EDC  |
| 2501EC07     | Integrated Circuits & Applications         | IC | 2         |          | 2         | 4         | 50 | 50 | 100 | EDC  |
| 2501EC08     | Linear Control Systems                     | IC | 2         | 1        |           | 3         | 50 | 50 | 100 | S&S  |
| 2501EC09     | Analog & Digital Communications            | IC | 2         | 1        | 1         | 4         | 50 | 50 | 100 | S&S  |
| 2501EC10     | Digital Signal Processing                  | IC | 2         |          | 1         | 3         | 50 | 50 | 100 | S&S  |
| 2501EC11     | VLSI Design                                | IC | 2         |          | 1         | 3         | 50 | 50 | 100 | EDC  |
| 2501EC12     | Microprocessors & Microcontrollers         | AC | 2         |          | 1         | 3         | 50 | 50 | 100 | DELD |
| 2501EC13     | Antenna & Microwave Engineering            | AC | 2         |          | 2         | 4         | 50 | 50 | 100 | EMTL |
| <b>Total</b> |                                            |    | <b>45</b> | <b>9</b> | <b>26</b> | <b>80</b> |    |    |     |      |

### Multi-Disciplinary Courses (MDC)

| Course Code           | Course Name                                         | Level | L        | T | P        | C        | CIE | SEE | Total | Pre-requisite |
|-----------------------|-----------------------------------------------------|-------|----------|---|----------|----------|-----|-----|-------|---------------|
| 2501CS03/<br>2601DS02 | Data Structures* /<br>Data Structures using<br>C++# | FC    | 2        |   | 2        | 4        | 50  | 50  | 100   | PPSC          |
| 2501MB02              | Engineering<br>Economics &<br>Management Science    | FC    | 3        |   |          | 3        | 50  | 50  | 100   | -             |
|                       | <b>Total</b>                                        |       | <b>5</b> |   | <b>2</b> | <b>7</b> |     |     |       |               |

### Ability Enhancement Courses (AEC)

| Course Code  | Course Name                                | Level | L        | T | P        | C        | CIE | SEE | Total | Pre-requisite |
|--------------|--------------------------------------------|-------|----------|---|----------|----------|-----|-----|-------|---------------|
| 2501EN01     | Essential Cognitive Skills for Engineering | FC    |          |   | 1        | 1        | 100 | -   | 100   | -             |
| 2501EN02     | Advanced Cognitive Skills for Engineering  | FC    |          |   | 1        | 1        | 100 | -   | 100   | -             |
| 2501UC07     | Design Thinking using AI                   | FC    |          |   | 1        | 1        | 100 | -   | 100   | -             |
| 2501UC08     | Universal Human Values                     | FC    | 2        |   |          | 2        | 100 | -   | 100   | -             |
| 2501UC09     | Technical Paper Publication                | AC    |          |   | 2        | 2        | 100 | -   | 100   | -             |
| 2501EC96     | Student Activity Based Learning            | AC    |          |   |          | 2        | 100 | -   | 100   | -             |
| <b>Total</b> |                                            |       | <b>2</b> |   | <b>5</b> | <b>9</b> |     |     |       |               |

### Skill Enhancement Courses (SEC)

| Course Code  | Course Name                              | Level | L | T | P         | C         | CIE | SEE | Total | Pre-requisite |
|--------------|------------------------------------------|-------|---|---|-----------|-----------|-----|-----|-------|---------------|
| 2501EC21     | PCB Design                               | FC    |   |   | 2         | 2         | 50  | 50  | 100   | -             |
| 2501EC94     | Soft Computing Tools                     | IC    |   |   | 2         | 2         | 50  | 50  | 100   | -             |
|              | Object Oriented Programming through JAVA | AC    |   |   | 2         | 2         | 50  | 50  | 100   | PPSC          |
| 2501EC16     | ECAD Tools                               | AC    |   |   | 2         | 2         | 50  | 50  | 100   | VLSI          |
| 2501EC17     | Verification using Verilog & UVM         | AC    |   |   | 2         | 2         | 50  | 50  | 100   | VLSI          |
| <b>Total</b> |                                          |       |   |   | <b>10</b> | <b>10</b> |     |     |       |               |



### Value Added Courses (VAC)

| Course Code  | Course Name                                   | Level | L        | T | P         | C        | CIE | SEE | Total | Pre-requisite |
|--------------|-----------------------------------------------|-------|----------|---|-----------|----------|-----|-----|-------|---------------|
| 2501CS04     | Internet of Things                            | FC    |          |   | 1         | 1        | 50  | 50  | 100   | -             |
| 2501CS02     | Data Analysis Using Python                    | IC    |          |   | 2         | 2        | 50  | 50  | 100   | PPSC          |
| 2501UC11     | Employability Skills-I                        | FC    |          |   | 3         | 0        | 100 | -   | 100   | -             |
| 2501UC13     | Employability Skills-II                       | FC    |          |   | 3         | 0        | 100 | -   | 100   | ES-I          |
| 2501UC14     | Employability Skills-III                      | IC    |          |   | 3         | 0        | 100 | -   | 100   | ES-II         |
| 2501UC15     | Employability Skills-IV                       | IC    |          |   | 3         | 0        | 100 | -   | 100   | ES-III        |
| 2501UC16     | Employability Skills-V                        | AC    |          |   | 3         | 0        | 100 | -   | 100   | ES-IV         |
| 2501CS10     | Advanced Data Structures & Algorithm Analysis | AC    | 2        |   | 1         | 3        | 100 | -   | 100   | DS            |
| <b>Total</b> |                                               |       | <b>2</b> |   | <b>19</b> | <b>6</b> |     |     |       |               |

### Summer Internships (SI)

| Course Code  | Course Name          | Level | L | T | P        | C        | CIE | SEE | Total | Pre-requisite |
|--------------|----------------------|-------|---|---|----------|----------|-----|-----|-------|---------------|
| 2501EC18     | Summer Internship-I  | IC    |   |   | 2        | 2        | 100 | -   | 100   | -             |
| 2501EC19     | Summer Internship-II | AC    |   |   | 2        | 2        | 100 | -   | 100   | -             |
| <b>Total</b> |                      |       |   |   | <b>4</b> | <b>4</b> |     |     |       |               |

### Full Semester Internship (PROJ)

| Course Code  | Course Name              | Level | L | T | P         | C         | CIE | SEE | Total | Pre-requisite |
|--------------|--------------------------|-------|---|---|-----------|-----------|-----|-----|-------|---------------|
| 2501EC20     | Full Semester Internship | AC    |   |   | 12        | 12        | 50  | 50  | 100   | -             |
| <b>Total</b> |                          |       |   |   | <b>12</b> | <b>12</b> |     |     |       |               |

### Mandatory Courses (MC)

| Course Code  | Course Name                            | Level | L         | T | P | C        | CIE | SEE | Total | Pre-requisite |
|--------------|----------------------------------------|-------|-----------|---|---|----------|-----|-----|-------|---------------|
| 2501AC01     | Environmental Science                  | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC02     | Constitution of India                  | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC03     | Research Methodology                   | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC04     | Intellectual Property Rights & Patents | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC05     | Indian Knowledge Systems               | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| <b>Total</b> |                                        |       | <b>10</b> |   |   | <b>0</b> |     |     |       |               |

### Minor Stream: VLSI

| Course Code | Course Name                                  | Level | L         | T        | P        | C         | CIE | SE<br>E | Total | Pre-<br>requisite |
|-------------|----------------------------------------------|-------|-----------|----------|----------|-----------|-----|---------|-------|-------------------|
| 2501EC86    | Digital System Design through Verilog        | IC    | 2         |          | 2        | 4         | 50  | 50      | 100   | DELD              |
| 2501EC26    | Digital System Design through system Verilog | AC    | 3         |          |          | 3         | 50  | 50      | 100   | DDTV              |
| 2501EC23    | CMOS Digital IC Design                       | IC    | 3         |          |          | 3         | 50  | 50      | 100   | DELD              |
| 2501EC27    | FPGAs & ASIC Design                          | AC    | 3         |          |          | 3         | 50  | 50      | 100   | VLSI,DFT          |
| 2501EC22    | Design For Testability                       | IC    | 3         |          |          | 3         | 50  | 50      | 100   | VLSI              |
| 2501EC30    | Testing & Verification of VLSI Circuits      | IC    | 3         |          |          | 3         | 50  | 50      | 100   | CDICD, AVLSI      |
| 2501EC24    | Analog VLSI Design                           | IC    | 3         |          |          | 3         | 50  | 50      | 100   | VLSI              |
| 2501EC28    | Low Power VLSI Design                        | AC    | 3         |          |          | 3         | 50  | 50      | 100   | DDTV              |
| 2501EC29    | SoC Design                                   | AC    | 3         |          |          | 3         | 50  | 50      | 100   | MPMC              |
| 2501EC25    | CMOS Mixed signal IC Design                  | AC    | 2         | 1        |          | 3         | 50  | 50      | 100   | DDTV              |
| 2501EC31    | VLSI Physical Design                         | AC    | 3         |          |          | 3         | 50  | 50      | 100   | LPVLSID           |
|             | <b>Total</b>                                 |       | <b>31</b> | <b>1</b> | <b>2</b> | <b>34</b> |     |         |       |                   |

### Minor Stream: Embedded Systems

| Course Code | Course Name                           | Level | L         | T | P        | C         | CIE | SEE | Total | Pre-requisite |
|-------------|---------------------------------------|-------|-----------|---|----------|-----------|-----|-----|-------|---------------|
|             | Sensors & Actuators                   | FC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | Embedded C                            | IC    | 2         |   | 1        | 3         | 50  | 50  | 100   | -             |
| 2501EC36    | Hardware interfacing & Networking     | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC38    | Microcontrollers for Embedded Systems | IC    | 3         |   |          | 3         | 50  | 50  | 100   | MPMC          |
| 2501EC32    | Embedded Real Time Systems            | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC42    | Wireless LANs & PANs                  | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | System Programming                    | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC34    | Embedded System Design                | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | Real Time operating System using QNX  | AC    | 0         | 0 | 2        | 2         | 50  | 50  | 100   | ERTS          |
|             | Machine Learning for Embedded Systems | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC35    | Hardware & Software Co-Design         | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | <b>Total</b>                          |       | <b>29</b> |   | <b>3</b> | <b>32</b> |     |     |       |               |

### Minor Stream: Signal Processing and Communication Technology

| Course Code  | Course Name                               | Level | L         | T        | P        | C         | CIE | SEE | Total | Pre-requisite |
|--------------|-------------------------------------------|-------|-----------|----------|----------|-----------|-----|-----|-------|---------------|
| 2501EC45     | Fundamentals of Speech Processing         | IC    | 2         |          | 1        | 3         | 50  | 50  | 100   | S&S           |
| 2501EC46     | Information Theory & Coding Techniques    | IC    | 2         |          | 1        | 3         | 50  | 50  | 100   | -             |
| 2501EC44     | Digital Signal Processors & Architectures | IC    | 2         | 1        |          | 3         | 50  | 50  | 100   | DSP           |
| 2501EC43     | Digital Image Processing                  | IC    | 2         |          | 1        | 3         | 50  | 50  | 100   | S&S           |
| 2501EC49     | Radar Engineering                         | IC    | 3         |          |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC51     | Soft Computing Techniques                 | AC    | 2         | 1        |          | 3         | 50  | 50  | 100   | -             |
| 2501EC47     | Optical Communications                    | AC    | 3         |          |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC50     | Satellite Communications                  | AC    | 3         |          |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC48     | Pattern Recognition                       | AC    | 2         |          |          | 2         | 50  | 50  | 100   | DIP           |
| 2501EC52     | Wireless Communications                   | AC    | 2         | 1        |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC53     | Wireless Sensor Networks                  | AC    | 3         |          |          | 3         | 50  | 50  | 100   | IOT           |
| <b>Total</b> |                                           |       | <b>26</b> | <b>3</b> | <b>3</b> | <b>32</b> |     |     |       |               |

### Minor Stream: Space Technology

| Course Code  | Course Name                                                 | Level | L         | T        | P | C         | CIE | SEE | Total | Pre-requisite |
|--------------|-------------------------------------------------------------|-------|-----------|----------|---|-----------|-----|-----|-------|---------------|
| 2501EC54     | Introduction to Space Laws                                  | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC55     | Aircraft Communication Systems                              | IC    | 2         | 1        |   | 3         | 50  | 50  | 100   | -             |
| 2501EC57     | Aircraft Navigation Systems                                 | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC62     | Missile & Space Vehicle Guidance & Control                  | IC    | 2         |          |   | 2         | 50  | 50  | 100   | -             |
| 2501EC60     | Flight Control Systems                                      | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC58     | Avionics Embedded Systems                                   | IC    | 2         | 1        |   | 3         | 50  | 50  | 100   | -             |
| 2501EC59     | Avionics Network Technology                                 | AC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC64     | Unmanned Aircraft Systems                                   | AC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC56     | Aerospace Electromagnetic Compatibility                     | AC    | 2         | 1        |   | 3         | 50  | 50  | 100   | -             |
| 2501EC61     | Global Navigation Satellite Systems & Applications          | AC    | 3         |          |   | 3         | 50  | 50  | 100   | SC            |
| 2501EC63     | Remote Sensing & Digital Image Processing of Satellite Data | AC    | 3         |          |   | 3         | 50  | 50  | 100   | DIP           |
| <b>Total</b> |                                                             |       | <b>29</b> | <b>3</b> |   | <b>32</b> |     |     |       |               |

**Minor Stream: Technology for Digital Resilience**  
**Industry Integrated Program- L & T**

| Course Code  | Course Name                                                             | Level | L         | T        | P        | C         | CIE | SEE | Total | Pre-requisite |
|--------------|-------------------------------------------------------------------------|-------|-----------|----------|----------|-----------|-----|-----|-------|---------------|
| 2501EC66     | Software Defined Radio                                                  | IC    | 3         | 1        |          | 4         | 50  | 50  | 100   | -             |
| 2501EC67     | Introduction to Internet of Things                                      | IC    | 2         |          | 1        | 3         | 50  | 50  | 100   | -             |
| 2501EC68     | Cloud based Internet of Things                                          | IC    | 2         |          | 2        | 4         | 50  | 50  | 100   | IIoT          |
| 2501EC69     | Cyber Defence & Information Security                                    | IC    | 3         |          |          | 3         | 50  | 50  | 100   | -             |
| 2501EC70     | Industrial Applications of Microcontrollers - A Practice based approach | IC    | 3         |          |          | 3         | 50  | 50  | 100   | -             |
| 2501EC65     | Applied Industrial IoT                                                  | IC    | 3         |          |          | 3         | 50  | 50  | 100   | -             |
| 2501EC71     | Data Engineering, Analytics & Security in Industries                    | AC    | 3         |          |          | 3         | 50  | 50  | 100   | -             |
| 2501EC72     | Cloud Adoption & Management Techniques                                  | AC    | 3         |          |          | 3         | 50  | 50  | 100   | -             |
| 2501EC73     | Artificial Intelligence & Edge Computing                                | AC    | 3         |          |          | 3         | 50  | 50  | 100   | -             |
| 2501EC74     | Modern Wireless Communications                                          | AC    | 3         |          |          | 3         | 50  | 50  | 100   | -             |
| <b>Total</b> |                                                                         |       | <b>28</b> | <b>1</b> | <b>3</b> | <b>32</b> |     |     |       |               |

#Syllabus for the industry partner courses will be released in the department as and when Required.

**Minor Stream: Smart Infrastructure (Electronics)**  
**Industry Integrated Program- L & T**

| Course Code  | Course Name                                                                        | Level | L         | T | P        | C         | CIE | SEE | Total | Pre-requisite |
|--------------|------------------------------------------------------------------------------------|-------|-----------|---|----------|-----------|-----|-----|-------|---------------|
| 2501EC75     | Digital Data Communications                                                        | IC    | 3         |   | 1        | 4         | 50  | 50  | 100   | -             |
| 2501EC76     | Introduction to Machine Learning                                                   | IC    | 3         |   | 1        | 4         | 50  | 50  | 100   | -             |
| 2501EC77     | Sensors & Transducers                                                              | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC78     | Cyber Physical Systems for Industrial Applications                                 | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC65     | Applied Industrial IoT                                                             | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC79     | Drone Technology and its Transformative Applications- A Practitioner's Perspective | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC73     | Artificial Intelligence and Edge Computing                                         | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC80     | 5G Technology for Smarter & Secure Connectivity                                    | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC74     | Modern Wireless Communications                                                     | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC81     | Chip based VLSI Design for Industrial Applications                                 | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| <b>Total</b> |                                                                                    |       | <b>30</b> |   | <b>2</b> | <b>32</b> |     |     |       |               |

#Syllabus for the industry partner courses will be released in the department as and when Required.



## Minor Stream: Embedded AI Association with NASSCOM

| Course Code | Course Name                                  | Level | L         | T | P | C         | CIE | SEE | Total | Pre-requisite |
|-------------|----------------------------------------------|-------|-----------|---|---|-----------|-----|-----|-------|---------------|
|             | AI, ML Data Foundation                       | FC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | Data Engineering & Feature Engineering       | FC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | Embedded System Design                       | FC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | Supervised & Unsupervised Learning           | IC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | Deep Learning & Neural Networks              | IC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | System Programming                           | IC    | 3         |   |   | 3         | 50  | 50  | 100   | PPSC          |
|             | Real Time Operating System                   | IC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | Generative AI & Large Language Models)       | AC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | MLOPS & AI Development                       | AC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | Applied agentic AI system                    | AC    | 3         |   |   | 3         | 50  | 50  | 100   | -             |
|             | AI for industry 5.0 & Cyber physical systems | AC    | 2         |   |   | 2         | 50  | 50  | 100   | -             |
|             | <b>Total</b>                                 |       | <b>32</b> |   |   | <b>32</b> |     |     |       |               |

## Minor Stream: Semiconductor Design Framework for Industrial ICs

| Course Code  | Course Name                                                | SEM | Level | L         | T        | P | C         | CIE | SEE | Total | Pre-requisite |
|--------------|------------------------------------------------------------|-----|-------|-----------|----------|---|-----------|-----|-----|-------|---------------|
|              | RTL Design Principles (RDP)                                | IV  | FC    | 3         |          |   | 3         | 50  | 50  | 100   | DELD          |
|              | System Design and Verification (SDV)                       | V   | IC    | 3         |          |   | 3         | 50  | 50  | 100   | DELD          |
|              | Embedded Computing Principles (ECP)                        | VI  | IC    | 3         |          |   | 3         | 50  | 50  | 100   | MPMC          |
|              | Product Architecture Models and Firmware                   | VI  | IC    | 3         |          |   | 3         | 50  | 50  | 100   | MPMC          |
|              | Logic Synthesis, DFT Chip Timing Analysis                  | VII | AC    | 3         | 1        |   | 4         | 50  | 50  | 100   | RDP           |
|              | Product Design Thinking                                    | VII | IC    | 3         |          |   | 3         | 50  | 50  | 100   | RDP           |
|              | Physical Design and Graphic                                | VII | AC    | 3         | 1        |   | 4         | 50  | 50  | 100   | SDV           |
|              | SOCs Design Principles for Industrial Automation Practices | VII | AC    | 3         | 1        |   | 4         | 50  | 50  | 100   | MPMC          |
|              | Foundry Process of IC                                      | VII | AC    | 3         | 0        |   | 3         | 50  | 50  | 100   | ICA           |
| <b>Total</b> |                                                            |     |       | <b>27</b> | <b>3</b> |   | <b>30</b> |     |     |       |               |

### UNIVERSITY OPEN ELECTIVE COURSES

| Branch | Course Code | Course Name                                                    | Level | L | T | P | C | CIE | SEE | Offered to                                      | Pre-requisite |
|--------|-------------|----------------------------------------------------------------|-------|---|---|---|---|-----|-----|-------------------------------------------------|---------------|
| CE     | 2501CE66    | Natural Disaster Management & Mitigation                       |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| CE     | 2501CE81    | Wastewater Management                                          |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| CE     | 2501CE82    | Integrated Solid Waste Management for a Smart City             |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| CE     | 2501CE83    | Watershed Management                                           |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| EEE    | 2501EE53    | Electric Power Generation, Transmission & Distribution Systems | AC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E   |               |
| EEE    | 2501EE36    | Electric Energy Storage Systems                                | FC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E   |               |
| EEE    | 2501EE43    | Electrical safety                                              | IC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E   |               |
| EEE    | 2501EE54    | Hybrid & Electric Vehicles                                     | IC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E       |               |
| ME     | 2501ME37    | Solar Energy Systems                                           | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ME     | 2501ME58    | Industry 5.0 for Engineers                                     | AC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ME     | 2501ME73    | Organizational Behavior                                        | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ME     | 2501ME36    | Sustainable Energy Systems                                     | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ECE    | 2501EC97    | Biomedical Electronics                                         | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |               |
| ECE    | 2501EC98    | Fundamentals of Wireless Communications                        | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |               |

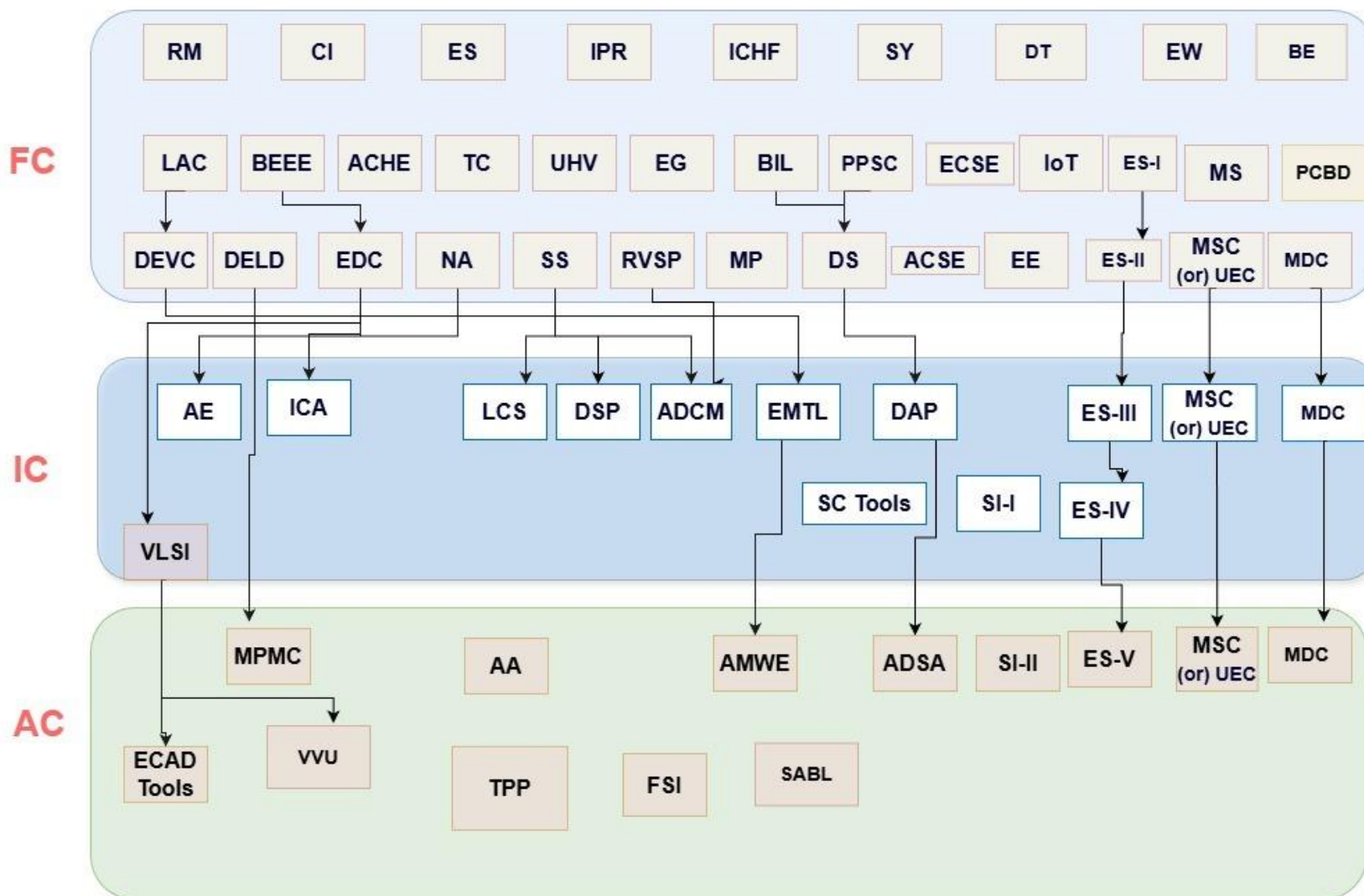
|       |                       |                                                      |    |   |  |   |   |    |    |                                                 |              |
|-------|-----------------------|------------------------------------------------------|----|---|--|---|---|----|----|-------------------------------------------------|--------------|
| ECE   | 2501EC99              | Principles of Embedded Systems                       | FC | 3 |  |   | 3 | 50 | 50 | CE,EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E  |              |
| ECE   | 2501ECA0              | Electronics for Healthcare                           | FC | 3 |  |   | 3 | 50 | 50 | CE,EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E  |              |
| ECE   | 2501ECA1              | Basics of VLSI Design                                | FC | 3 |  |   | 3 | 50 | 50 | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |              |
| ECE   | 2501ECA2              | System on Chip Design                                | FC | 3 |  |   | 3 | 50 | 50 | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |              |
| ECE   | 2501ECA3              | Introduction to Quantum Computing                    | FC | 3 |  |   | 3 | 50 | 50 | CE,EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E  |              |
| CSE   | 2501CS03/<br>2601DS02 | Data Structures* /<br>Data Structures<br>using C++/# | FC | 2 |  | 2 | 4 | 50 | 50 | CE, ME, PT, Min.E                               | PPSC         |
| CSE   | 2501CS13              | Operating Systems                                    | IC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | -            |
| IT    | 2501IT05              | Database Management Systems                          | IC | 2 |  | 2 | 4 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | PPSC / CP&DS |
| IT    | 2501CS07              | Computer Networks                                    | AC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | -            |
| AI&ML | 2501AI02              | Artificial Intelligence                              | FC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ECE, PT, Min.E                         | -            |
| AI&ML | 2501AI05              | Machine Learning                                     | AC | 2 |  | 2 | 4 | 50 | 50 | CE, ECE, PT, Min.E                              | DAUP         |
| DS    | 2501CS34              | Fundamental of Data Science                          | FC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | PPSC / CP&DS |

**Note:** \*Courses are applicable only to students admitted in the year 2025.

#Courses are applicable to the students admitted from the year 2026 onwards.

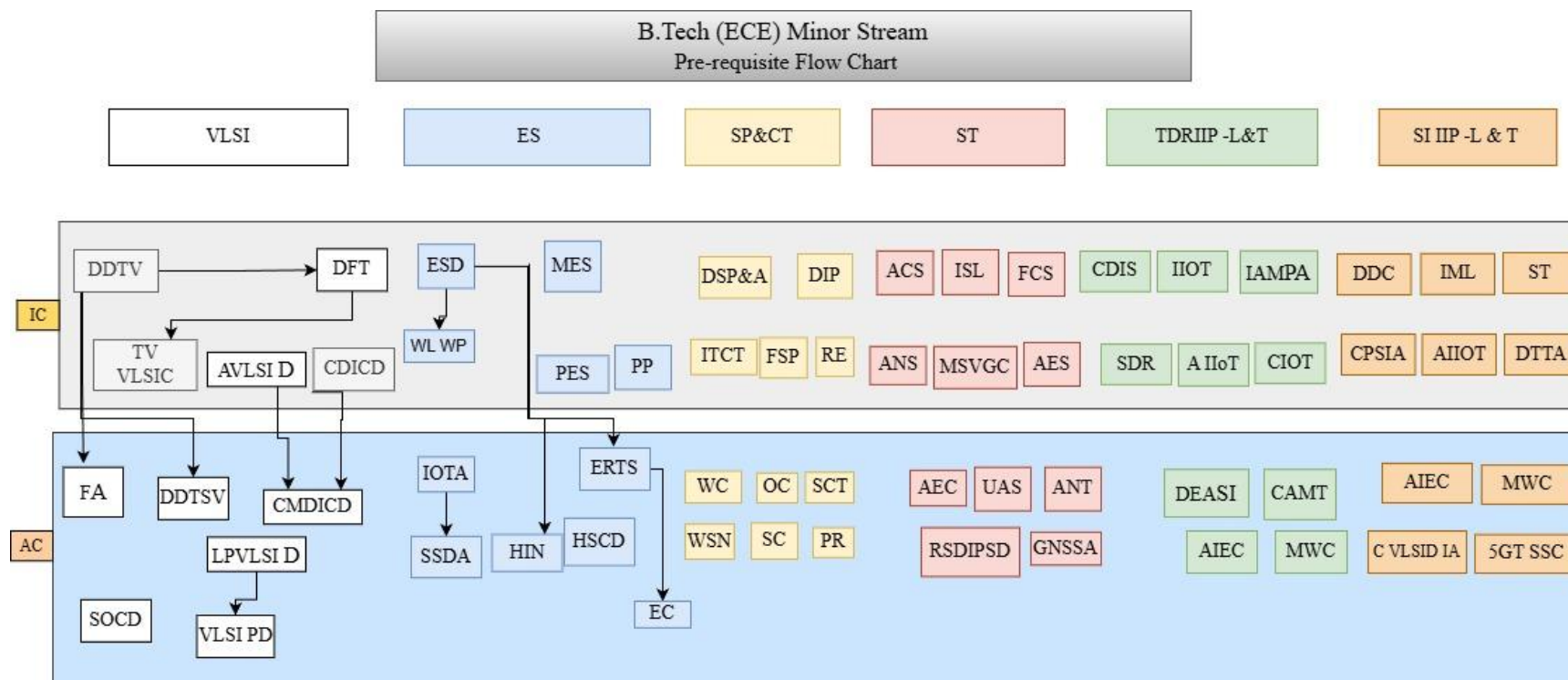
All the other courses are applicable to students admitted from the year 2025 onwards.

## B.Tech (ECE) Program Curriculum Pre-requisite Flowchart



| FOUNDATION COURSES |                                            | INTERMEDIATE-LEVEL COURSES |                                                                  | ADVANCED COURSES |                                       |
|--------------------|--------------------------------------------|----------------------------|------------------------------------------------------------------|------------------|---------------------------------------|
| LAC                | Linear Algebra & Calculus                  | EMTL                       | Electromagnetic Waves & Transmission Lines<br>Analog Electronics | MPMC             | Microprocessors & Microcontrollers    |
| DEVC               | Differential Equations & Vector Calculus   | AE                         |                                                                  | AMWE             | Antenna & Microwave Engineering       |
| TC                 | Transform Calculus                         | ICA                        | Integrated Circuits & Applications                               | DIP              | Digital Image Processing              |
| ACHE               | Applied Chemistry                          | LCS                        | Linear Control Systems                                           | AA               | Android Applications                  |
| MP                 | Modern Physics                             | ADC M                      | Analog & Digital Communications                                  | ECAD             | ECAD Tools                            |
| PPSC               | Programming for Problem Solving Using C    | DSP                        | Digital Signal Processing                                        | VVU              | Verification using Verilog & UVM      |
|                    |                                            |                            |                                                                  | ADSA             | Advanced Data Structures & algorithms |
| BIL                | Business Intelligence Lab                  | DAP                        | Data Analysis Using Python                                       | SI-II            | Summer Internship-II                  |
| PCBD               | PCB Design                                 | VLSI                       | VLSI                                                             | TPP              | Technical Paper Publication           |
| EG                 | Engineering Graphics                       | SC Tools                   | Soft Computing Tools                                             | FSI              | Full Semester Internship              |
| EW                 | Engineering Workshop                       | SI-I                       | Summer Internship-I                                              | ES-V             | Employability Skills-V                |
| BEEE               | Basic Electrical & Electronics Engineering | ES-III                     | Employability Skills-III                                         | SABL             | Student Activity based Learning       |
| NA                 | Network Analysis                           | ES-IV                      | Employability Skills-IV                                          |                  |                                       |
| DE                 | Digital Electronics                        |                            |                                                                  |                  |                                       |
| EDC                | Electronic Devices & Circuits              |                            |                                                                  |                  |                                       |
| RVSP               | Random Variables & Stochastic Processes    |                            |                                                                  |                  |                                       |
| SS                 | Signals & Systems                          |                            |                                                                  |                  |                                       |
| ECSE               | Essential Cognitive Skills for Engineers   |                            |                                                                  |                  |                                       |
| ACSE               | Advanced Cognitive Skills for Engineers    |                            |                                                                  |                  |                                       |
| DT                 | Design Thinking using AI                   |                            |                                                                  |                  |                                       |
| UHV                | Universal Human Values                     |                            |                                                                  |                  |                                       |
| IOT                | Internet of Things                         |                            |                                                                  |                  |                                       |
| EEM                | Engineering & Management                   |                            |                                                                  |                  |                                       |
| MS                 | Management Science                         |                            |                                                                  |                  |                                       |
| DS                 | Data Structures                            |                            |                                                                  |                  |                                       |

|       |                                           |
|-------|-------------------------------------------|
| ES    | Environmental Science                     |
| COI   | Constitution of India                     |
| RM    | Research Methodology                      |
| IPR   | Intellectual Property Rights &<br>Patents |
| ES-I  | Employability Skills-I                    |
| ES-II | Employability Skills-II                   |
| BE    | Biology for Engineers                     |





| INTERMEDIATE - LEVEL COURSES                                                                   |       |                                                                         | ADVANCED COURSES |                                                             |
|------------------------------------------------------------------------------------------------|-------|-------------------------------------------------------------------------|------------------|-------------------------------------------------------------|
| <b>VLSI</b>                                                                                    | DDTV  | Digital System Design Through Verilog                                   | CMICD            | CMOS Mixed Signal IC Design                                 |
|                                                                                                | DFT   | Design for Testability                                                  | LVLSI            | Low Power VLSI Design                                       |
|                                                                                                | CDIC  | CMOS Digital IC Design                                                  | FA               | FPGAs & ASIC Design                                         |
|                                                                                                | D     |                                                                         |                  |                                                             |
|                                                                                                | TVVL  | Testing & Verification of VLSI Circuits                                 | SoCD             | SoC design                                                  |
|                                                                                                | SI    |                                                                         |                  |                                                             |
| <b>Embedded Systems-ES</b>                                                                     | AVLSI | Analog VLSI Design                                                      | DDTSV            | Digital System Design Through System Verilog                |
|                                                                                                |       |                                                                         | VLSIPD           | VLSI Physical System Design                                 |
|                                                                                                | MES   | Microcontrollers for Embedded Systems                                   | ERTS             | Embedded & Real Time Systems                                |
|                                                                                                | ESD   | Embedded System Design                                                  | HSCD             | Hardware & Software Codesign                                |
|                                                                                                | PES   | Programming Languages for Embedded System                               | SSDAS            | Smart Sensors & Devices for Agriculture                     |
|                                                                                                | WLW   | Wireless LAN's & PAN's                                                  | HIN              | Hardware interfacing & Networking                           |
| <b>Signal Processing and Communication Technology-ST&amp;CT</b>                                | PP    | Parallel Processing                                                     | EC               | Embedded Computing                                          |
|                                                                                                |       |                                                                         | IOTA             | Internet of Things & its Applications.                      |
|                                                                                                | FSP   | Fundamentals of Speech Processing                                       | SCT              | Soft Computing Techniques                                   |
|                                                                                                | ITCT  | Information Theory & Coding Techniques                                  | OC               | Optical Communications                                      |
|                                                                                                | DSPA  | Digital Signal Processors & Architectures                               | SC               | Satellite Communications                                    |
|                                                                                                | RE    | Radar Engineering                                                       | WC               | Wireless Communications                                     |
| <b>Space Technology-ST</b>                                                                     | DIP   | Digital Image Processing                                                | WSN              | Wireless Sensor Networks                                    |
|                                                                                                |       |                                                                         | PR               | Pattern Recognition                                         |
|                                                                                                | ISL   | Introduction to Space Laws                                              | ANS              | Avionics Technology                                         |
|                                                                                                | ACS   | Aircraft Communication Systems                                          | GNSSA            | Global Navigation Satellite Systems & Applications          |
|                                                                                                | ANS   | Aircraft Navigation Systems                                             | UAS              | Unmanned Aircraft System                                    |
|                                                                                                | MSV   | Missile & Space Vehicle Guidance and Control                            | AEC              | Aerospace Electromagnetic Compatibility                     |
| <b>Technology for Digital Resilience Industry Integrated Program- L &amp; T-TDRIIP-L&amp;T</b> | GC    |                                                                         | RSDIPSD          | Remote Sensing & Digital Image Processing of Satellite Data |
|                                                                                                | FCS   | Flight Control System                                                   |                  |                                                             |
|                                                                                                | AEC   | Avionics Embedded System                                                | DEASI            | Data Engineering, Analytics & Security in Industries        |
|                                                                                                | CDIS  | Cyber Defence & Information Security                                    | CAMT             | Cloud Adoption & Management Techniques                      |
|                                                                                                | IAMP  | Industrial Applications of Microcontrollers - A Practice based approach | AIEC             | Artificial Intelligence & Edge Computing                    |
|                                                                                                | A     |                                                                         |                  |                                                             |
|                                                                                                | AIIoT | Applied Industrial IoT                                                  | IIoT             | Introduction to Internet of things                          |
|                                                                                                | SDR   | Software Defined Radio                                                  |                  |                                                             |

|                                                                                  |       |                                                           |         |                                                    |
|----------------------------------------------------------------------------------|-------|-----------------------------------------------------------|---------|----------------------------------------------------|
| <b>Smart Infrastructure (Electronics) Industry Integrated Program- L &amp; T</b> | CBIoT | Cloud Based IoT                                           | MWC     | Modern Wireless communication                      |
|                                                                                  | CPSIA | Cyber Physical Systems for Industrial Applications        | 5GTSSC  | 5G Technology for Smarter & Secure Connectivity    |
|                                                                                  |       | Drone Technology and its                                  | CVLSIIA | Chip based VLSI Design for Industrial Applications |
|                                                                                  | DTTA  | Transformative Applications -A Practitioner's Perspective |         |                                                    |
|                                                                                  | DDC   | Digital Data Communication                                |         |                                                    |
|                                                                                  | IML   | Introduction to Machine Learning                          |         |                                                    |
|                                                                                  | S&T   | Sensors & Transducers                                     |         |                                                    |

## Suggestive Semester-wise Curriculum

### I SEMESTER

| Course code         | Course Title                                                                      | Course   |       |           |          |          |           | Total Hours |
|---------------------|-----------------------------------------------------------------------------------|----------|-------|-----------|----------|----------|-----------|-------------|
|                     |                                                                                   | Category | Level | L         | T        | P        | C         |             |
| 2501MA01            | Linear Algebra & Calculus                                                         | MCC      | FC    | 2         | 1        |          | 3         | 3           |
| 2501CH02            | Applied Chemistry                                                                 | MCC      | FC    | 2         |          | 1        | 3         | 4           |
| 2501CS01 / 2601DS01 | Programming for Problem Solving Using C* / Problem Solving Through C Programming# | MCC      | FC    | 2         |          | 2        | 4         | 6           |
| 2501EE01            | Basic Electrical & Electronics Engineering                                        | MCC      | FC    | 2         |          | 2        | 4         | 6           |
| 2501IT01/ 2601AI01  | Business Intelligence Lab* / Business Intelligence & AI Tools Lab#                | MCC      | FC    |           |          | 2        | 2         | 4           |
| 2501EN01            | Essential Cognitive Skills for Engineers                                          | AEC      | FC    |           |          | 1        | 1         | 2           |
| 2501UC08            | Universal Human Values                                                            | AEC      | FC    | 2         |          |          | 2         | 2           |
|                     | <b>Total</b>                                                                      |          |       | <b>10</b> | <b>1</b> | <b>8</b> | <b>19</b> | <b>27</b>   |

## II SEMESTER

| Course code           | Course Title                                  | Course   |       |           |          |           |           | Total Hours |
|-----------------------|-----------------------------------------------|----------|-------|-----------|----------|-----------|-----------|-------------|
|                       |                                               | Category | Level | L         | T        | P         | C         |             |
| 2501MA02              | Differential Equations & Vector Calculus      | MCC      | FC    | 2         | 1        |           | 3         | 3           |
| 2501PH02              | Modern Physics                                | MCC      | FC    | 2         |          | 1         | 3         | 4           |
| 2501ME01              | Engineering Graphics                          | MCC      | FC    | 1         |          | 2         | 3         | 5           |
| 2501EC02              | Network Analysis                              | MCC      | FC    | 3         | 1        |           | 4         | 4           |
| 2501ME03              | Engineering Workshop                          | MCC      | FC    |           |          | 1         | 1         | 2           |
| 2501CS03/<br>2601DS02 | Data Structures* / Data Structures using C++# | MDC      | FC    | 2         |          | 2         | 4         | 6           |
| 2501UC07              | Design Thinking using AI                      | AEC      | FC    |           |          | 1         | 1         | 2           |
| 2501EN02              | Advanced Cognitive Skills for Engineers       | AEC      | FC    |           |          | 1         | 1         | 2           |
| 2501UC11              | Employability Skills-I                        | VAC      | FC    |           |          | 3         | 0         | 3           |
| 2501AC01              | Environmental Science                         | MC       | FC    | 2         |          |           | 0         | 2           |
| 2501EC21              | PCB Design                                    | SEC      | FC    |           |          | 2         | 2         | 4           |
|                       | <b>Total</b>                                  |          |       | <b>12</b> | <b>2</b> | <b>13</b> | <b>22</b> | <b>37</b>   |

### III SEMESTER

| Course code | Course Title                                  | Course   |       |           |          |           |           | Total Hours |
|-------------|-----------------------------------------------|----------|-------|-----------|----------|-----------|-----------|-------------|
|             |                                               | Category | Level | L         | T        | P         | C         |             |
| 2501MA07    | Transform Calculus                            | MCC      | FC    | 2         | 1        |           | 3         | 3           |
| 2501EC01    | Digital Electronics                           | MCC      | FC    | 2         |          | 2         | 4         | 6           |
| 2501EC03    | Electronic Devices & Circuits                 | MCC      | FC    | 2         |          | 2         | 4         | 6           |
| 2501EC14    | Signals & Systems                             | MCC      | FC    | 2         | 1        | 1         | 4         | 5           |
| 2501CS02    | Data Analysis Using Python                    | VAC      | FC    |           |          | 2         | 2         | 2           |
| 2501CS10    | Advanced Data Structures & Algorithm Analysis | VAC      | AC    | 2         |          | 1         | 3         | 4           |
| 2501UC13    | Employability Skills-II                       | VAC      | FC    |           |          | 3         | 0         | 3           |
| 2501AC02    | Constitution of India                         | MC       | FC    | 2         |          |           | 0         | 2           |
|             | <b>Total</b>                                  |          |       | <b>12</b> | <b>2</b> | <b>11</b> | <b>20</b> | <b>31</b>   |

### IV SEMESTER

| Course code | Course Title                                               | Course     |       |           |          |           |           | Total Hours |
|-------------|------------------------------------------------------------|------------|-------|-----------|----------|-----------|-----------|-------------|
|             |                                                            | Category   | Level | L         | T        | P         | C         |             |
| 2501EC04    | Random Variables & Stochastic Processes                    | MCC        | FC    | 3         | 1        |           | 4         | 4           |
| 2501EC06    | Analog Electronics                                         | MCC        | IC    | 2         |          | 2         | 4         | 6           |
| 2501EC11    | VLSI Design                                                | MCC        | IC    | 2         |          | 1         | 3         | 4           |
|             | Minor Stream Course-1or University Open Elective Course -1 | MSC or UEC | FC    | 2         |          | 1         | 3         | 4           |
| 2501EC12    | Microprocessors & Microcontrollers                         | MCC        | AC    | 2         |          | 1         | 3         | 4           |
|             | OOPS Through JAVA                                          | SEC        | AC    |           |          | 2         | 2         | 4           |
| 2510CS04    | Internet of Things                                         | SEC        | FC    |           |          | 1         | 1         | 2           |
| 2501UC14    | Employability Skills-III                                   | VAC        | IC    |           |          | 3         | 0         | 3           |
| 2501AC03    | Research Methodology                                       | MC         | FC    | 2         |          |           | 0         | 2           |
|             | <b>Total</b>                                               |            |       | <b>13</b> | <b>1</b> | <b>11</b> | <b>20</b> | <b>33</b>   |

### V SEMESTER

| Course code | Course Title                                                 | Course     |       |           |          |          |           | Total Hours |
|-------------|--------------------------------------------------------------|------------|-------|-----------|----------|----------|-----------|-------------|
|             |                                                              | Category   | Level | L         | T        | P        | C         |             |
| 2501EC05    | Electromagnetic Waves & Transmission Lines                   | MCC        | IC    | 2         | 1        |          | 3         | 3           |
| 2501EC09    | Analog & Digital Communications                              | MCC        | IC    | 2         | 1        | 1        | 4         | 5           |
| 2501EC07    | Integrated Circuits & Applications                           | MCC        | IC    | 2         |          | 2        | 4         | 6           |
| 2501EC08    | Linear Control Systems                                       | MCC        | IC    | 2         | 1        |          | 3         | 3           |
|             | Minor Stream Course -2 or University Open Elective Course -2 | MSC or UEC | IC    | 3         |          |          | 3         | 3           |
| 2501UC15    | Employability Skills-IV                                      | VAC        | IC    |           |          | 3        | 0         | 3           |
| 2501EC18    | Summer Internship-I                                          | SI         | IC    |           |          | 2        | 2         | 4           |
| 2501AC04    | Intellectual Property Rights & Patents                       | MC         | FC    | 2         |          |          | 0         | 2           |
|             | <b>Total</b>                                                 |            |       | <b>13</b> | <b>3</b> | <b>8</b> | <b>19</b> | <b>30</b>   |

### VI SEMESTER

| Course code | Course Title                                                 | Course     |       |           |          |          |           | Total Hours |
|-------------|--------------------------------------------------------------|------------|-------|-----------|----------|----------|-----------|-------------|
|             |                                                              | Category   | Level | L         | T        | P        | C         |             |
| 2501EC10    | Digital Signal Processing                                    | MCC        | IC    | 2         |          | 1        | 3         | 4           |
| 2501EC13    | Antenna & Microwave Engineering                              | MCC        | AC    | 2         |          | 2        | 4         | 6           |
| 2501MB01    | Engineering Economics and Management                         | MDC        | FC    | 3         |          |          | 3         | 3           |
|             | Minor Stream Course-3 or University Open Elective Course -3  | MSC or UEC | IC    | 2         |          | 1        | 3         | 4           |
|             | Minor Stream Course -4 or University Open Elective Course -4 | MSC or UEC | IC    | 2         | 1        |          | 3         | 3           |
|             | Minor Stream Course -5 or University Open Elective Course -5 | MSC or UEC | AC    | 2         | 1        |          | 3         | 3           |
| 2501EC94    | Soft Computing Tools                                         | SEC        | IC    |           |          | 2        | 2         | 4           |
| 2501AC05    | Indian Knowledge Systems                                     | MC         | FC    | 2         |          |          |           | 2           |
|             | <b>Total</b>                                                 |            |       | <b>15</b> | <b>2</b> | <b>6</b> | <b>21</b> | <b>29</b>   |

## VII SEMESTER

| Course code | Course Title                                                   | Course       |       |           |          |          |           | Total Hours |
|-------------|----------------------------------------------------------------|--------------|-------|-----------|----------|----------|-----------|-------------|
|             |                                                                | Category     | Level | L         | T        | P        | C         |             |
|             | Minor Stream Course -6 or University Open Elective Course -6   | MSC (or) UEC | IC    | 2         | 1        |          | 3         | 3           |
|             | Minor Stream Course -7 or University Open Elective Course -7   | MSC (or) UEC | IC    | 3         |          |          | 3         | 3           |
|             | Minor Stream Course -8 or University Open Elective Course -8   | MSC (or) UEC | AC    | 2         | 1        |          | 3         | 3           |
|             | Minor Stream Courses -9 or University Open Elective Course -9  | MSC (or) UEC | AC    | 3         |          |          | 3         | 3           |
|             | Minor Stream Course -10 or University Open Elective Course -10 | MSC (or) UEC | AC    | 3         |          |          | 3         | 3           |
|             | Minor Stream Course -11 or University Open Elective Course -11 | MSC (or) UEC | AC    | 2         |          |          | 2         | 2           |
| 2501EC17    | Verification using Verilog & UVM                               | SEC          | AC    |           |          | 2        | 2         | 4           |
| 2501EC19    | Summer Internship-II                                           | SI           | IC    |           |          | 2        | 2         | 4           |
|             | <b>Total</b>                                                   |              |       | <b>15</b> | <b>2</b> | <b>4</b> | <b>21</b> | <b>25</b>   |

### VIII SEMESTER

| Course code | Course Title                    | Course   |       |   |   |           |           | Total Hours |
|-------------|---------------------------------|----------|-------|---|---|-----------|-----------|-------------|
|             |                                 | Category | Level | L | T | P         | C         |             |
| 2501EC16    | ECAD Tools                      | SEC      | AC    |   |   |           | 2         | 4           |
| 2501UC09    | Technical Paper Publication     | AEC      | AC    |   |   | 2         | 2         | 4           |
| 2501UC16    | Employability Skills-V          | VAC      | AC    |   |   | 3         | 0         | 3           |
| 2501EC96    | Student Activity Based Learning | AEC      | AC    |   |   |           | 2         | 2           |
| 2501EC20    | Full Semester Internship        | PROJ     | AC    |   |   | 12        | 12        | 24          |
|             | <b>Total</b>                    |          |       |   |   | <b>17</b> | <b>18</b> | <b>37</b>   |

**Total Credits: 160**

**Note:** \*Courses are applicable only to students admitted in the year 2025.

#Courses are applicable to the students admitted from the year 2026 onwards.

All the other courses are applicable to students admitted from the year 2025 onwards.



**Minor Degree in Electronics and Communication Engineering  
(Offered to other branches students):**

| Course Code | Course Name                                                            | Level | L  | T | P | C  | CIE | SEE | Total | Pre-Requisite      |
|-------------|------------------------------------------------------------------------|-------|----|---|---|----|-----|-----|-------|--------------------|
| 2501EC87    | Fundamentals of Communications                                         | FC    | 2  |   | 1 | 3  | 50  | 50  | 100   | -                  |
| 2501EC88    | Fundamentals of Signal Processing                                      | FC    | 2  |   | 1 | 3  | 50  | 50  | 100   | -                  |
| 2501EC89    | Analog & Digital Circuits                                              | IC    | 2  |   |   | 2  | 50  | 50  | 100   | BEEE               |
| 2501EC42    | Wireless LAN's & PAN's                                                 | IC    | 2  | 1 |   | 3  | 50  | 50  | 100   | -                  |
| 2501EC90    | Linear & Digital IC Applications (or) Sensors & Actuators              | IC    | 3  |   |   | 3  | 50  | 50  | 100   | ADC                |
| 2501EC91    |                                                                        |       |    |   |   |    |     |     |       |                    |
| 2501EC92    | Embedded Microcontrollers (or) Digital System Design                   | IC    | 2  |   | 1 | 3  | 50  | 50  | 100   | ADC, PPSC          |
| 2501EC93    |                                                                        |       |    |   |   |    |     |     |       |                    |
| 2501EC67    | Introduction to Internet of things (or) Modern Wireless Communications | AC    | 2  |   | 1 | 3  | 50  | 50  | 100   | EM, WLAN's & PAN's |
| 2501EC74    |                                                                        |       | 3  |   |   | 3  | 50  | 50  | 100   | FC                 |
| Total       |                                                                        |       | 15 | 1 | 4 | 20 |     |     |       |                    |

### Minor Degree in Civil Engineering

| Course Code | Course Name                                                             | Level | L  | T | P | C  | CIE | SEE | Total | Pre-requisite |
|-------------|-------------------------------------------------------------------------|-------|----|---|---|----|-----|-----|-------|---------------|
| 2501CE25    | Repair & Rehabilitation of Structures                                   | FC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501CE43    | Building Planning & Computer-Aided Drawing                              | FC    |    |   | 2 | 2  | 50  | 50  | 100   | -             |
| 2501CE27    | Green Buildings                                                         | FC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501CE40    | Fundamentals of Soil Behaviour                                          | FC    | 2  | 1 |   | 3  | 50  | 50  | 100   | -             |
| 2501CE54    | Railway Engineering(or)<br>Docks & Harbour Engineering                  | FC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501CE47    |                                                                         |       |    |   |   |    |     |     |       |               |
| 2501CE36    | Environmental Impact & Risk Management(or)<br>Environmental Management  | IC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501CE37    |                                                                         |       |    |   |   |    |     |     |       |               |
| 2501CE56    | Urban Transportation Planning(or)<br>Intelligent Transportation Systems | IC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501CE49    |                                                                         |       |    |   |   |    |     |     |       |               |
| Total       |                                                                         |       | 17 | 1 | 2 | 20 |     |     |       |               |

### Minor Degree in Electrical and Electronics Engineering

| Course Code | Course Name                                                      | Level | L  | T | P | C  | CIE | SEE | Total | Pre-requisite     |
|-------------|------------------------------------------------------------------|-------|----|---|---|----|-----|-----|-------|-------------------|
| 2501EE55    | Operation &Control of Electric machines                          | FC    | 2  |   |   | 2  | 50  | 50  | 100   | BEEE              |
| 2501EE56    | Fundamentals of Power Electronics                                | FC    | 2  |   |   | 2  | 50  | 50  | 100   | BEEE              |
| 2501EE13    | Electrical Measurements & Instrumentation                        | FC    | 2  | 1 | 1 | 4  | 50  | 50  | 100   | ENA-1/BEEE        |
| 2501EE53    | Electric Power Generation, Transmission and Distribution Systems | IC    | 3  |   |   | 3  | 50  | 50  | 100   | ENA-1/BEEE        |
| 2501EE34    | Alternative Energy Sources (or)                                  | IC    | 3  |   |   | 3  | 50  | 50  | 100   | EPGDS / BEEE/ ISM |
| 2501EE27    | Utilization of Electrical Energy                                 |       |    |   |   |    |     |     |       |                   |
| 2501EE37    | Hybrid Electric Vehicles (or)                                    | AC    | 3  |   |   | 3  | 50  | 50  | 100   | FPE/ OCEM         |
| 2501EE35    | Special Electric machines                                        |       |    |   |   |    |     |     |       |                   |
| 2501EE43    | Electrical Safety (or)                                           | AC    | 3  |   |   | 3  | 50  | 50  | 100   | EPGDS /PSA        |
| 2501EE30    | Methods &Algorithms for Intelligent Control                      |       |    |   |   |    |     |     |       |                   |
|             | Total                                                            |       | 18 | 1 | 1 | 20 |     |     |       |                   |

### Minor Degree in Mechanical Engineering

| Course Code | Course Name                                 | Level | L  | T | P | C  | CIE | SEE | Total | Pre-requisite |
|-------------|---------------------------------------------|-------|----|---|---|----|-----|-----|-------|---------------|
| 2501ME74    | Basic Mechanical Engineering                | FC    | 2  |   |   | 2  | 50  | 50  | 100   | -             |
| 2501ME04    | Engineering Thermodynamics                  | IC    | 2  | 1 |   | 3  | 50  | 50  | 100   | SSP/MP        |
| 2501ME77    | Introduction to Automobile Engineering (or) | IC    | 3  |   |   | 3  | 50  | 50  | 100   | SSP/MP        |
| 2501ME78    | Mechanics of Solids                         |       |    |   |   |    |     |     |       |               |
| 2501ME12    | Heat Power Engineering (or)                 | IC    | 2  | 1 |   | 3  | 50  | 50  | 100   | ETD           |
| 2501ME40    | Refrigeration & Air Conditioning            |       |    |   |   |    |     |     |       |               |
| 2501ME75    | Production Technology                       | IC    | 3  |   |   | 3  | 50  | 50  | 100   | EW            |
| 2501ME76    | Metallurgy & Material Science               | IC    | 3  |   |   | 3  | 50  | 50  | 100   | SSP/MP        |
| 2501ME79    | Theory of Machines (or)                     | AC    | 3  |   |   | 3  | 50  | 50  | 100   | SSP/MP        |
| 2501ME80    | Advanced Engineering Metrology              |       |    |   |   |    |     |     |       |               |
|             | Total                                       |       | 18 | 2 |   | 20 |     |     |       |               |

### Minor Degree in Computer Science and Engineering

| Course Code  | Course Title                                                  | Level | L         | T | P        | C         | CIE | SE E | Total | Pre-requisite |
|--------------|---------------------------------------------------------------|-------|-----------|---|----------|-----------|-----|------|-------|---------------|
| 2501CS13     | Operating Systems                                             | IC    | 2         |   | 1        | 3         | 50  | 50   | 100   | -             |
| 2501CS07     | Computer Networks                                             | IC    | 2         |   | 1        | 3         | 50  | 50   | 100   | -             |
| 2501IT07     | Agile Software Engineering                                    | IC    | 2         |   | 1        | 3         | 50  | 50   | 100   | PPSC          |
| 2501AI03     | Data Mining                                                   | IC    | 1         |   | 2        | 3         | 50  | 50   | 100   | -             |
| 2501CS08     | Object Oriented Programming through C++ (or) Java Programming | IC    | 2         |   | 2        | 4         | 50  | 50   | 100   | PPSC          |
| 2501IT06     |                                                               |       |           |   |          |           |     |      |       |               |
| 2501CS16     | Introduction to MERN Stack                                    | IC    |           |   | 2        | 2         | 50  | 50   | 100   | JP            |
| 2501CS30     | Development(or) Information Security Analysis & Audit         | IC    | 2         |   |          | 2         | 50  | 50   | 100   | -             |
| 2501CS18     | Advanced MERN Stack                                           | AC    |           |   | 2        | 2         | 50  | 50   | 100   | IMSD          |
| 2501IT12     | Development(or) Flutter Fundamentals                          | AC    |           |   | 2        | 2         | 50  | 50   | 100   | -             |
| <b>Total</b> |                                                               |       | <b>11</b> |   | <b>9</b> | <b>20</b> |     |      |       |               |

### Minor Degree in Data Science

| Course Code | Course Name                               | Level | L  | T | P | C  | CIE | SEE | Total | Pre-requisite |
|-------------|-------------------------------------------|-------|----|---|---|----|-----|-----|-------|---------------|
| 2501IT07    | Agile Software Engineering                | IC    | 2  |   | 1 | 3  | 50  | 50  | 100   | PPSC          |
| 2501CS34    | Fundamentals of Data Science              | IC    | 2  |   | 1 | 3  | 50  | 50  | 100   | PPSC          |
| 2501CS12    | NoSQL Databases                           | IC    | 2  |   |   | 2  | 50  | 50  | 100   | -             |
| 2501AI03    | Data Mining                               | IC    | 1  |   | 2 | 3  | 50  | 50  | 100   | -             |
| 2501CS37    | Health Care Data Analytics                | IC    | 2  |   | 1 | 3  | 50  | 50  | 100   | PPSC          |
| 2501CS36    | (or)<br>Business Intelligence & Analytics |       |    |   |   |    |     |     |       |               |
| 2501AI04    | Big Data Analytics (or)                   | AC    | 2  |   | 1 | 3  | 50  | 50  | 100   | DM            |
| 2501AI19    | Data Visualization                        |       |    |   |   |    |     |     |       | DAP           |
| 2501CS41    | Social Network Analysis (or)              | AC    | 2  |   | 1 | 3  | 50  | 50  | 100   | -             |
| 2501CS40    | Social Networks & Semantic Web            |       |    |   |   |    |     |     |       |               |
|             | Total                                     |       | 13 |   | 7 | 20 |     |     |       |               |

### Minor Degree in Artificial Intelligence and Machine Learning

| Course Code  | Course Name                                                     | Level | L         | T | P        | C         | CIE | SEE | Total | Pre-requisite |
|--------------|-----------------------------------------------------------------|-------|-----------|---|----------|-----------|-----|-----|-------|---------------|
| 2501AI02     | Artificial Intelligence                                         | IC    | 2         |   | 1        | 3         | 50  | 50  | 100   | DAP           |
| 2501AI05     | Machine Learning                                                | IC    | 2         |   | 2        | 4         | 50  | 50  | 100   | DAP           |
| 2501AI15     | AI Chatbots                                                     | IC    | 2         |   |          | 2         | 50  | 50  | 100   | DAP           |
| 2501AI14     | Soft Computing (or)<br>Fundamentals of Data<br>Science          | IC    | 1         |   | 2        | 3         | 50  | 50  | 100   | AI            |
| 2501CS34     |                                                                 |       | 2         |   | 1        | 3         | 50  | 50  | 100   | PPSC          |
| 2501AI10     | Natural Language<br>Processing (or)<br>Data Visualization       | AC    | 2         |   | 1        | 3         | 50  | 50  | 100   | DAP           |
| 2501AI19     |                                                                 |       |           |   |          |           |     |     |       |               |
| 2501AI16     | Prompt Engineering and<br>GenAI (or)<br>Social Network Analysis | AC    | 2         |   | 1        | 3         | 50  | 50  | 100   | ML            |
| 2501CS41     |                                                                 |       |           |   |          |           |     |     |       |               |
| 2501AI17     | Federated Machine<br>Learning                                   | AC    | 2         |   |          | 2         | 50  | 50  | 100   | ML            |
| <b>TOTAL</b> |                                                                 |       | <b>14</b> |   | <b>6</b> | <b>20</b> |     |     |       |               |

### Minor Degree in Petroleum Technology

| Course Code  | Course Name                                                                                 | Level | L         | T        | P | C         | CIE | SEE | Total | Pre-requisite |
|--------------|---------------------------------------------------------------------------------------------|-------|-----------|----------|---|-----------|-----|-----|-------|---------------|
| 2501PT27     | Introduction to Petroleum Engineering                                                       | FC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501PT35     | Unit Operations in Petroleum Industry                                                       | FC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501PT47     | Fundamentals of Geology & Reservoir Engineering                                             | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501PT48     | Fundamentals of Drilling & Production Engineering (or) Unconventional Hydrocarbon Resources | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501PT16     |                                                                                             |       | 1         | 1        |   | 2         |     |     |       |               |
| 2501PT49     | Natural Gas Hydrates (or) Fundamentals of Liquefied Natural Gas                             | AC    | 2         |          |   | 2         | 50  | 50  | 100   | -             |
| 2501PT05     |                                                                                             |       | 3         |          |   | 3         |     |     |       |               |
| 2501PT50     | Artificial Lift Techniques (or) Enhanced Oil Recovery                                       | AC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501PT03     |                                                                                             |       | 2         | 1        |   | 3         |     |     |       |               |
| 2501PT12     | Petroleum Refinery Engineering                                                              | AC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| <b>Total</b> |                                                                                             |       | <b>18</b> | <b>2</b> |   | <b>20</b> |     |     |       |               |



### Minor Degree in Mining Engineering

| Course Code | Course Name                                 | Level | L  | T | P | C  | CIE | SEE | Total | Pre-requisite |
|-------------|---------------------------------------------|-------|----|---|---|----|-----|-----|-------|---------------|
| 2501MN003   | Development of Mineral Deposits             | FC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MN41    | Green Mining                                | FC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MN06    | Surface Mining                              | IC    | 3  |   |   | 3  | 50  | 50  | 100   | DMD           |
| 2501MN24    | Drilling & Blasting                         | IC    | 3  |   |   | 3  | 50  | 50  | 100   | DMD           |
| 2501MN07    | Underground Coal Mining Technology          | IC    | 3  |   |   | 3  | 50  | 50  | 100   | DMD           |
| 2501MN08    | (or)<br>Underground Metal Mining Technology |       |    |   |   |    |     |     |       |               |
| 2501MN14    | Mine Legislation & General Safety (or)      | AC    | 3  |   |   | 3  | 50  | 50  | 100   | UCMT / UMMT   |
| 2501MN28    | Environmental Pollution & Control           |       |    |   |   |    |     |     |       |               |
| 2501MN45    | Industrial Safety Practices (or)            | AC    | 2  |   |   | 2  | 50  | 50  | 100   | -             |
| 2501MN46    | Ground Control                              |       |    |   |   |    |     |     |       |               |
| Total       |                                             |       | 20 |   |   | 20 |     |     |       |               |

### Minor Degree in Agricultural Engineering

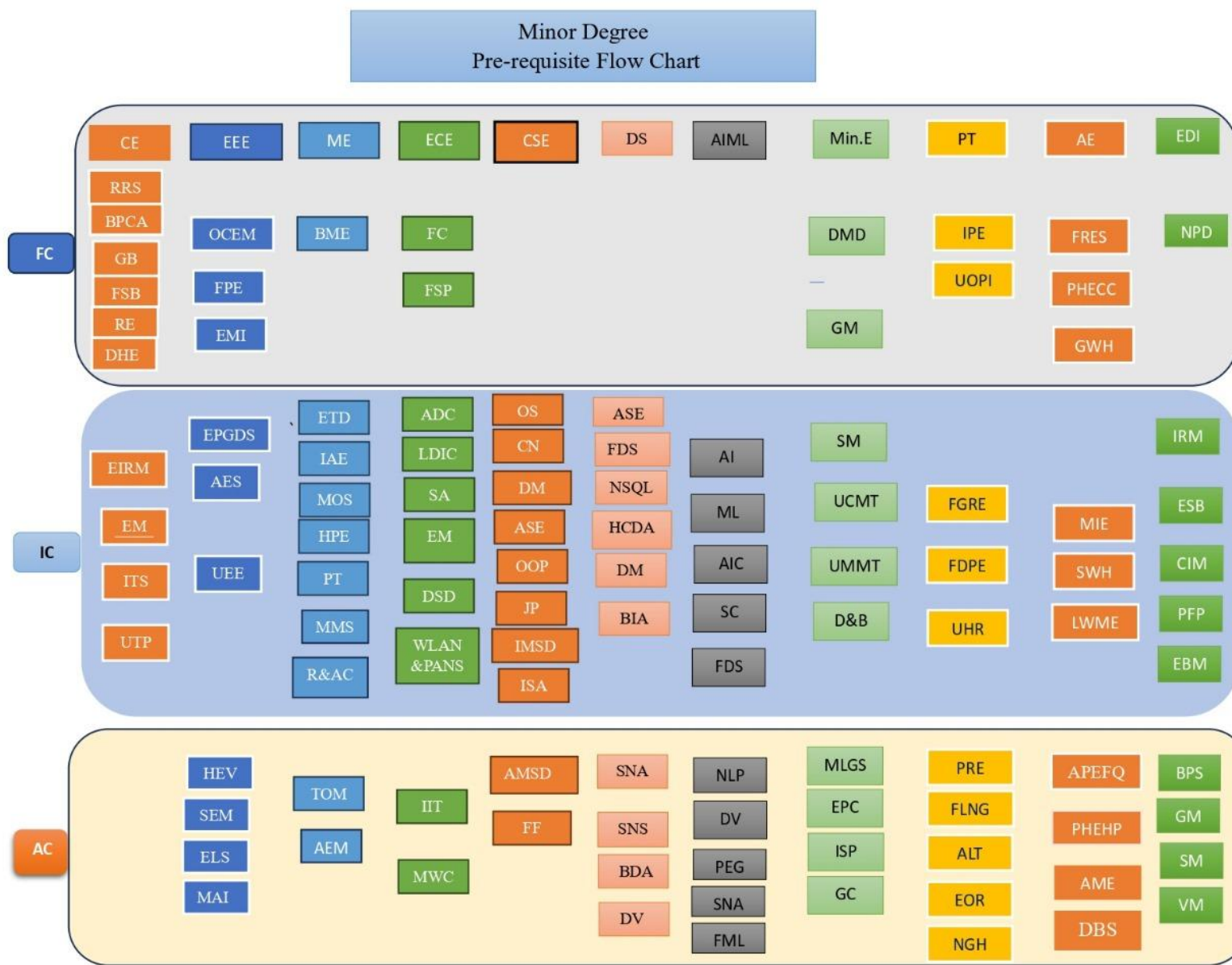
| Agricultural Engineering |                                                      |       |           |   |   |           | Marks |     |       | Pre-requisite |
|--------------------------|------------------------------------------------------|-------|-----------|---|---|-----------|-------|-----|-------|---------------|
| Course Code              | Course Name                                          | Level | L         | T | P | C         | CIE   | SEE | Total |               |
| 2501AE82                 | Fundamentals of Renewable Energy Sources             | FC    | 3         |   |   | 3         | 50    | 50  | 100   | -             |
| 2501AE83                 | Post-harvest Engineering of Cereal Crops             | FC    | 3         |   |   | 3         | 50    | 50  | 100   | -             |
| 2501AE84                 | Ground Water Hydrology                               | FC    | 3         |   |   | 3         | 50    | 50  | 100   | -             |
| 2501AE85                 | Micro Irrigation Systems                             | IC    | 2         |   |   | 2         | 50    | 50  | 100   | -             |
| 2501AE86                 | Surface Water Hydrology (OR)                         | IC    | 3         |   |   | 3         | 50    | 50  | 100   | GWH           |
| 2501AE87                 | Land & Water Management Engineering                  |       |           |   |   |           |       |     |       |               |
| 2501AE88                 | Agricultural Process Engineering & Food Quality (OR) | AC    | 3         |   |   | 3         | 50    | 50  | 100   | PHECC         |
| 2501AE89                 | Post-harvest Engineering for Horticultural Products  |       |           |   |   |           |       |     |       |               |
| 2501AE90                 | Agricultural & Machinery Equipment                   | AC    | 3         | 0 | 0 | 3         | 50    | 50  | 100   | FRES          |
| 2501AE91                 | (or) Design of Bio-energy systems                    |       |           |   |   |           |       |     |       |               |
|                          | <b>Total</b>                                         |       | <b>20</b> |   |   | <b>20</b> |       |     |       |               |

### Minor Degree in Entrepreneurship Development & Incubation

| Course Code | Course Name                                                 | Level | L  | T | P | C  | CIE | SEE | Total | Pre-requisite |
|-------------|-------------------------------------------------------------|-------|----|---|---|----|-----|-----|-------|---------------|
| 2501MB07    | New Product Development                                     | FC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MB08    | Entrepreneurship & Small Business Management                | IC    | 2  |   |   | 2  | 50  | 50  | 100   | -             |
| 2501MB09    | Insurance & Risk Management                                 | IC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MB10    | Change & Innovations Management                             | IC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MB11    | Personal Financial Planning (or) E-Business management      | IC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MB12    |                                                             |       |    |   |   |    |     |     |       |               |
| 2501MB13    | Business Policy & Strategic Management (or) Green Marketing | AC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MB14    |                                                             |       |    |   |   |    |     |     |       |               |
| 2501MB15    | Startup Management (or) Venture Management                  | AC    | 3  |   |   | 3  | 50  | 50  | 100   | -             |
| 2501MB16    |                                                             |       |    |   |   |    |     |     |       |               |
| Total       |                                                             |       | 20 |   |   | 20 |     |     |       |               |

### Minor Degree in Quantum Technologies

| S.No.                         | Course Code | Course Name                                      | L                             | T | P | C  | Semester |
|-------------------------------|-------------|--------------------------------------------------|-------------------------------|---|---|----|----------|
| Mandatory Courses             |             |                                                  |                               |   |   |    |          |
| 1                             | 251EC097    | Survey of Quantum technologies and Application   | 3                             | 0 | 0 | 3  | IV       |
| 2                             | 251EC098    | Foundations of Quantum Technologies              | 3                             | 0 | 0 | 3  | V        |
| 3                             | 251EC099    | Basic Programming Lab (or)                       | 1                             | 0 | 2 | 3  | V        |
|                               | 251EC100    | Basic Laboratory Course for Quantum Technologies |                               |   |   |    |          |
| 4                             | 251EC101    | Quantum Algorithms and Cryptography              | 12 week 3 Credit - NPTEL MOOC |   |   | 3  | VII/VIII |
| Any One course from the below |             |                                                  |                               |   |   |    |          |
| 5                             | 251EC102    | Introduction to Quantum Computation              | 3                             | 0 | 0 | 3  | VI       |
| 6                             | 251EC103    | Introduction to Quantum Communication            | 3                             | 0 | 0 | 3  | VI       |
| 7                             | 251EC104    | Introduction to Quantum Sensing                  | 3                             | 0 | 0 | 3  | VI       |
| 8                             | 251EC105    | Introduction to Quantum Materials                | 3                             | 0 | 0 | 3  | VI       |
| Any One course from the below |             |                                                  |                               |   |   |    |          |
| 9                             | 251EC106    | Engineering Foundations of Quantum Technologies  | 3                             | 0 | 0 | 3  | VII      |
| 10                            | 251EC107    | Solid State Physics for Quantum Technologies     | 3                             | 0 | 0 | 3  | VII      |
| 11                            | 251EC108    | Quantum Optics                                   | 3                             | 0 | 0 | 3  | VII      |
| 12                            | 251EC109    | Quantum Cybersecurity                            | 3                             | 0 | 0 | 3  | VII      |
| 13                            | 251EC110    | Quantum Machine Learning                         | 3                             | 0 | 0 | 3  | VII      |
| Total                         |             |                                                  | 18                            | 0 | 0 | 18 |          |



| Dept.      | FOUNDATION COURSE |                                            | INTERMEDIATE- LEVEL COURSE |                                                  | ADVANCED COURSE |                                              |
|------------|-------------------|--------------------------------------------|----------------------------|--------------------------------------------------|-----------------|----------------------------------------------|
| <b>CE</b>  | RRS               | Repair & Rehabilitation of Structures      | EIRM                       | Environmental Impact & Risk Management           |                 |                                              |
|            | BPCA              | Building Planning & Computer-Aided Drawing | EM                         | Environmental Management                         |                 |                                              |
|            | GB                | Green Building                             | UTP                        | Urban Transportation Planning                    |                 |                                              |
|            | FSB               | Fundamental of Soil Behaviour              | ITS                        | Intelligent Transportation Systems               |                 |                                              |
|            | RE                | Railway Engineering                        |                            |                                                  |                 |                                              |
|            | DHE               | Docks & Harbour Engineering                |                            |                                                  |                 |                                              |
| <b>EEE</b> | OCEM              | Operation control of Electric Machines     | AES                        | Alternative Energy Sources                       | MAI             | Methods & Algorithms for Intelligent Control |
|            | FPE               | Fundamentals of Power Electronics          | EPGDS                      | Electric Power Generation & Distribution Systems | HEV             | Hybrid Electric Vehicles                     |
|            | EMI               | Electrical Measurements & Instrumentation  | UEE                        | Utilization of Electrical Energy                 | SEM             | Special Electric Machines                    |
|            | BME               | Basic Mechanical Engineering               | ETD                        | Engineering Thermodynamics                       | ELS             | Electrical Safety                            |
| <b>ME</b>  |                   |                                            | IAE                        | Introduction to Automobile Engineering           | TOM             | Theory of Machines                           |
|            |                   |                                            | MOS                        | Mechanics of Solids                              | AEM             | Advanced Engineering Metrology               |
|            |                   |                                            | HPE                        | Heat Power Engineering                           |                 |                                              |
|            |                   |                                            | PT                         | Production Technology                            |                 |                                              |
|            |                   |                                            | MMS                        | Metallurgy & Material Science                    |                 |                                              |
|            |                   |                                            | R&AC                       | Refrigeration & Air Conditioning                 |                 |                                              |
|            |                   |                                            | ADC                        | Analog & Digital Circuits                        |                 |                                              |
|            |                   |                                            | LDIC                       | Linear & Digital IC Applications                 | IIT             | Introduction to Internet of things           |
|            |                   |                                            | SA                         | Sensors & Actuators                              |                 |                                              |
|            |                   |                                            |                            |                                                  |                 |                                              |
| <b>ECE</b> | FC                | Fundamentals of Communications             | EM                         | Embedded Microcontrollers                        | MWC             | Modern Wireless Communications               |
|            | FSP               | Fundamentals of Signal Processing          | DSD                        | Digital System Design                            |                 |                                              |
|            |                   |                                            | WLAN & PAN                 | Wireless LANS & PANS                             |                 |                                              |
|            |                   |                                            | SE                         | Software Engineering                             |                 |                                              |
| <b>CSE</b> |                   |                                            | OOP                        | Object Oriented Programming through C++          | AMSD            | Advanced MERN Stack Development              |
|            |                   |                                            | OS                         | Operating Systems                                | FF              | Flutter Fundamentals                         |
|            |                   |                                            | CN                         | Computer Networks                                |                 |                                              |
|            |                   |                                            | JP                         | Java Programming                                 |                 |                                              |
|            |                   |                                            | IMSD                       | Introduction to MERN Stack Development           |                 |                                              |
|            |                   |                                            | ISA                        | Information Security Analysis and Audit          |                 |                                              |
|            |                   |                                            | DM                         | Data Mining                                      |                 |                                              |
|            |                   |                                            | DM                         | Data Mining                                      | SNA             | Social Network Analysis                      |
|            |                   |                                            | FDS                        | Fundamentals of Data Science                     | DV              | Data Visualization                           |
|            |                   |                                            | SE                         | Software Engineering                             | BDA             | Big Data Analytics                           |
| <b>DS</b>  |                   |                                            | NSQL                       | NoSQL Databases                                  | SNSW            | Social Networks and Semantic Web             |

|              |      |                                          |      |                                                     |       |                                                    |
|--------------|------|------------------------------------------|------|-----------------------------------------------------|-------|----------------------------------------------------|
| <b>AIML</b>  |      |                                          | BIA  | Business Intelligence & Analytics                   |       |                                                    |
|              |      |                                          | HCDA | Health Care Data Analysis                           |       |                                                    |
|              |      |                                          | ML   | Machine Learning                                    | DV    | Data Visualization                                 |
|              |      |                                          | AI   | Artificial Intelligence                             | PEG   | Prompt Engineering and GenAI                       |
|              |      |                                          | AI C | AI Chatbot                                          | SNA   | Social Network Analysis                            |
|              |      |                                          | FDS  | Fundamentals of Data Science                        | FML   | Federated Machine Learning                         |
|              |      |                                          | SC   | Soft Computing                                      | NLP   | Natural Language Processing                        |
|              |      |                                          | SM   | Surface Mining                                      | MLGS  | Mine Legislation and General Safety                |
|              |      |                                          | UCMT | Underground Coal Mining Technology                  | EPC   | Environmental Pollution & Control                  |
|              |      |                                          | UMMT | Underground Metal Mining Technology                 | ISP   | Industrial Safety Practices                        |
| <b>Min.E</b> | DMD  | Development of Mineral Deposits          |      |                                                     | GC    | Ground Control                                     |
|              | GM   | Green Mining                             |      |                                                     | PRE   | Petroleum Refinery Engineering                     |
|              |      |                                          | DB   | Drilling & Blasting                                 | FLNG  | Fundamentals of Liquefied Natural Gas              |
|              | IPE  | Introduction to Petroleum Engineering    | FGRE | Fundamentals of Geology and Reservoir Engineering   | NGH   | Natural Gas Hydrates                               |
|              |      |                                          | FDPE | Fundamentals of Drilling and Production Engineering | ALT   | Artificial Lift Techniques                         |
|              |      |                                          | UHR  | Unconventional Hydrocarbon Resources                | EOR   | Enhanced Oil Recovery                              |
|              |      |                                          | LWME | Land and Water Management                           | DBS   | Design of Bio-Energy Systems                       |
|              |      |                                          | SWH  | Surface Water Hydrology                             | PHEHP | Post-Harvest Engineering for Horticultural Produce |
|              |      |                                          | MIE  | Micro Irrigation Systems                            | AME   | Agricultural Machinery and Equipment               |
|              |      |                                          |      |                                                     | APEFQ | Agriculture Process Engineering and Food Quality   |
| <b>PT</b>    | UOPI | Unit operations in Petroleum Industry    |      |                                                     | BPS   | Business Policy & Strategic Management             |
|              |      |                                          |      |                                                     | GM    | Green Marketing                                    |
|              | GWH  | Ground Water Hydrology                   |      |                                                     | SM    | Startup Management                                 |
|              | PHEC | Post-harvest Engineering of Cereal Crops |      |                                                     | VM    | Venture Management                                 |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
| <b>Ag.E</b>  | FRES | Fundamentals of Renewable Energy Sources |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
| <b>EDC</b>   | NPD  | New Product Development                  | ESB  | Entrepreneurship and Small Business Management      |       |                                                    |
|              |      |                                          | CIM  | Change & Innovations Management                     |       |                                                    |
|              |      |                                          | PFP  | Personal Financial Planning                         |       |                                                    |
|              |      |                                          | EBM  | E-Business Management                               |       |                                                    |
|              |      |                                          | IRM  | Insurance and Risk Management                       |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |
|              |      |                                          |      |                                                     |       |                                                    |

### Major Core Courses (MCC)

| Course Code         | Course Name                                                                       | Level | L | T | P | C | CI E | SEE | Total | Pre-requisite |
|---------------------|-----------------------------------------------------------------------------------|-------|---|---|---|---|------|-----|-------|---------------|
| 2501MA01            | Linear Algebra & Calculus                                                         | FC    | 2 | 1 |   | 3 | 50   | 50  | 100   | -             |
| 2501MA02            | Differential Equations & Vector Calculus                                          | FC    | 2 | 1 |   | 3 | 50   | 50  | 100   | -             |
| 2501MA07            | Transform Calculus                                                                | FC    | 2 | 1 |   | 3 | 50   | 50  | 100   | LAC, DEVC     |
| 2501CH02            | Applied Chemistry                                                                 | FC    | 2 |   | 1 | 3 | 50   | 50  | 100   | -             |
| 2501PH02            | Modern Physics                                                                    | FC    | 2 |   | 1 | 3 | 50   | 50  | 100   | -             |
| 2501CS01 / 2601DS01 | Programming for Problem Solving Using C* / Problem Solving Through C Programming# | FC    | 2 |   | 2 | 4 | 50   | 50  | 100   | -             |
| 2501IT01/ 2601AI01  | Business Intelligence Lab* / Business Intelligence & AI Tools Lab#                | FC    |   |   | 2 | 2 | 50   | 50  | 100   | -             |
| 2501ME01            | Engineering Graphics                                                              | FC    | 1 |   | 2 | 3 | 50   | 50  | 100   | -             |
| 2501ME03            | Engineering Workshop                                                              | FC    |   |   | 1 | 1 | 100  | -   | 100   | -             |
| 2501EE01            | Basic Electrical & Electronics Engineering                                        | FC    | 2 |   | 2 | 4 | 50   | 50  | 100   | -             |
| 2501EC02            | Network Analysis                                                                  | FC    | 3 | 1 |   | 4 | 50   | 50  | 100   | -             |
| 2501EC01            | Digital Electronics                                                               | FC    | 2 |   | 2 | 4 | 50   | 50  | 100   | -             |
| 2501EC03            | Electronic Devices & Circuits                                                     | FC    | 2 |   | 2 | 4 | 50   | 50  | 100   | BEEE          |
| 2501EC04            | Random Variables & Stochastic Processes                                           | FC    | 3 | 1 |   | 4 | 50   | 50  | 100   | -             |



|              |                                            |    |           |          |           |           |    |    |     |      |
|--------------|--------------------------------------------|----|-----------|----------|-----------|-----------|----|----|-----|------|
| 2501EC14     | Signals & Systems                          | FC | 2         | 1        | 1         | 4         | 50 | 50 | 100 | -    |
| 2501EC05     | Electromagnetic Waves & Transmission Lines | IC | 2         | 1        |           | 3         | 50 | 50 | 100 | DEVC |
| 2501EC06     | Analog Electronics                         | IC | 2         |          | 2         | 4         | 50 | 50 | 100 | EDC  |
| 2501EC07     | Integrated Circuits & Applications         | IC | 2         |          | 2         | 4         | 50 | 50 | 100 | EDC  |
| 2501EC08     | Linear Control Systems                     | IC | 2         | 1        |           | 3         | 50 | 50 | 100 | S&S  |
| 2501EC09     | Analog & Digital Communications            | IC | 2         | 1        | 1         | 4         | 50 | 50 | 100 | S&S  |
| 2501EC10     | Digital Signal Processing                  | IC | 2         |          | 1         | 3         | 50 | 50 | 100 | S&S  |
| 2501EC11     | VLSI Design                                | IC | 2         |          | 1         | 3         | 50 | 50 | 100 | EDC  |
| 2501EC12     | Microprocessors & Microcontrollers         | AC | 2         |          | 1         | 3         | 50 | 50 | 100 | DELD |
| 2501EC13     | Antenna & Microwave Engineering            | AC | 2         |          | 2         | 4         | 50 | 50 | 100 | EMTL |
| <b>Total</b> |                                            |    | <b>45</b> | <b>7</b> | <b>28</b> | <b>80</b> |    |    |     |      |

## Linear Algebra & Calculus

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

**Course Code: 2501MA01**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the Course, Student will be able to:**

- CO1:** Solve the system of Linear equations.
- CO2:** Calculate Eigen values and Eigen vectors.
- CO3:** Apply differential calculus for one and several variable functions.
- CO4:** Calculate the Maximum value and Minimum value of a function of several variables.
- CO5:** Compute areas and volumes using multiple integrals.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |

### UNIT – I

**System of linear Equations:** Vector Space, Linear Independence, Rank of a matrix by echelon form, normal form, Inverse of Non-singular matrices by Gauss-Jordan method, Solutions of Linear Systems: Existence, Uniqueness, Solving the system by Gauss elimination method.

#### Practice(Using any computational tool)

- Variables, arithmetic operations, elementary mathematical functions.
- Defining row vector, column vector, Arithmetic operations on matrices
- finding transpose of a matrix, inverse of a matrix, determinant of a matrix
- rank of a matrix, , solving system of linear equations.

### UNIT – II

**Eigenvalues, Eigenvectors :** Eigenvalues and properties(without proof), Eigenvectors, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), Quadratic forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation, Nature of Quadratic forms.

**Practice(Using any computational tool):** Computing eigen values and eigen vectors, matrix diagonalization

### UNIT – III

**One Variable Calculus:**Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems.

**Several Variable Calculus:** Limit, Continuity, partial derivatives and their geometrical interpretation.

**Practice(Using any computational tool):**Basics of plotting,Plot graphs of single variable functions.

### UNIT – IV

**Functions of several variables:**Total differential and differentiability, derivatives of composite and implicit functions, derivatives of higher order and their commutativity,Euler's theorem on homogeneous functions, Taylor's and Maclaurin's expansion of functions of two variables. Jacobians, maxima and minima, constrained maxima/minima problems using Lagrange's method of multipliers.

**Practice(Using any computational tool):** Plot graphs of various multi variable functions

### UNIT – V

**Multiple Integrals:** Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

**Practice(Using any computational tool):**Plotting the region of Integration

Students are advised to use any computational / AI Tool like Wolfram Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

#### Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5<sup>th</sup>Edition (9th reprint), 2021, ISBN:978-8184875607.
2. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 5<sup>th</sup> Edition, 2018, ISBN: 978-1292174341.

#### Reference Books:

1. Advanced Engineering Mathematics, Michael Greenberg, , Pearson publishers, 9<sup>th</sup>Edition, ISBN: 9788177585469.
2. Higher Engineering Mathematics, H. K Das, Er. Rajnish Verma, S. Chand Publications, Third Edition, 2023, ISBN: 9788121938907.

**Web Links:**

1. <https://archive.nptel.ac.in/courses/111/104/111104137/>
2. <https://archive.nptel.ac.in/courses/111/107/111107108/>
3. <https://www.khanacademy.org/math/linear-algebra/>
4. <https://www.khanacademy.org/math/multivariable-calculus>

## Differential Equations & Vector Calculus

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

|                      | L | T | P | C |
|----------------------|---|---|---|---|
| Course Code:2501MA02 | 2 | 1 | 0 | 3 |

### Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Solve the linear differential equations of first order and apply in various engineering problems.
- CO2:** Solve the linear differential equations of higher order and apply in various engineering problems.
- CO3:** Solve the linear partial differential equations
- CO4:** Calculate the gradient, divergence and curl.
- CO5:** Compute work done, flux using vector integration

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO4   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |

### UNIT – I

#### Ordinary Differential Equations of First Order and First Degree:

Solution of first order linear differential equations, exact differential equations and equations reducible to exact differential equations, Orthogonal Trajectories, Modelling of RL- circuit.

**Practice(Using any computational tool):**Solving the first order initial value problems using **odesolver** and plot the solution curves.

### UNIT – II

#### Linear Differential Equations of Higher Order:

Solution of linear differential equations with constant coefficients, method of variation of parameters, solution of simultaneous linear differential equations.

Equations reducible to Linear differential equations with constant coefficients: Cauchy's homogeneous Linear Equations, Legendre's Linear Equations. Study of oscillations arising in LCR circuit (free oscillations and forced oscillations).

**Practice(Using any computational tool):**Solving the second order initial value problems using **odesolver** and plot the solution curves

## UNIT – III

### **Partial Differential Equations:**

Solution of linear PDE of first order by Lagrange's method, solution of homogeneous linear PDE of higher order with constant coefficients.

## UNIT – IV

### **Vector Differentiation:**

Gradient of a scalar field, finding angle between two surfaces, directional derivative.

Divergence and solenoidal fields. Curl and irrotational fields, Finding Scalar Potential.

**Practice(Using any computational tool):**Plotting of surfaces, 3D-plots, plotting vector fields

## UNIT – V

### **Vector Integration:**

Line integrals, work done by a force, conservative force field, surface integral, flux, volume integral. Green's theorem, Stoke's theorem and Gauss divergence theorem.

Students are advised to use any computational / AI Tool like Wolfram Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

### **Text Books:**

1. Advanced Engineering Mathematics, E. Kreyszig, John Wiley & Sons, 10<sup>th</sup> Edition, 2018, ISBN 978-0470458365.
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44<sup>th</sup> Edition 2021, ISBN 978-9383214204.

### **Reference Books:**

1. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, 6<sup>th</sup> Edition. ISBN 978-1284105902.
2. Higher Engineering Mathematics, B.V. Ramana, McGraw-Hill Education, 11<sup>th</sup> Edition, ISBN 978-9339216016.

### **Web Links:**

1. <https://www.classcentral.com/course/differential-equations-engineers-13258>
2. <https://archive.nptel.ac.in/courses/111/106/111106100/>
3. <https://www.khanacademy.org/math/differential-equations>
4. <https://archive.nptel.ac.in/courses/111/101/111101153/>
5. <https://archive.nptel.ac.in/courses/111/105/111105122/>

## Transform Calculus

|                       | L | T | P | C |
|-----------------------|---|---|---|---|
| Course Code: 2501MA07 | 2 | 1 | 0 | 3 |

### Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Calculate the Fourier series of a given function and examine the convergence of the series.
- CO2:** Calculate Laplace transform of standard functions and examine the properties of Laplace transform.
- CO3:** Apply Laplace transform to solve Initial value problems.
- CO4:** Calculate the Fourier transform for certain functions.
- CO5:** Compute Z- transform of various functions and apply to solve difference equations.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO4   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |

### UNIT – I

**Fourier Series:** Fourier series of periodic function, Half-range series, Change of interval and Fourier series in complex form, Parseval's formula and R.M.S Value.

**Practice(Using any computational tool):** Generating Fourier Series of functions .

### UNIT – II

**Laplace Transforms:** Laplace transforms of standard functions, Shifting theorems, Change of scale property, Multiplication with t, Division by t, Transforms of derivatives and integrals, Unit step function, Dirac delta function, Periodic function, Evaluating improper integrals of the type  $\int_0^{\infty} f(t) dt$  using Laplace Transforms.

**Practice(Using any computational tool):** Find Laplace transform of elementary functions.

### UNIT – III

**Inverse Laplace Transforms :** Inverse Laplace transforms of functions, First shifting theorem, Convolution theorem (without proof), Method of partial fractions, Second shifting theorem, Solving initial value problems and integro-differential equations using Laplace transforms.

## UNIT – IV

**Fourier Transforms:** Fourier integral theorem (without proof), Fourier sine and cosine integral, Fourier Transform, Properties, Fourier sine and cosine transforms and Finite Fourier transforms.

## UNIT – V

**Z-Transforms:** Definition of Z-transform, Properties, Damping rule, Shifting rule, Initial and final value theorems, Inverse Z-transform, Convolution theorem (without proof), Solution of Difference equation by using Z-transforms.

Students are advised to use any computational / AI Tool like Wolfram Alpha, Symbolab, Mathway, Desmos, Geogebra etc., for the practice

### Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 5th Edition (9th reprint), 2021 · ISBN978-8184875607.
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44'th Edition (2021).ISBN 978-9383214204.

### Reference Books:

1. A text book of Engineering Mathematics, N.P. Bali and Manish Goyal, Laxmi Publications, Reprint, 2016.ISBN 978-8131808320.
2. Higher Engineering Mathematics, H. K. Dass, Er. R. Verma, S-Chand publishers, 3rd edition 2023.ISBN 9788121938907.

### Web Links:

1. <https://nptel.ac.in/courses/117105134/13>
2. <https://nptel.ac.in/courses/108106075/23>
3. <https://tutorial.math.lamar.edu/Classes/DE/LaplaceTransforms.aspx>
4. <https://archive.nptel.ac.in/courses/111/106/111106111/>



**Applied Chemistry**  
(Common to EEE, ECE, CSE, IT, CSE(DS) & AIML)

|                              |          |          |          |          |
|------------------------------|----------|----------|----------|----------|
|                              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 2501CH02</b> | <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

**Course Outcomes:**

**At the end of the course, the students will be able to:**

- CO1:** Interpret the essence of polymers and explore engineering applications.
- CO2:** Exemplify the principles and applications of electrochemical cells.
- CO3:** Summarize the preliminaries of Computational Chemistry and its applications.
- CO4:** Infer the preliminaries of Nano, smart materials and their applications.
- CO5:** Apply the knowledge of water treatment and E-waste management.

**Mapping of Course Outcomes with Program Outcomes:**

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

**UNIT-I**

**Polymer Chemistry:**

Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordination polymerization, with specific examples and methods of polymerization (Suspension polymerization and Emulsion Polymerization) Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - PTFE and Bakelite.

**Polymer composites:** Composites as structural material; Synthesis and applications of Kevlar and Carbon Fibers.

**Conducting polymers:** Polyacetylene- Mechanism of conduction – applications (polymers in sensors, Self-Cleaning windows), Biodegradable polymers - Introduction, Polyglycolic acid - synthesis, degradation and uses.

**Practice:**

1. Preparation of a polymer (Bakelite).
2. Determination of molecular weight of polymer using Ostwald's viscometer.

**UNIT- II**

**Electrochemistry and Applications:**

Electrochemical cell, Nernst equation, cell potential calculations and numerical problems,

Electrochemical sensors: potentiometric sensors with examples, amperometry sensors with examples.

**Primary cells** – Zinc-air battery, Secondary cells –Ni-Cd and, Lead-Acid battery, lithium-ion batteries- working of the batteries including cell reactions; Fuel cells, hydrogen-oxygen, Methanol-Oxygen fuel cell– working of the cells. Polymer Electrolyte Membrane Fuel cells (PEMFC)

**Electrochemical sensors** – potentiometric sensors with examples, amperometric sensors with example (Glucose Electrochemical sensor)

**Practice:**

1. Conductometric titration of strong acid vs strong base.
2. Potentiometric titration of red-ox.
3.  $\text{pH}$ -metric titration of Acid-Base.
4. Determination of Glucose by Electrochemical Sensor.

### UNIT- III

#### Computational Chemistry

Computational Quantum Chemistry and its applications, Prediction of Molecular Properties using Computational Chemistry, Molecular Modelling and Structure - molecular Modelling today: overview of problems, tools, and solution analysis. Techniques for Conformational Sampling-Monte Carlo, global Optimization etc.

**Practice:**

1. Molecular docking to predict the interaction energy between molecules.

### UNIT-IV

#### Nano and Smart Materials

Introduction to nano materials and general applications, basic chemical methods of preparation (top down and bottom up approach) - Sol-gel method. Applications of Carbon nano tubes and Fullerenes, Graphene (water treatment and drug delivery) Characterisation of nano materials by SEM and TEM (only Principle). Smart materials and their engineering applications, Shape memory materials- Poly L-Lactic acid, Thermo response materials – Poly acryl amides, Poly vinyl Amides.

**Practice:**

1. Preparation of nano particles by Green synthesis.
2. Characterization of nanoparticles (SEM & TEM).

### UNIT- V

**Water Treatment & E-Waste Management:** Water treatment: Introduction, hardness of water, types, determination of hardness by EDTA method, disadvantages of hard water,

removal of hardness by Zeolite and ion exchange method, Desalination of water – reverse osmosis and Electrodialysis.

E-Waste: Introduction, sources of e-waste, Composition, Characteristics, and Need of e-waste management. Toxic materials used in manufacturing electronic and electrical products; Recycling: Recycling of Li-Ion batteries. Extraction of copper from E-waste.

**Practice:**

1. Determination of Hardness of a ground water sample.
2. Determination of Chloride content in given water sample.
3. Estimation of dissolved oxygen in given water sample.

**Text Books:**

1. Engineering Chemistry, Prasanta Rath, S. Aruna Kumari, CENGAGE Learning, ISBN 978-93-5350-651-3, ISBN 93-5350-651-4.
2. Engineering Chemistry Fundamentals and Applications, Shikha Agarwal, Cambridge, 2<sup>nd</sup> Edition, ISBN 978-1-108-72444-9.

**Reference Books:**

1. Engineering Chemistry, Uppal M.M, Jain and Jain, Khanna Publishers, 35<sup>th</sup> Edition.
2. A Textbook of Engineering Chemistry, Dr.S.S.Dara, Dr.S.S.Umare, S.Chand Publication, 2022, ISBN 978-817-409-2625.
3. Molecular Modelling Principles and applications, Andrew R. Leach, Prentice Hall, II Edition, ISBN 978-935-501-2585.

**Web Links:**

1. <https://archive.nptel.ac.in/courses/104/106/104106096/>
2. <https://archive.nptel.ac.in/courses/104/105/104105124/>
3. <https://archive.nptel.ac.in/courses/104/106/104106137/>
4. <https://nptel.ac.in/courses/118102003>

**Modern Physics**  
(Common to EEE, ECE, CSE, IT, AIML & CSE (DS))

|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|-----------------------------|----------|----------|----------|----------|
| <b>Course Code:2501PH02</b> | <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

**Course Outcomes:**

**At the end of the Course, Student will be able to:**

- CO1:** Apply the principles of interference and diffraction to design and enhance the resolving power of grating
- CO2:** Familiarize the concepts of LASER's and Optical fibers with applications.
- CO3:** Explain the fundamental concepts of Quantum behavior of matter
- CO4:** Differentiate various electron theories to understand the properties of solids.
- CO5:** Explain the basic concepts of Semiconductors and identify the type of semiconductors using Hall effect.

**Mapping of Course Outcomes with Program Outcomes:**

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

**UNIT-I**

**Wave Optics**

**Interference:** Introduction - Principle of Superposition - Interference of light- Conditions for sustained Interference- Interference in thin films (reflected geometry) – Colours in thin films – Newton's Rings (reflected geometry) – Determination of wavelength and refractive index – Applications.

**Diffraction:** Introduction – Fresnel and Fraunhofer Diffraction - Diffraction due to Single slit (quantitative), Double slit (qualitative) - N-Slits Intensity distribution curves (qualitative) – Grating spectrum–Rayleigh's criterion - Resolving powers of grating (qualitative) - Applications.

**Practice:**

1. Determination of Radius of curvature of a plano-convex lens using Newton's Rings.
2. Measurement of Width or thickness of a thin wire by forming interference fringes.
3. Determination of Wavelength of light source using Diffraction grating by normal incidence method.
4. Resolving power of grating.
5. Determination of wavelength of light by using prism.

## UNIT-II

### **Lasers & Optical Fibers**

**Lasers:** Introduction - Characteristics of Lasers – Spontaneous and Stimulated emission of radiation – population inversion- Einstein's coefficients – Relation - significance - Pumping Mechanisms - Ruby laser – Helium-Neon laser - Applications.

**Optical Fibers:** Introduction – Principle of propagation in Optical Fiber – Angle of acceptance – Expression for Numerical Aperture and condition for propagation – Classification of Optical fibers - Applications.

#### **Practice:**

1. Determination of Wavelength of He-Ne laser source by using diffraction grating.

## UNIT-III

### **Quantum Mechanics**

Introduction – Matter waves – de Broglie's hypothesis – Davisson and Germer Experiment - Heisenberg's Uncertainty Principle – interpretation of wave function – Schrödinger Time dependent and Time Independent wave equations– Particle in a potential box.

## UNIT-IV

### **Free electron Theory**

**Free Electron Theory:** Introduction–Classical free electron theory (merits and demerits only) -Quantum Free electron theory – Electrical conductivity- Fermi energy state–Fermi Dirac distribution function - Temperature dependence – Density of states.

**Band theory of solids:** Bloch Theorem – Origin of energy bands in crystalline solids – classification of crystalline solids.

#### **Practice:**

1. Study the variation of magnetic field along the axis of a circular coil carrying current by using Stewart and Gee's apparatus.
2. Determination of Frequency of electrically maintained tuning fork by Melde's apparatus.

## UNIT-V

### **Semiconductor Physics**

**Semiconductors** Introduction – Intrinsic semiconductors – density of charge carriers (Qualitative only) – Electrical conductivity –Fermi level - extrinsic semiconductors - P-type & N-type semiconductors-Density of charge carriers (Qualitative) - Dependence of Fermi energy on carrier concentration and temperature–Hall effect-Hall coefficient - Applications of Hall effect–Drift and Diffusion currents - Einstein's equation Working of PN junction diode – Zener diode.

#### **Practice:**

1. Determination of V-I characteristics and Breakdown voltage of a Zener diode.

2. Determination of Energy band gap of a semiconductor by using P-N junction diode.
3. Study the relation between Temperature and resistance and finding the constants A & B of a thermistor.
4. Determine the resistivity of a semiconductor by four probe method.

**Text books:**

1. Engineering Physics by M N Avadhanulu & T.V.S. Arun Murthy, S Chand & Company Ltd, 1st edition 2024. ISBN: 978-93-5870-932-3
2. Engineering Physics by Satyendra Sharma and Jyotshna Sharma, Pearson publications. ISBN: 978-81-3151-178-7.

**Reference Books:**

1. Concepts of Modern Physics by Authur Beiser, Shobhit Mahajan and S Rai Choudhary, McGraw Hill (2017). ISBN: 9789351341857
2. Engineering Physics by M.R. Srinivasan, New Age international publishers (2009). ISBN: 978-1848290501
3. Optics by Ajoy Ghatak, 6th Edition McGraw Hill Education, 2017. ISBN: 978-9390113590

**Web Links:**

1. <http://nptel.ac.in/courses/122107035/11>
2. <http://nptel.ac.in/courses/115102023/->
3. <https://phet.colorado.edu/en/simulations/category/physics>
4. <http://physicsgecg.blogspot.in/p/reading-materials.html>

**Programming for Problem Solving using C**  
(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)  
(Syllabus for the batch admitted in the year 2025)

**Course Code: 2501CS01**

**L      T      P      C**  
**2      0      2      4**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Demonstrate basics of computer, algorithm and flow chart for problem solving.
- CO2:** Make use of an appropriate control structures to solve given problems.
- CO3:** Solve complex problems using arrays and strings.
- CO4:** Develop modular programming using functions.
- CO5:** Demonstrate dynamic memory allocations and file handling using file operations.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 3    | 2    | 1    | 3    | -    | -    | 2    | -    | -     | 1     |
| <b>CO2</b> | 2    | 3    | 2    | 1    | 3    | -    | -    | 2    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | 1    | 3    | -    | 1    | 2    | -    | -     | 1     |
| <b>CO4</b> | 2    | 3    | 2    | 1    | 3    | -    | 1    | 2    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 2    | 1    | 3    | -    | 1    | 2    | -    | -     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | 2    |
| <b>CO2</b> | 2    | 2    |
| <b>CO3</b> | 2    | 2    |
| <b>CO4</b> | 2    | 2    |
| <b>CO5</b> | 2    | 2    |

## UNIT – I

### Introduction to Programming and Problem Solving

Introduction to Programming Languages, Basics of a Computer Program- Algorithms, Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms, flowcharts (Using Dia Tool), pseudo code. Structure of C Program, Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, operators, keywords, identifiers, Type Conversion, and Casting.

#### Practice 1:

1. Explore different platforms
  - a. Basic linux environment and its editors like Vi, Vim & Emacs etc.
  - b. Exposure to turbo C, gcc.
  - c. Explore to hacker rank or any other Online coding platform and compiler environment.
  - d. “Hello world” in C.

<https://www.codechef.com/learn/course/c/CDEVINTRO/problems/CDEV004B>

- e. Objective: Learn about the syntax of reading from stdin and writing to stdout.  
<https://www.hackerrank.com/challenges/hello-world-c/problem?isFullScreen=true>
  - f. Write a simple program to read int, float, char and string using scanf() and display using printf() in all the above given platforms.
2. Basics and Operators
- a. Sum and Difference of 2 numbers.  
Objective: Learn int and float data types.  
<https://www.hackerrank.com/challenges/sum-numbers-c/problem?isFullScreen=true>  
<https://maya.technicalhub.io/owl-program-details/668b9ec2e069313510b0235a>
  - b. Playing with Characters.  
Objective: Learn how to take a character, a string and a sentence as input in C.  
<https://www.hackerrank.com/challenges/playing-with-characters/problem?isFullScreen=true>
  - c. Bitwise Operators  
Objective: Learn how to work with bits (0,1) and bitwise operators.  
<https://www.hackerrank.com/challenges/bitwise-operators-in-c/problem?isFullScreen=true>
  - d. Conversion of Fahrenheit to Celsius and vice versa.  
<https://www.codechef.com/practice/course/c/LPCAS03/problems/LCAS30>  
<https://maya.technicalhub.io/owl-program-details/66a0c0dda7d31805366af641>
  - e. Distance travelled by an object.  
<https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a>
  - f. Calculate Simple interest and compound interest.  
<https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab>
3. Operators and Expressions, Variables and Type conversions.
- a. Evaluate the following expressions
    - i.  $a/b*c-b+a*d/3$
    - ii.  $j = (i++) + (++i)$
  - b. Square root of a given number.
  - c. Find the area of circle, square, rectangle and triangle.  
<https://maya.technicalhub.io/owl-program-details/6686546930bfbd35127c869c>  
<https://maya.technicalhub.io/owl-program-details/6688cf91e467bfe336f8352f>  
[https://www.hackerrank.com/challenges/rectangle-area/problem?utm\\_source=chatgpt.com](https://www.hackerrank.com/challenges/rectangle-area/problem?utm_source=chatgpt.com)  
<https://maya.technicalhub.io/owl-program-details/6688ea3ce467bfe336f8ab9d>
  - d. Find the maximum of three numbers using conditional operator.  
<https://maya.technicalhub.io/owl-program-details/668690d230bfbd35127c9bf5>
  - e. Take marks of 5 subjects in integers, find the total in integer and average in float.

## UNIT – II

### Control Structures



Simple sequential programs, Conditional Statements (if, if-else, else if ladder, switch), Loops (for, nested for loop, while, do-while), break and continue, goto statement.

**Practice:**

1. Conditional Statements
  1. Objective: Understand if and else Conditional statements in C.  
<https://www.hackerrank.com/challenges/conditional-statements-in-c/problem?isFullScreen=true>
  2. Roots of a Quadratic Equation.
  3. Generate electricity bill.  
<https://maya.technicalhub.io/owl-program-details/66868f6730bfbd35127c9ba7>
  4. Simulate a calculator using switch case.
  5. Find the given year is a leap year or not.
2. Loops
  - a. Objective: Learn the usage of the for loop in C.  
<https://www.hackerrank.com/challenges/for-loop-in-c/problem?isFullScreen=true>
  - b. Sum of the digits of a 5-digit number.  
Objective: Learn the usage of while loop and usage of operators - % and /.  
<https://www.hackerrank.com/challenges/sum-of-digits-of-a-five-digit-number/problem?isFullScreen=true>  
<https://maya.technicalhub.io/owl-program-details/66864717f56afec5c0c917e1>
  - c. Given number is a prime or not. (Also Prime numbers between a given range.)  
<https://maya.technicalhub.io/owl-program-details/6687b69ddfe02cea4b5404a3>
  - d. Armstrong Number or not.
  - e. Palindrome or not.  
<https://maya.technicalhub.io/owl-program-details/6687af17dfe02cea4b5376ae>
  - f. Objective: Print a pattern of numbers using Loops.  
<https://www.hackerrank.com/challenges/printing-pattern-2/problem?isFullScreen=true>
  - g. Construct a Pyramid pattern.  
<https://www.codechef.com/practice/course/c/LPCAS02/problems/LCAS20>

**UNIT – III**

**Arrays:** Arrays indexing, Accessing programs with array of integers, two dimensional arrays, Introduction to Strings, string handling functions.

**Sorting Techniques:** bubble sort, selection sort.

**Searching Techniques:** linear, Binary search.

**Practice:**

1. 1-Dimensional Arrays
  - a. Objective: Print the sum and free the memory where the array is stored.  
<https://www.hackerrank.com/challenges/1d-arrays-in-c/problem?isFullScreen=true>
  - b. Objective: Working with indices in array.
  - c. Search an element in array (Linear Search).  
<https://maya.technicalhub.io/owl-program-details/6687c40ffd042085d9ec15d6>

- d. Find min and max elements in array.  
<https://maya.technicalhub.io/owl-program-details/66879493dfe02cea4b529041>
- e. Insert an element into array.
- f. Eliminate duplicate elements from array.  
<https://maya.technicalhub.io/owl-program-details/66e920a1aca93b27f3364b57>
- g. Sorting of elements in an array using Bubble sort.
2. 2-Demensional Arrays
  - a. Sum of two 2-D arrays.  
<https://maya.technicalhub.io/owl-program-details/66864fa9f56afec5c0c924f6>
  - b. Multiplication of two 2-D arrays.
  - c. Transpose of a Matrix.
  - d. Trace of a Matrix.
  - e. Lower Triangular Matrix.
3. Hacker Rank
  - a. Objective: print each word of the sentence in a new line.
  - b. Count number of alphabets (lowercase, uppercase, consonants, vowels) and digits  
Lowercase to Uppercase, Uppercase to Lowercase, Toggle case, Sentential case  
<https://maya.technicalhub.io/owl-program-details/6698e2fbc6bd470f35b73d8>  
<https://maya.technicalhub.io/owl-program-details/6698ef03cb6bd470f35b7c3e>
  - c. find the frequency of each digit in the given string.  
<https://www.hackerrank.com/challenges/frequency-of-digits-1/problem?isFullScreen=true>
  - d. Find string length, concatenate 2 strings, reverse a string using built-in and without built-in string functions.  
<https://maya.technicalhub.io/owl-program-details/6698ed2dcb6bd470f35b7ae7>

## UNIT – IV

**Functions:** Introduction to Functions, Function Declaration and Definition, Function call Return **Types and Arguments**, arrays as parameters, Scope and Lifetime of Variables, **storage classes**, **recursion**, functions and arrays.

**Practice:** Functions in C

1. Objective: Learn simple usage of functions.  
<https://www.hackerrank.com/challenges/functions-in-c/problem?isFullScreen=true>
2. Objective: Fibonacci Numbers using recursive function.  
<https://www.hackerrank.com/challenges/ctci-fibonacci-numbers/problem>
3. Objective:  $N^{\text{th}}$  factorial using recursion.
4. Objective: Find the super digit of the integer.
5. Implement LCM
6. Objective: Calculate the Nth term of series.  
<https://www.hackerrank.com/challenges/recursion-in-c/problem?isFullScreen=true>

## UNIT – V

**Pointer:** Introduction to Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, **functions & pointers** modifying parameters inside functions using pointers, Command line Arguments, Dynamic memory allocation, Null Pointer, generic pointer, dangling pointer.

**File Handling:-**Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

**Practice:**

1. Pointers
  - a. Objective: learn to implement the basic functionalities of pointers in C.  
<https://www.hackerrank.com/challenges/pointer-in-c/problem?isFullScreen=true>
  - b. Objective: Learn using Pointers with Arrays and Functions.  
<https://www.hackerrank.com/challenges/students-marks-sum/problem?isFullScreen=true>
  - c. Objective: sort a given array of strings into lexicographically increasing order or into an order in which the string with the lowest length appears first.  
<https://www.hackerrank.com/challenges/sorting-array-of-strings/problem?isFullScreen=true>
  - d. Find the sum of a 1D array using malloc().
  - e. Swap two numbers using functions and pointers - call by value and reference.
  - f. Objective: Dynamic Handling requests by a Librarian to place the books in the shelves.  
<https://www.hackerrank.com/challenges/dynamic-array-in-c/problem?isFullScreen=true>
2. File handling concepts
  - a) Write text into and read text from a file.
  - b) Write text into and read text from a binary file using fread() and fwrite().
  - c) Copy the contents of one file to another file.
  - d) Merge two files into the third file using command-line arguments
  - e) Find no. of lines, words and characters in a file.

**Text Books:**

- 1 Programming in C, Rema Theraja, Oxford, 2nd edition. ISBN 93-5497-9
- 2 "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall. ISBN 13: 9780131103627

**Reference Books:**

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education. ISBN.No: 9352604172
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill. ISBN No. 0071367993
3. Let Us C Yashwanth, Kanetkar, Eighth edition, BPB Publications. ISBN No. 1934015253
4. Programming in C A-Practical Approach, Ajay Mittal. Pearson Education. ISBN No. 9788131729342
5. R G Dromey How to Solve It by Computer (Prentice-Hall International Series in Computer Science. ISBN-13 : 978-0134340012

**Web Links:**

- 1 <https://www.hackerrank.com/>
- 2 [https://onlinecourses.nptel.ac.in/noc22\\_cs40/preview](https://onlinecourses.nptel.ac.in/noc22_cs40/preview)
- 3 <https://archive.nptel.ac.in/courses/106/104/106104128/>

### Additional Practice:

| S.No | Difficulty | Problem Name                        | Link                                                                                                                                                                                                    |
|------|------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Easy       | Add Two Numbers                     | <a href="https://www.codechef.com/practice/course/cpp/PCPP05/problems/FLOW001">https://www.codechef.com/practice/course/cpp/PCPP05/problems/FLOW001</a>                                                 |
| 2    | Easy       | Enormous Input Test                 | <a href="https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/INTEST">https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/INTEST</a>   |
| 3    | Easy       | ATM                                 | <a href="https://www.codechef.com/practice/course/1-star-difficulty-problems/DIFF1200/problems/ATM2">https://www.codechef.com/practice/course/1-star-difficulty-problems/DIFF1200/problems/ATM2</a>     |
| 4    | Easy       | Number Mirror                       | <a href="https://www.codechef.com/practice/course/python/PPY01/problems/START01">https://www.codechef.com/practice/course/python/PPY01/problems/START01</a>                                             |
| 5    | Easy       | Sum of Digits                       | <a href="https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW006">https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW006</a>                             |
| 6    | Easy       | Remainder                           | <a href="https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW002">https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW002</a>                             |
| 7    | Easy       | First and Last Digit                | <a href="https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/FLOW004">https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/FLOW004</a> |
| 8    | Easy       | Reverse The Number                  | <a href="https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/FLOW007">https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/FLOW007</a>                     |
| 9    | Easy       | Life, the Universe, and Everything  | <a href="https://staging.codechef.com/practice/course/cpp/PRACTICECPP2/problems/TEST">https://staging.codechef.com/practice/course/cpp/PRACTICECPP2/problems/TEST</a>                                   |
| 10   | Easy       | Chef and Operators                  | <a href="https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/CHOPRT">https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/CHOPRT</a>                       |
| 11   | Easy       | Difference and Sum                  | <a href="https://www.codechef.com/problems/DIFFSUM">https://www.codechef.com/problems/DIFFSUM</a>                                                                                                       |
| 12   | Easy       | Second Largest                      | <a href="https://www.codechef.com/practice/course/arrays/ARRAYS/problems/LARGESECOND">https://www.codechef.com/practice/course/arrays/ARRAYS/problems/LARGESECOND</a>                                   |
| 13   | Easy       | Two Sum                             | <a href="https://leetcode.com/problems/two-sum/">https://leetcode.com/problems/two-sum/</a>                                                                                                             |
| 14   | Easy       | Reverse Integer                     | <a href="https://leetcode.com/problems/reverse-integer/">https://leetcode.com/problems/reverse-integer/</a>                                                                                             |
| 15   | Easy       | Palindrome Number                   | <a href="https://leetcode.com/problems/palindrome-number/">https://leetcode.com/problems/palindrome-number/</a>                                                                                         |
| 16   | Easy       | Roman to Integer                    | <a href="https://leetcode.com/problems/roman-to-integer/">https://leetcode.com/problems/roman-to-integer/</a>                                                                                           |
| 17   | Easy       | Remove Duplicates from Sorted Array | <a href="https://leetcode.com/problems/remove-duplicates-from-sorted-array/">https://leetcode.com/problems/remove-duplicates-from-sorted-array/</a>                                                     |
| 18   | Easy       | Remove Element                      | <a href="https://leetcode.com/problems/remove-element/">https://leetcode.com/problems/remove-element/</a>                                                                                               |

|    |      |                                                    |                                                                                                                                                                                   |
|----|------|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19 | Easy | Find the Index of the First Occurrence in a String | <a href="https://leetcode.com/problems/find-the-index-of-the-first-occurrence-in-a-string/">https://leetcode.com/problems/find-the-index-of-the-first-occurrence-in-a-string/</a> |
| 20 | Easy | Length of Last Word                                | <a href="https://leetcode.com/problems/length-of-last-word/">https://leetcode.com/problems/length-of-last-word/</a>                                                               |
| 21 | Easy | Plus One                                           | <a href="https://leetcode.com/problems/plus-one/">https://leetcode.com/problems/plus-one/</a>                                                                                     |

|    |        |                            |                                                                                                                                       |
|----|--------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 22 | Easy   | Merge Sorted Array         | <a href="https://leetcode.com/problems/merge-sorted-array/">https://leetcode.com/problems/merge-sorted-array/</a>                     |
| 23 | Easy   | Majority Element           | <a href="https://leetcode.com/problems/majority-element/">https://leetcode.com/problems/majority-element/</a>                         |
| 24 | Easy   | Single Number              | <a href="https://leetcode.com/problems/single-number/">https://leetcode.com/problems/single-number/</a>                               |
| 25 | Easy   | Move Zeroes                | <a href="https://leetcode.com/problems/move-zeroes/">https://leetcode.com/problems/move-zeroes/</a>                                   |
| 26 | Easy   | Missing Number             | <a href="https://leetcode.com/problems/missing-number/">https://leetcode.com/problems/missing-number/</a>                             |
| 27 | Easy   | Contains Duplicate         | <a href="https://leetcode.com/problems/contains-duplicate/">https://leetcode.com/problems/contains-duplicate/</a>                     |
| 28 | Easy   | Valid Anagram              | <a href="https://leetcode.com/problems/valid-anagram/">https://leetcode.com/problems/valid-anagram/</a>                               |
| 29 | Easy   | Valid Parentheses          | <a href="https://leetcode.com/problems/valid-parentheses/">https://leetcode.com/problems/valid-parentheses/</a>                       |
| 30 | Easy   | Fibonacci Number           | <a href="https://leetcode.com/problems/fibonacci-number/">https://leetcode.com/problems/fibonacci-number/</a>                         |
| 31 | Easy   | Climbing Stairs            | <a href="https://leetcode.com/problems/climbing-stairs/">https://leetcode.com/problems/climbing-stairs/</a>                           |
| 32 | Easy   | Binary Search              | <a href="https://leetcode.com/problems/binary-search/">https://leetcode.com/problems/binary-search/</a>                               |
| 33 | Easy   | Number of 1 Bits           | <a href="https://leetcode.com/problems/number-of-1-bits/">https://leetcode.com/problems/number-of-1-bits/</a>                         |
| 34 | Easy   | Hamming Weight             | <a href="https://leetcode.com/problems/number-of-1-bits/description/">https://leetcode.com/problems/number-of-1-bits/description/</a> |
| 35 | Easy   | Power of Two               | <a href="https://leetcode.com/problems/power-of-two/">https://leetcode.com/problems/power-of-two/</a>                                 |
| 36 | Easy   | Power of Three             | <a href="https://leetcode.com/problems/power-of-three/">https://leetcode.com/problems/power-of-three/</a>                             |
| 37 | Easy   | Same Tree                  | <a href="https://leetcode.com/problems/same-tree/">https://leetcode.com/problems/same-tree/</a>                                       |
| 38 | Easy   | Maximum Subarray           | <a href="https://leetcode.com/problems/maximum-subarray/">https://leetcode.com/problems/maximum-subarray/</a>                         |
| 39 | Medium | Chef and Notebooks         | <a href="https://www.codechef.com/problems/CNOTE">https://www.codechef.com/problems/CNOTE</a>                                         |
| 40 | Medium | Chef and Wildcard Matching | <a href="https://www.codechef.com/search?q=TWOSTR">https://www.codechef.com/search?q=TWOSTR</a>                                       |
| 41 | Medium | Minimum Moves              | <a href="https://www.codechef.com/search?q=SALARY">https://www.codechef.com/search?q=SALARY</a>                                       |
| 42 | Medium | Lucky Four                 | <a href="https://www.codechef.com/search?q=LUCKFOUR">https://www.codechef.com/search?q=LUCKFOUR</a>                                   |
| 43 | Medium | Maximum Difference         | <a href="https://www.codechef.com/search?q=MAXDIFF">https://www.codechef.com/search?q=MAXDIFF</a>                                     |
| 44 | Medium | Uncle Johny                | <a href="https://www.codechef.com/search?q=JOHNY">https://www.codechef.com/search?q=JOHNY</a>                                         |
| 45 | Medium | Chef and Strings           | <a href="https://www.codechef.com/search?q=CHEFSTL I">https://www.codechef.com/search?q=CHEFSTL I</a>                                 |
| 46 | Medium | Two vs Rib                 | <a href="https://www.codechef.com/search?q=TWOVRIB">https://www.codechef.com/search?q=TWOVRIB</a>                                     |

|    |        |                                                |                                                                                                                                                                           |
|----|--------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 47 | Medium | Chef and Array                                 | <a href="https://www.codechef.com/search?q=CHFARRP">https://www.codechef.com/search?q=CHFARRP</a>                                                                         |
| 48 | Medium | Add Two Numbers                                | <a href="https://leetcode.com/problems/add-two-numbers/">https://leetcode.com/problems/add-two-numbers/</a>                                                               |
| 49 | Medium | Longest Substring Without Repeating Characters | <a href="https://leetcode.com/problems/longest-substring-without-repeating-characters/">https://leetcode.com/problems/longest-substring-without-repeating-characters/</a> |
| 50 | Medium | Longest Palindromic Substring                  | <a href="https://leetcode.com/problems/longest-palindromic-substring/">https://leetcode.com/problems/longest-palindromic-substring/</a>                                   |
| 51 | Medium | 3Sum                                           | <a href="https://leetcode.com/problems/3sum/">https://leetcode.com/problems/3sum/</a>                                                                                     |
| 52 | Medium | Container With Most Water                      | <a href="https://leetcode.com/problems/container-with-most-water/">https://leetcode.com/problems/container-with-most-water/</a>                                           |
| 53 | Medium | Integer to Roman                               | <a href="https://leetcode.com/problems/integer-to-roman/">https://leetcode.com/problems/integer-to-roman/</a>                                                             |
| 54 | Medium | String to Integer (atoi)                       | <a href="https://leetcode.com/problems/string-to-integer-atoi/">https://leetcode.com/problems/string-to-integer-atoi/</a>                                                 |
| 55 | Medium | Divide Two Integers                            | <a href="https://leetcode.com/problems/divide-two-integers/">https://leetcode.com/problems/divide-two-integers/</a>                                                       |
| 56 | Medium | Rotate Image                                   | <a href="https://leetcode.com/problems/rotate-image/">https://leetcode.com/problems/rotate-image/</a>                                                                     |
| 57 | Medium | Set Matrix Zeroes                              | <a href="https://leetcode.com/problems/set-matrix-zeroes/">https://leetcode.com/problems/set-matrix-zeroes/</a>                                                           |
| 58 | Medium | Spiral Matrix                                  | <a href="https://leetcode.com/problems/spiral-matrix/">https://leetcode.com/problems/spiral-matrix/</a>                                                                   |
| 59 | Medium | Jump Game                                      | <a href="https://leetcode.com/problems/jump-game/">https://leetcode.com/problems/jump-game/</a>                                                                           |
| 60 | Medium | Permutations                                   | <a href="https://leetcode.com/problems/permutations/">https://leetcode.com/problems/permutations/</a>                                                                     |
| 61 | Medium | Combination Sum                                | <a href="https://leetcode.com/problems/combination-sum/">https://leetcode.com/problems/combination-sum/</a>                                                               |
| 62 | Medium | Search in Rotated Sorted Array                 | <a href="https://leetcode.com/problems/search-in-rotated-sorted-array/">https://leetcode.com/problems/search-in-rotated-sorted-array/</a>                                 |
| 63 | Medium | Group Anagrams                                 | <a href="https://leetcode.com/problems/group-anagrams/">https://leetcode.com/problems/group-anagrams/</a>                                                                 |
| 64 | Medium | Sort Colors                                    | <a href="https://leetcode.com/problems/sort-colors/">https://leetcode.com/problems/sort-colors/</a>                                                                       |
| 65 | Medium | Subsets                                        | <a href="https://leetcode.com/problems/subsets/">https://leetcode.com/problems/subsets/</a>                                                                               |
| 66 | Medium | Reverse Linked List II                         | <a href="https://leetcode.com/problems/reverse-linked-list-ii/">https://leetcode.com/problems/reverse-linked-list-ii/</a>                                                 |
| 67 | Medium | Add Two Numbers II                             | <a href="https://leetcode.com/problems/add-two-numbers-ii/">https://leetcode.com/problems/add-two-numbers-ii/</a>                                                         |
| 68 | Medium | Reorder List                                   | <a href="https://leetcode.com/problems/reorder-list/">https://leetcode.com/problems/reorder-list/</a>                                                                     |

|    |        |                                  |                                                                                                                                                                                 |
|----|--------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 69 | Medium | Linked List Cycle II             | <a href="https://leetcode.com/problems/linked-list-cycle-ii/">https://leetcode.com/problems/linked-list-cycle-ii/</a>                                                           |
| 70 | Medium | K-th Largest Element in an Array | <a href="https://leetcode.com/problems/kth-largest-element-in-an-array/">https://leetcode.com/problems/kth-largest-element-in-an-array/</a>                                     |
| 71 | Medium | Product of Array Except Self     | <a href="https://leetcode.com/problems/product-of-array-except-self/">https://leetcode.com/problems/product-of-array-except-self/</a>                                           |
| 72 | Medium | Word Search                      | <a href="https://leetcode.com/problems/word-search/">https://leetcode.com/problems/word-search/</a>                                                                             |
| 73 | Medium | Unique Paths                     | <a href="https://leetcode.com/problems/unique-paths/">https://leetcode.com/problems/unique-paths/</a>                                                                           |
| 74 | Medium | Minimum Path Sum                 | <a href="https://leetcode.com/problems/minimum-path-sum/">https://leetcode.com/problems/minimum-path-sum/</a>                                                                   |
| 75 | Medium | Temperature Converter - II       | <a href="https://www.codechef.com/practice/course/c/LPCAS03/problems/LCAS30B">https://www.codechef.com/practice/course/c/LPCAS03/problems/LCAS30B</a>                           |
| 76 | Medium | Reverse                          | <a href="https://www.hackerrank.com/challenges/reverse-array-c/problem?isFullScreen=true">https://www.hackerrank.com/challenges/reverse-array-c/problem?isFullScreen=true</a>   |
| 77 | Medium | Sentence in a new line           | <a href="https://www.hackerrank.com/challenges/printing-tokens-/problem?isFullScreen=true">https://www.hackerrank.com/challenges/printing-tokens-/problem?isFullScreen=true</a> |
| 78 | Hard   | Median of Two Sorted Arrays      | <a href="https://leetcode.com/problems/median-of-two-sorted-arrays/">https://leetcode.com/problems/median-of-two-sorted-arrays/</a>                                             |
| 79 | Hard   | Regular Expression Matching      | <a href="https://leetcode.com/problems/regular-expression-matching/">https://leetcode.com/problems/regular-expression-matching/</a>                                             |
| 80 | Hard   | Wildcard Matching                | <a href="https://leetcode.com/problems/wildcard-matching/">https://leetcode.com/problems/wildcard-matching/</a>                                                                 |
| 81 | Hard   | Trapping Rain Water              | <a href="https://leetcode.com/problems/trapping-rain-water/">https://leetcode.com/problems/trapping-rain-water/</a>                                                             |
| 82 | Hard   | First Missing Positive           | <a href="https://leetcode.com/problems/first-missing-positive/">https://leetcode.com/problems/first-missing-positive/</a>                                                       |
| 83 | Hard   | Longest Valid Parentheses        | <a href="https://leetcode.com/problems/longest-valid-parentheses/">https://leetcode.com/problems/longest-valid-parentheses/</a>                                                 |
| 84 | Hard   | Merge k Sorted Lists             | <a href="https://leetcode.com/problems/merge-k-sorted-lists/">https://leetcode.com/problems/merge-k-sorted-lists/</a>                                                           |
| 85 | Hard   | Reverse Nodes in k-Group         | <a href="https://leetcode.com/problems/reverse-nodes-in-k-group/description/">https://leetcode.com/problems/reverse-nodes-in-k-group/description/</a>                           |
| 86 | Hard   | Sudoku Solver                    | <a href="https://leetcode.com/problems/sudoku-solver/">https://leetcode.com/problems/sudoku-solver/</a>                                                                         |
| 87 | Hard   | N-Queens                         | <a href="https://leetcode.com/problems/n-queens/description/">https://leetcode.com/problems/n-queens/description/</a>                                                           |
| 88 | Hard   | Edit Distance                    | <a href="https://leetcode.com/problems/edit-distance/">https://leetcode.com/problems/edit-distance/</a>                                                                         |
| 89 | Hard   | Word Ladder II                   | <a href="https://leetcode.com/problems/word-ladder-ii/">https://leetcode.com/problems/word-ladder-ii/</a>                                                                       |
| 90 | Hard   | Maximal Rectangle                | <a href="https://leetcode.com/problems/maximal-rectangle/">https://leetcode.com/problems/maximal-rectangle/</a>                                                                 |
| 91 | Hard   | Binary Tree Maximum Path Sum     | <a href="https://leetcode.com/problems/binary-tree-maximum-path-sum/">https://leetcode.com/problems/binary-tree-maximum-path-sum/</a>                                           |



|    |      |                                       |                                                                                                                                                                                                               |
|----|------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 92 | Hard | Serialize and Deserialize Binary Tree | <a href="https://leetcode.com/problems/serialize-and-deserialize-binary-tree/">https://leetcode.com/problems/serialize-and-deserialize-binary-tree/</a>                                                       |
| 93 | Hard | Variadic functions in C               | <a href="https://www.hackerrank.com/challenges/variadic-functions-in-c/problem?isFullScreen=true">https://www.hackerrank.com/challenges/variadic-functions-in-c/problem?isFullScreen=true</a>                 |
| 94 | Hard | Small Triangles, Large Triangles      | <a href="https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem?isFullScreen=true">https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem?isFullScreen=true</a> |
| 95 | Hard | Permutations of Strings               | <a href="https://www.hackerrank.com/challenges/permutation-s-of-strings/problem?isFullScreen=true">https://www.hackerrank.com/challenges/permutation-s-of-strings/problem?isFullScreen=true</a>               |

### Maya Programs

| S.N o. | Problem Name                 | Maya Program Link                                                                                                                                                 |
|--------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Can Cross the Bridge         | <a href="https://maya.technicalhub.io/owl-program-details/6686308df56afec5c0c8e2dd">https://maya.technicalhub.io/owl-program-details/6686308df56afec5c0c8e2dd</a> |
| 2      | Hypotenuse                   | <a href="https://maya.technicalhub.io/owl-program-details/6686404ef56afec5c0c90135">https://maya.technicalhub.io/owl-program-details/6686404ef56afec5c0c90135</a> |
| 3      | Heron's Formula              | <a href="https://maya.technicalhub.io/owl-program-details/66864474f56afec5c0c911f5">https://maya.technicalhub.io/owl-program-details/66864474f56afec5c0c911f5</a> |
| 4      | Loss Percentage              | <a href="https://maya.technicalhub.io/owl-program-details/66864868f56afec5c0c91a4a">https://maya.technicalhub.io/owl-program-details/66864868f56afec5c0c91a4a</a> |
| 5      | King Tours                   | <a href="https://maya.technicalhub.io/owl-program-details/66864c96f56afec5c0c921f1">https://maya.technicalhub.io/owl-program-details/66864c96f56afec5c0c921f1</a> |
| 6      | Profit Percentage            | <a href="https://maya.technicalhub.io/owl-program-details/66865237f56afec5c0c92694">https://maya.technicalhub.io/owl-program-details/66865237f56afec5c0c92694</a> |
| 7      | Area and Perimeter of Square | <a href="https://maya.technicalhub.io/owl-program-details/6686546930bfd35127c869c">https://maya.technicalhub.io/owl-program-details/6686546930bfd35127c869c</a>   |
| 8      | Volume of Sphere             | <a href="https://maya.technicalhub.io/owl-program-details/6686565530bfd35127c8818">https://maya.technicalhub.io/owl-program-details/6686565530bfd35127c8818</a>   |
| 9      | Required Points              | <a href="https://maya.technicalhub.io/owl-program-details/66865b1130bfd35127c8a04">https://maya.technicalhub.io/owl-program-details/66865b1130bfd35127c8a04</a>   |
| 10     | Instant Noodles              | <a href="https://maya.technicalhub.io/owl-program-details/66865ddb30bfd35127c8c0a">https://maya.technicalhub.io/owl-program-details/66865ddb30bfd35127c8c0a</a>   |
| 11     | Find Second Number           | <a href="https://maya.technicalhub.io/owl-program-details/668660a530bfd35127c8cde">https://maya.technicalhub.io/owl-program-details/668660a530bfd35127c8cde</a>   |
| 12     | Kmph to Mps                  | <a href="https://maya.technicalhub.io/owl-program-details/668663ce30bfd35127c8dfb">https://maya.technicalhub.io/owl-program-details/668663ce30bfd35127c8dfb</a>   |
| 13     | Inches to Centimeters        | <a href="https://maya.technicalhub.io/owl-program-details/6686665e30bfd35127c8f3a">https://maya.technicalhub.io/owl-program-details/6686665e30bfd35127c8f3a</a>   |
| 14     | Capacity                     | <a href="https://maya.technicalhub.io/owl-program-details/668678aa30bfd35127c95b9">https://maya.technicalhub.io/owl-program-details/668678aa30bfd35127c95b9</a>   |
| 15     | Average of Two Numbers       | <a href="https://maya.technicalhub.io/owl-program-details/6687b002dfe02cea4b5389d6">https://maya.technicalhub.io/owl-program-details/6687b002dfe02cea4b5389d6</a> |
| 16     | Compound Interest            | <a href="https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab">https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab</a> |
| 17     | Average Weight               | <a href="https://maya.technicalhub.io/owl-program-details/6687b93edfe02cea4b54367a">https://maya.technicalhub.io/owl-program-details/6687b93edfe02cea4b54367a</a> |
| 18     | Arithmetic Operations        | <a href="https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1">https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1</a> |



|    |                                               |                                                                                                                                                                   |
|----|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19 | Distance Between Two Points                   | <a href="https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a">https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a</a> |
| 20 | Days into Years, Weeks                        | <a href="https://maya.technicalhub.io/owl-program-details/6687cad1fd042085d9ec95a8">https://maya.technicalhub.io/owl-program-details/6687cad1fd042085d9ec95a8</a> |
| 21 | Convert Seconds to Hours, Minutes and Seconds | <a href="https://maya.technicalhub.io/owl-program-details/6688c926e467bfe336f8007b">https://maya.technicalhub.io/owl-program-details/6688c926e467bfe336f8007b</a> |
| 22 | Hours and Minutes                             | <a href="https://maya.technicalhub.io/owl-program-details/6688e4f0e467bfe336f89673">https://maya.technicalhub.io/owl-program-details/6688e4f0e467bfe336f89673</a> |
| 23 | Romeo and Juliet                              | <a href="https://maya.technicalhub.io/owl-program-details/6688e068e467bfe336f87a8b">https://maya.technicalhub.io/owl-program-details/6688e068e467bfe336f87a8b</a> |
| 24 | Gross Salary of an Employee                   | <a href="https://maya.technicalhub.io/owl-program-details/6688dd95e467bfe336f87682">https://maya.technicalhub.io/owl-program-details/6688dd95e467bfe336f87682</a> |
| 25 | Surface Area and Volume of a Cube             | <a href="https://maya.technicalhub.io/owl-program-details/6688d909e467bfe336f872ca">https://maya.technicalhub.io/owl-program-details/6688d909e467bfe336f872ca</a> |
| 26 | Area of Trapezium                             | <a href="https://maya.technicalhub.io/owl-program-details/6688d637e467bfe336f86c5e">https://maya.technicalhub.io/owl-program-details/6688d637e467bfe336f86c5e</a> |
| 27 | Swap Two Numbers                              | <a href="https://maya.technicalhub.io/owl-program-details/6688d2d0e467bfe336f84f55">https://maya.technicalhub.io/owl-program-details/6688d2d0e467bfe336f84f55</a> |
| 28 | Last Two Digits of a Given Year               | <a href="https://maya.technicalhub.io/owl-program-details/6688ccfae467bfe336f81f90">https://maya.technicalhub.io/owl-program-details/6688ccfae467bfe336f81f90</a> |
| 29 | Arithmetic Operations                         | <a href="https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1">https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1</a> |
| 30 | Uppercase Letters in a String                 | <a href="https://maya.technicalhub.io/owl-program-details/669a2453c03fc56b320b215c">https://maya.technicalhub.io/owl-program-details/669a2453c03fc56b320b215c</a> |
| 31 | Factors Finding                               | <a href="https://maya.technicalhub.io/owl-program-details/66866c4a30bfbd35127c90b4">https://maya.technicalhub.io/owl-program-details/66866c4a30bfbd35127c90b4</a> |
| 32 | String Copy                                   | <a href="https://maya.technicalhub.io/owl-program-details/669a03ded62716a9c6d4fa9a">https://maya.technicalhub.io/owl-program-details/669a03ded62716a9c6d4fa9a</a> |
| 33 | Recursive Digit Sum                           | <a href="https://www.hackerrank.com/challenges/recursive-digit-sum/problem">https://www.hackerrank.com/challenges/recursive-digit-sum/problem</a>                 |

|                            | Basic Programs | Aditya's Internal Coding Platform (Maya) | Code chef | Hacker rank | Leet code | Total      |
|----------------------------|----------------|------------------------------------------|-----------|-------------|-----------|------------|
| <b>Unit-1</b>              | 4              | 8                                        | 2         | 5           | 0         | <b>19</b>  |
| <b>Unit-2</b>              | 4              | 4                                        | 1         | 4           | 0         | <b>13</b>  |
| <b>Unit-3</b>              | 8              | 7                                        | 0         | 2           | 0         | <b>17</b>  |
| <b>Unit-4</b>              | 3              | 0                                        | 0         | 3           | 0         | <b>6</b>   |
| <b>Unit-5</b>              | 7              | 0                                        | 4         | 4           | 0         | <b>15</b>  |
| <b>Additional Practice</b> | 0              | 33                                       | 22        | 5           | 68        | <b>128</b> |
| <b>Total</b>               | <b>26</b>      | <b>52</b>                                | <b>29</b> | <b>23</b>   | <b>68</b> | <b>198</b> |

**Problem Solving Through C Programming**  
(Common to CE, EEE, ME, ECE, CSE, AIML, CSE(DS), PT & Min.E)  
(Revised Syllabus for batches admitted from 2026 Onwards)

**Course Code: 2601DS01**

**L      T      P      C**  
**2      0      2      4**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Demonstrate basics of computer, algorithm and flow chart for problem solving.
- CO2:** Make use of an appropriate control structures to solve given problems.
- CO3:** Solve complex problems using arrays and strings.
- CO4:** Develop modular programming using functions and dynamic memory allocation.
- CO5:** Develop programs using structures and file handling operations.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 3    | 2    | 1    | 3    | -    | -    | 2    | -    | -     | 1     |
| <b>CO2</b> | 2    | 3    | 2    | 1    | 3    | -    | -    | 2    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | 1    | 3    | -    | 1    | 2    | -    | -     | 1     |
| <b>CO4</b> | 2    | 3    | 2    | 1    | 3    | -    | 1    | 2    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 2    | 1    | 3    | -    | 1    | 2    | -    | -     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | 2    |
| <b>CO2</b> | 2    | 2    |
| <b>CO3</b> | 2    | 2    |
| <b>CO4</b> | 2    | 2    |
| <b>CO5</b> | 2    | 2    |

**UNIT – I**

**Introduction to Programming and Problem Solving**

Introduction to Programming Languages, Basics of a Computer Program- Algorithms, characteristics of algorithm, flowcharts, pseudo code.

Structure of C Program, Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, operators, keywords, identifiers, Type Conversion, and Casting and operator precedence.

**Practice 1:**

4. Explore different platforms
  - g. Basic linux environment and its editors like Vi, Vim & Emacs etc.
  - h. Exposure to turbo C, gcc.
  - i. Explore to hacker rank or any other Online coding platform and compiler environment.
  - j. “Hello world” in C.

<https://www.codechef.com/learn/course/c/CDEVINTRO/problems/CDEV004B>

- k. Objective: Learn about the syntax of reading from stdin and writing to stdout.  
<https://www.hackerrank.com/challenges/hello-world-c/problem?isFullScreen=true>
  - l. Write a simple program to read int, float, char and string using scanf() and display using printf() in all the above given platforms.
5. Basics and Operators
- g. Sum and Difference of 2 numbers.  
Objective: Learn int and float data types.  
<https://www.hackerrank.com/challenges/sum-numbers-c/problem?isFullScreen=true>  
<https://maya.technicalhub.io/owl-program-details/668b9ec2e069313510b0235a>
  - h. Playing with Characters.  
Objective: Learn how to take a character, a string and a sentence as input in C.  
<https://www.hackerrank.com/challenges/playing-with-characters/problem?isFullScreen=true>
  - i. Bitwise Operators  
Objective: Learn how to work with bits (0,1) and bitwise operators.  
<https://www.hackerrank.com/challenges/bitwise-operators-in-c/problem?isFullScreen=true>
  - j. Conversion of Fahrenheit to Celsius and vice versa.  
<https://www.codechef.com/practice/course/c/LPCAS03/problems/LCAS30>  
<https://maya.technicalhub.io/owl-program-details/66a0c0dda7d31805366af641>
  - k. Distance travelled by an object.  
<https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a>
  - l. Calculate Simple interest and compound interest.  
<https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab>
6. Operators and Expressions, Variables and Type conversions.
- f. Evaluate the following expressions
    - i.  $a/b * c - b + a * d / 3$
    - ii.  $j = (i++) + (++i)$
  - g. Square root of a given number.
  - h. Find the area of circle, square, rectangle and triangle.  
<https://maya.technicalhub.io/owl-program-details/6686546930bfbd35127c869c>  
<https://maya.technicalhub.io/owl-program-details/6688cf91e467bfe336f8352f>  
[https://www.hackerrank.com/challenges/rectangle-area/problem?utm\\_source=chatgpt.com](https://www.hackerrank.com/challenges/rectangle-area/problem?utm_source=chatgpt.com)  
<https://maya.technicalhub.io/owl-program-details/6688ea3ce467bfe336f8ab9d>
  - i. Find the maximum of three numbers using conditional operator.  
<https://maya.technicalhub.io/owl-program-details/668690d230bfbd35127c9bf5>
  - j. Take marks of 5 subjects in integers, find the total in integer and average in float.

## UNIT – II

**Control Structures** Conditional Statements (if, if-else, else if ladder, switch), Loops (for, nested for loop, while, do-while), break and continue, goto statement.

**Practice:**

3. Conditional Statements
  6. Objective: Understand if and else Conditional statements in C.  
<https://www.hackerrank.com/challenges/conditional-statements-in-c/problem?isFullScreen=true>
  7. Roots of a Quadratic Equation.
  8. Generate electricity bill.  
<https://maya.technicalhub.io/owl-program-details/66868f6730bfd35127c9ba7>
  9. Simulate a calculator using switch case.
  10. Find the given year is a leap year or not.
4. Loops
  - h. Objective: Learn the usage of the for loop in C. <https://www.hackerrank.com/challenges/for-loop-in-c/problem?isFullScreen=true>
  - i. Sum of the digits of a 5-digit number.  
Objective: Learn the usage of while loop and usage of operators - % and /.  
<https://www.hackerrank.com/challenges/sum-of-digits-of-a-five-digit-number/problem?isFullScreen=true>  
<https://maya.technicalhub.io/owl-program-details/66864717f56afec5c0c917e1>
  - j. Given number is a prime or not. (Also Prime numbers between a given range.)  
<https://maya.technicalhub.io/owl-program-details/6687b69ddf02cea4b5404a3>
  - k. Armstrong Number or not.
  - l. Palindrome or not.  
<https://maya.technicalhub.io/owl-program-details/6687af17dfe02cea4b5376ae>
  - m. Objective: Print a pattern of numbers using Loops.  
<https://www.hackerrank.com/challenges/printing-pattern-2/problem?isFullScreen=true>
  - n. Construct a Pyramid pattern.  
<https://www.codechef.com/practice/course/c/LPCAS02/problems/LCAS20>

**UNIT – III**

**Arrays:** Definition, types, 1-D array(declaration, initialization, representation, accessing, input and output), 2-D(declaration, initialization, representation, accessing, input and output), searching (Linear search, Binary Search non recursive) and sorting(Bubble Sort, Selection Sort, Insertion Sort).

**Introduction to Strings:** declaration, initialization, representation, accessing, input and output, string handling functions.

**Practice:**

4. 1-Dimensional Arrays
  - h. Objective: Print the sum and free the memory where the array is stored.  
<https://www.hackerrank.com/challenges/1d-arrays-in-c/problem?isFullScreen=true>
  - i. Objective: Working with indices in array.  
Search an element in array .  
<https://maya.technicalhub.io/owl-program-details/6687c40ffd042085d9ec15d6>
  - j. Find min and max elements in array.  
<https://maya.technicalhub.io/owl-program-details/66879493dfe02cea4b529041>
  - k. Insert an element into array.
  - l. Eliminate duplicate elements from array.  
<https://maya.technicalhub.io/owl-program-details/66e920a1aca93b27f3364b57>
  - m. Sorting of elements in an array

5. 2-Dimensional Arrays
  - f. Sum of two 2-D arrays.  
<https://maya.technicalhub.io/owl-program-details/66864fa9f56afec5c0c924f6>
  - g. Multiplication of two 2-D arrays.
  - h. Transpose of a Matrix.
  - i. Trace of a Matrix.
  - j. Lower Triangular Matrix.
6. Strings
  - e. Objective: print each word of the sentence in a new line.
  - f. Count number of alphabets (lowercase, uppercase, consonants, vowels) and digits Lowercase to Uppercase, Uppercase to Lowercase, Toggle case, Sentential case  
<https://maya.technicalhub.io/owl-program-details/6698e2fbc6bd470f35b73d8>  
<https://maya.technicalhub.io/owl-program-details/6698ef03cb6bd470f35b7c3e>
  - g. find the frequency of each digit in the given string.  
<https://www.hackerrank.com/challenges/frequency-of-digits-1/problem?isFullScreen=true>
  - h. Find string length, concatenate 2 strings, reverse a string using built-in and without built-in string functions.  
<https://maya.technicalhub.io/owl-program-details/6698ed2dcb6bd470f35b7ae7>

#### UNIT – IV

**Pointer:** Introduction to Pointers, dereferencing and address operators, pointer arithmetic, array manipulation using pointers, Dynamic memory allocation, Null Pointer, generic pointer, dangling pointer, pointer to pointer.

**Functions:** Introduction to Functions, Function Declaration and Definition, Function call Return **Types and Arguments**, Scope and Lifetime of Variables (block scope, function scope, program scope and file scope), **storage classes, recursion**, functions and arrays, Command line Arguments, functions and pointers.

#### Practice:

7. **Functions in C**
  - a. Objective: Learn simple usage of functions. <https://www.hackerrank.com/challenges/functions-in-c/problem?isFullScreen=true>
  - b. Objective: Fibonacci Numbers using recursive function.  
<https://www.hackerrank.com/challenges/ctci-fibonacci-numbers/problem>
  - c. Objective: N<sup>th</sup> factorial using recursion.
  - d. Objective: Find the super digit of the integer.
  - e. Implement LCM
  - f. Objective: Calculate the Nth term of series.  
<https://www.hackerrank.com/challenges/recursion-in-c/problem?isFullScreen=true>
8. **Pointers**
  - g. Objective: learn to implement the basic functionalities of pointers in C.  
<https://www.hackerrank.com/challenges/pointer-in-c/problem?isFullScreen=true>
  - h. Objective: Learn using Pointers with Arrays and Functions.  
<https://www.hackerrank.com/challenges/students-marks-sum/problem?isFullScreen=true>
  - i. Objective: sort a given array of strings into lexicographically increasing order or into an order in which the string with the lowest length appears first.  
<https://www.hackerrank.com/challenges/sorting-array-of-strings/problem?isFullScreen=true>
  - j. Find the sum of a 1D array using malloc().
  - k. Swap two numbers using functions and pointers - call by value and reference.
  - l. Objective: Dynamic Handling requests by a Librarian to place the books in the shelves.  
<https://www.hackerrank.com/challenges/dynamic-array-in-c/problem?isFullScreen=true>

## UNIT – V

**Structures and Unions:** Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, structures and pointers. Unions, Enumerated Data Type - enum variables, Using Typedef keyword, Bit Fields.

**File Handling:-**Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, File Operations, Random File Access.

### Practice:

#### 1. Structures

1. Write a C program to find the total, average of n students using structures
2. Copy one structure variable to another structure of the same type.
3. Read student name and marks from the command line and display the student details along with the total.

#### 2. File handling concepts

- f) Write text into and read text from a file.
- g) Write text into and read text from a binary file using fread() and fwrite().
- h) Copy the contents of one file to another file.
- i) Merge two files into the third file using command-line arguments
- j) Find no. of lines, words and characters in a file.

### Text Books:

- 1 Programming in C, Rema Theraja, Oxford, 2nd edition. ISBN 93-5497-9
- 2 "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall. ISBN 13: 9780131103627

### Reference Books:

6. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education. ISBN.No: 9352604172
7. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill. ISBN No. 0071367993
8. Let Us C Yashwanth, Kanetkar, Eighth edition, BPB Publications. ISBN No. 1934015253
9. Programming in C A-Practical Approach, Ajay Mittal. Pearson Education. ISBN No. 9788131729342
10. R G Dromey How to Solve It by Computer (Prentice-Hall International Series in Computer Science. ISBN-13 : 978-0134340012

### Web Links:

- 1 <https://www.hackerrank.com/>
- 2 [https://onlinecourses.nptel.ac.in/noc22\\_cs40/preview](https://onlinecourses.nptel.ac.in/noc22_cs40/preview)
- 3 <https://archive.nptel.ac.in/courses/106/104/106104128/>

**Additional Practice:**

| S.No . | Difficulty | Problem Name                                       | Link                                                                                                                                                                                                    |
|--------|------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Easy       | Add Two Numbers                                    | <a href="https://www.codechef.com/practice/course/cpp/PCPP05/problems/FLOW001">https://www.codechef.com/practice/course/cpp/PCPP05/problems/FLOW001</a>                                                 |
| 2      | Easy       | Enormous Input Test                                | <a href="https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/INTEST">https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/INTEST</a>   |
| 3      | Easy       | ATM                                                | <a href="https://www.codechef.com/practice/course/1-star-difficulty-problems/DIFF1200/problems/ATM2">https://www.codechef.com/practice/course/1-star-difficulty-problems/DIFF1200/problems/ATM2</a>     |
| 4      | Easy       | Number Mirror                                      | <a href="https://www.codechef.com/practice/course/python/PPY01/problems/START01">https://www.codechef.com/practice/course/python/PPY01/problems/START01</a>                                             |
| 5      | Easy       | Sum of Digits                                      | <a href="https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW006">https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW006</a>                             |
| 6      | Easy       | Remainder                                          | <a href="https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW002">https://www.codechef.com/practice/course/basic-math/BASICMATH/problems/FLOW002</a>                             |
| 7      | Easy       | First and Last Digit                               | <a href="https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/FLOW004">https://www.codechef.com/practice/course/basic-programming-concepts/DIFF500/problems/FLOW004</a> |
| 8      | Easy       | Reverse The Number                                 | <a href="https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/FLOW007">https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/FLOW007</a>                     |
| 9      | Easy       | Life, the Universe, and Everything                 | <a href="https://staging.codechef.com/practice/course/cpp/PRACTICECPP2/problems/TEST">https://staging.codechef.com/practice/course/cpp/PRACTICECPP2/problems/TEST</a>                                   |
| 10     | Easy       | Chef and Operators                                 | <a href="https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/CHOPRT">https://www.codechef.com/practice/course/logical-problems/DIFF800/problems/CHOPRT</a>                       |
| 11     | Easy       | Difference and Sum                                 | <a href="https://www.codechef.com/problems/DIFFSUM">https://www.codechef.com/problems/DIFFSUM</a>                                                                                                       |
| 12     | Easy       | Second Largest                                     | <a href="https://www.codechef.com/practice/course/arrays/ARRAYS/problems/LARGESECOND">https://www.codechef.com/practice/course/arrays/ARRAYS/problems/LARGESECOND</a>                                   |
| 13     | Easy       | Two Sum                                            | <a href="https://leetcode.com/problems/two-sum/">https://leetcode.com/problems/two-sum/</a>                                                                                                             |
| 14     | Easy       | Reverse Integer                                    | <a href="https://leetcode.com/problems/reverse-integer/">https://leetcode.com/problems/reverse-integer/</a>                                                                                             |
| 15     | Easy       | Palindrome Number                                  | <a href="https://leetcode.com/problems/palindrome-number/">https://leetcode.com/problems/palindrome-number/</a>                                                                                         |
| 16     | Easy       | Roman to Integer                                   | <a href="https://leetcode.com/problems/roman-to-integer/">https://leetcode.com/problems/roman-to-integer/</a>                                                                                           |
| 17     | Easy       | Remove Duplicates from Sorted Array                | <a href="https://leetcode.com/problems/remove-duplicates-from-sorted-array/">https://leetcode.com/problems/remove-duplicates-from-sorted-array/</a>                                                     |
| 18     | Easy       | Remove Element                                     | <a href="https://leetcode.com/problems/remove-element/">https://leetcode.com/problems/remove-element/</a>                                                                                               |
| 19     | Easy       | Find the Index of the First Occurrence in a String | <a href="https://leetcode.com/problems/find-the-index-of-the-first-occurrence-in-a-string/">https://leetcode.com/problems/find-the-index-of-the-first-occurrence-in-a-string/</a>                       |
| 20     | Easy       | Length of Last Word                                | <a href="https://leetcode.com/problems/length-of-last-word/">https://leetcode.com/problems/length-of-last-word/</a>                                                                                     |
| 21     | Easy       | Plus One                                           | <a href="https://leetcode.com/problems/plus-one/">https://leetcode.com/problems/plus-one/</a>                                                                                                           |
| 22     | Easy       | Merge Sorted Array                                 | <a href="https://leetcode.com/problems/merge-sorted-array/">https://leetcode.com/problems/merge-sorted-array/</a>                                                                                       |
| 23     | Easy       | Majority Element                                   | <a href="https://leetcode.com/problems/majority-element/">https://leetcode.com/problems/majority-element/</a>                                                                                           |
| 24     | Easy       | Single Number                                      | <a href="https://leetcode.com/problems/single-number/">https://leetcode.com/problems/single-number/</a>                                                                                                 |
| 25     | Easy       | Move Zeroes                                        | <a href="https://leetcode.com/problems/move-zeroes/">https://leetcode.com/problems/move-zeroes/</a>                                                                                                     |
| 26     | Easy       | Missing Number                                     | <a href="https://leetcode.com/problems/missing-number/">https://leetcode.com/problems/missing-number/</a>                                                                                               |



|    |        |                                                |                                                                                                                                                                           |
|----|--------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27 | Easy   | Contains Duplicate                             | <a href="https://leetcode.com/problems/contains-duplicate/">https://leetcode.com/problems/contains-duplicate/</a>                                                         |
| 28 | Easy   | Valid Anagram                                  | <a href="https://leetcode.com/problems/valid-anagram/">https://leetcode.com/problems/valid-anagram/</a>                                                                   |
| 29 | Easy   | Valid Parentheses                              | <a href="https://leetcode.com/problems/valid-parentheses/">https://leetcode.com/problems/valid-parentheses/</a>                                                           |
| 30 | Easy   | Fibonacci Number                               | <a href="https://leetcode.com/problems/fibonacci-number/">https://leetcode.com/problems/fibonacci-number/</a>                                                             |
| 31 | Easy   | Climbing Stairs                                | <a href="https://leetcode.com/problems/climbing-stairs/">https://leetcode.com/problems/climbing-stairs/</a>                                                               |
| 32 | Easy   | Binary Search                                  | <a href="https://leetcode.com/problems/binary-search/">https://leetcode.com/problems/binary-search/</a>                                                                   |
| 33 | Easy   | Number of 1 Bits                               | <a href="https://leetcode.com/problems/number-of-1-bits/">https://leetcode.com/problems/number-of-1-bits/</a>                                                             |
| 34 | Easy   | Hamming Weight                                 | <a href="https://leetcode.com/problems/number-of-1-bits/description/">https://leetcode.com/problems/number-of-1-bits/description/</a>                                     |
| 35 | Easy   | Power of Two                                   | <a href="https://leetcode.com/problems/power-of-two/">https://leetcode.com/problems/power-of-two/</a>                                                                     |
| 36 | Easy   | Power of Three                                 | <a href="https://leetcode.com/problems/power-of-three/">https://leetcode.com/problems/power-of-three/</a>                                                                 |
| 37 | Easy   | Same Tree                                      | <a href="https://leetcode.com/problems/same-tree/">https://leetcode.com/problems/same-tree/</a>                                                                           |
| 38 | Easy   | Maximum Subarray                               | <a href="https://leetcode.com/problems/maximum-subarray/">https://leetcode.com/problems/maximum-subarray/</a>                                                             |
| 39 | Medium | Chef and Notebooks                             | <a href="https://www.codechef.com/problems/CNOTE">https://www.codechef.com/problems/CNOTE</a>                                                                             |
| 40 | Medium | Chef and Wildcard Matching                     | <a href="https://www.codechef.com/search?q=TWOSTR">https://www.codechef.com/search?q=TWOSTR</a>                                                                           |
| 41 | Medium | Minimum Moves                                  | <a href="https://www.codechef.com/search?q=SALARY">https://www.codechef.com/search?q=SALARY</a>                                                                           |
| 42 | Medium | Lucky Four                                     | <a href="https://www.codechef.com/search?q=LUCKFOUR">https://www.codechef.com/search?q=LUCKFOUR</a>                                                                       |
| 43 | Medium | Maximum Difference                             | <a href="https://www.codechef.com/search?q=MAXDIFF">https://www.codechef.com/search?q=MAXDIFF</a>                                                                         |
| 44 | Medium | Uncle Johny                                    | <a href="https://www.codechef.com/search?q=JOHNY">https://www.codechef.com/search?q=JOHNY</a>                                                                             |
| 45 | Medium | Chef and Strings                               | <a href="https://www.codechef.com/search?q=CHEFSTLT">https://www.codechef.com/search?q=CHEFSTLT</a>                                                                       |
| 46 | Medium | Two vs Rib                                     | <a href="https://www.codechef.com/search?q=TWOVRIB">https://www.codechef.com/search?q=TWOVRIB</a>                                                                         |
| 47 | Medium | Chef and Array                                 | <a href="https://www.codechef.com/search?q=CHEFARRP">https://www.codechef.com/search?q=CHEFARRP</a>                                                                       |
| 48 | Medium | Add Two Numbers                                | <a href="https://leetcode.com/problems/add-two-numbers/">https://leetcode.com/problems/add-two-numbers/</a>                                                               |
| 49 | Medium | Longest Substring Without Repeating Characters | <a href="https://leetcode.com/problems/longest-substring-without-repeating-characters/">https://leetcode.com/problems/longest-substring-without-repeating-characters/</a> |
| 50 | Medium | Longest Palindromic Substring                  | <a href="https://leetcode.com/problems/longest-palindromic-substring/">https://leetcode.com/problems/longest-palindromic-substring/</a>                                   |
| 51 | Medium | 3Sum                                           | <a href="https://leetcode.com/problems/3sum/">https://leetcode.com/problems/3sum/</a>                                                                                     |
| 52 | Medium | Container With Most Water                      | <a href="https://leetcode.com/problems/container-with-most-water/">https://leetcode.com/problems/container-with-most-water/</a>                                           |
| 53 | Medium | Integer to Roman                               | <a href="https://leetcode.com/problems/integer-to-roman/">https://leetcode.com/problems/integer-to-roman/</a>                                                             |
| 54 | Medium | String to Integer (atoi)                       | <a href="https://leetcode.com/problems/string-to-integer-atoi/">https://leetcode.com/problems/string-to-integer-atoi/</a>                                                 |



|    |        |                                  |                                                                                                                                                                                 |
|----|--------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 55 | Medium | Divide Two Integers              | <a href="https://leetcode.com/problems/divide-two-integers/">https://leetcode.com/problems/divide-two-integers/</a>                                                             |
| 56 | Medium | Rotate Image                     | <a href="https://leetcode.com/problems/rotate-image/">https://leetcode.com/problems/rotate-image/</a>                                                                           |
| 57 | Medium | Set Matrix Zeroes                | <a href="https://leetcode.com/problems/set-matrix-zeroes/">https://leetcode.com/problems/set-matrix-zeroes/</a>                                                                 |
| 58 | Medium | Spiral Matrix                    | <a href="https://leetcode.com/problems/spiral-matrix/">https://leetcode.com/problems/spiral-matrix/</a>                                                                         |
| 59 | Medium | Jump Game                        | <a href="https://leetcode.com/problems/jump-game/">https://leetcode.com/problems/jump-game/</a>                                                                                 |
| 60 | Medium | Permutations                     | <a href="https://leetcode.com/problems/permutations/">https://leetcode.com/problems/permutations/</a>                                                                           |
| 61 | Medium | Combination Sum                  | <a href="https://leetcode.com/problems/combination-sum/">https://leetcode.com/problems/combination-sum/</a>                                                                     |
| 62 | Medium | Search in Rotated Sorted Array   | <a href="https://leetcode.com/problems/search-in-rotated-sorted-array/">https://leetcode.com/problems/search-in-rotated-sorted-array/</a>                                       |
| 63 | Medium | Group Anagrams                   | <a href="https://leetcode.com/problems/group-anagrams/">https://leetcode.com/problems/group-anagrams/</a>                                                                       |
| 64 | Medium | Sort Colors                      | <a href="https://leetcode.com/problems/sort-colors/">https://leetcode.com/problems/sort-colors/</a>                                                                             |
| 65 | Medium | Subsets                          | <a href="https://leetcode.com/problems/subsets/">https://leetcode.com/problems/subsets/</a>                                                                                     |
| 66 | Medium | Reverse Linked List II           | <a href="https://leetcode.com/problems/reverse-linked-list-ii/">https://leetcode.com/problems/reverse-linked-list-ii/</a>                                                       |
| 67 | Medium | Add Two Numbers II               | <a href="https://leetcode.com/problems/add-two-numbers-ii/">https://leetcode.com/problems/add-two-numbers-ii/</a>                                                               |
| 68 | Medium | Reorder List                     | <a href="https://leetcode.com/problems/reorder-list/">https://leetcode.com/problems/reorder-list/</a>                                                                           |
| 69 | Medium | Linked List Cycle II             | <a href="https://leetcode.com/problems/linked-list-cycle-ii/">https://leetcode.com/problems/linked-list-cycle-ii/</a>                                                           |
| 70 | Medium | K-th Largest Element in an Array | <a href="https://leetcode.com/problems/kth-largest-element-in-an-array/">https://leetcode.com/problems/kth-largest-element-in-an-array/</a>                                     |
| 71 | Medium | Product of Array Except Self     | <a href="https://leetcode.com/problems/product-of-array-except-self/">https://leetcode.com/problems/product-of-array-except-self/</a>                                           |
| 72 | Medium | Word Search                      | <a href="https://leetcode.com/problems/word-search/">https://leetcode.com/problems/word-search/</a>                                                                             |
| 73 | Medium | Unique Paths                     | <a href="https://leetcode.com/problems/unique-paths/">https://leetcode.com/problems/unique-paths/</a>                                                                           |
| 74 | Medium | Minimum Path Sum                 | <a href="https://leetcode.com/problems/minimum-path-sum/">https://leetcode.com/problems/minimum-path-sum/</a>                                                                   |
| 75 | Medium | Temperature Converter - II       | <a href="https://www.codechef.com/practice/course/c/LPCAS03/problems/LCAS30B">https://www.codechef.com/practice/course/c/LPCAS03/problems/LCAS30B</a>                           |
| 76 | Medium | Reverse                          | <a href="https://www.hackerrank.com/challenges/reverse-array-c/problem?isFullScreen=true">https://www.hackerrank.com/challenges/reverse-array-c/problem?isFullScreen=true</a>   |
| 77 | Medium | Sentence in a new line           | <a href="https://www.hackerrank.com/challenges/printing-tokens-/problem?isFullScreen=true">https://www.hackerrank.com/challenges/printing-tokens-/problem?isFullScreen=true</a> |
| 78 | Hard   | Median of Two Sorted Arrays      | <a href="https://leetcode.com/problems/median-of-two-sorted-arrays/">https://leetcode.com/problems/median-of-two-sorted-arrays/</a>                                             |
| 79 | Hard   | Regular Expression Matching      | <a href="https://leetcode.com/problems/regular-expression-matching/">https://leetcode.com/problems/regular-expression-matching/</a>                                             |
| 80 | Hard   | Wildcard Matching                | <a href="https://leetcode.com/problems/wildcard-matching/">https://leetcode.com/problems/wildcard-matching/</a>                                                                 |

|    |      |                                       |                                                                                                                                                                                                               |
|----|------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 81 | Hard | Trapping Rain Water                   | <a href="https://leetcode.com/problems/trapping-rain-water/">https://leetcode.com/problems/trapping-rain-water/</a>                                                                                           |
| 82 | Hard | First Missing Positive                | <a href="https://leetcode.com/problems/first-missing-positive/">https://leetcode.com/problems/first-missing-positive/</a>                                                                                     |
| 83 | Hard | Longest Valid Parentheses             | <a href="https://leetcode.com/problems/longest-valid-parentheses/">https://leetcode.com/problems/longest-valid-parentheses/</a>                                                                               |
| 84 | Hard | Merge k Sorted Lists                  | <a href="https://leetcode.com/problems/merge-k-sorted-lists/">https://leetcode.com/problems/merge-k-sorted-lists/</a>                                                                                         |
| 85 | Hard | Reverse Nodes in k-Group              | <a href="https://leetcode.com/problems/reverse-nodes-in-k-group/description/">https://leetcode.com/problems/reverse-nodes-in-k-group/description/</a>                                                         |
| 86 | Hard | Sudoku Solver                         | <a href="https://leetcode.com/problems/sudoku-solver/">https://leetcode.com/problems/sudoku-solver/</a>                                                                                                       |
| 87 | Hard | N-Queens                              | <a href="https://leetcode.com/problems/n-queens/description/">https://leetcode.com/problems/n-queens/description/</a>                                                                                         |
| 88 | Hard | Edit Distance                         | <a href="https://leetcode.com/problems/edit-distance/">https://leetcode.com/problems/edit-distance/</a>                                                                                                       |
| 89 | Hard | Word Ladder II                        | <a href="https://leetcode.com/problems/word-ladder-ii/">https://leetcode.com/problems/word-ladder-ii/</a>                                                                                                     |
| 90 | Hard | Maximal Rectangle                     | <a href="https://leetcode.com/problems/maximal-rectangle/">https://leetcode.com/problems/maximal-rectangle/</a>                                                                                               |
| 91 | Hard | Binary Tree Maximum Path Sum          | <a href="https://leetcode.com/problems/binary-tree-maximum-path-sum/">https://leetcode.com/problems/binary-tree-maximum-path-sum/</a>                                                                         |
| 92 | Hard | Serialize and Deserialize Binary Tree | <a href="https://leetcode.com/problems/serialize-and-deserialize-binary-tree/">https://leetcode.com/problems/serialize-and-deserialize-binary-tree/</a>                                                       |
| 93 | Hard | Variadic functions in C               | <a href="https://www.hackerrank.com/challenges/variadic-functions-in-c/problem?isFullScreen=true">https://www.hackerrank.com/challenges/variadic-functions-in-c/problem?isFullScreen=true</a>                 |
| 94 | Hard | Small Triangles, Large Triangles      | <a href="https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem?isFullScreen=true">https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem?isFullScreen=true</a> |
| 95 | Hard | Permutations of Strings               | <a href="https://www.hackerrank.com/challenges/permutations-of-strings/problem?isFullScreen=true">https://www.hackerrank.com/challenges/permutations-of-strings/problem?isFullScreen=true</a>                 |

## Maya Programs

| S.N o. | Problem Name                 | Maya Program Link                                                                                                                                                 |
|--------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Can Cross the Bridge         | <a href="https://maya.technicalhub.io/owl-program-details/6686308df56afec5c0c8e2dd">https://maya.technicalhub.io/owl-program-details/6686308df56afec5c0c8e2dd</a> |
| 2      | Hypotenuse                   | <a href="https://maya.technicalhub.io/owl-program-details/6686404ef56afec5c0c90135">https://maya.technicalhub.io/owl-program-details/6686404ef56afec5c0c90135</a> |
| 3      | Heron's Formula              | <a href="https://maya.technicalhub.io/owl-program-details/66864474f56afec5c0c911f5">https://maya.technicalhub.io/owl-program-details/66864474f56afec5c0c911f5</a> |
| 4      | Loss Percentage              | <a href="https://maya.technicalhub.io/owl-program-details/66864868f56afec5c0c91a4a">https://maya.technicalhub.io/owl-program-details/66864868f56afec5c0c91a4a</a> |
| 5      | King Tours                   | <a href="https://maya.technicalhub.io/owl-program-details/66864c96f56afec5c0c921f1">https://maya.technicalhub.io/owl-program-details/66864c96f56afec5c0c921f1</a> |
| 6      | Profit Percentage            | <a href="https://maya.technicalhub.io/owl-program-details/66865237f56afec5c0c92694">https://maya.technicalhub.io/owl-program-details/66865237f56afec5c0c92694</a> |
| 7      | Area and Perimeter of Square | <a href="https://maya.technicalhub.io/owl-program-details/6686546930bfd35127c869c">https://maya.technicalhub.io/owl-program-details/6686546930bfd35127c869c</a>   |
| 8      | Volume of Sphere             | <a href="https://maya.technicalhub.io/owl-program-details/6686565530bfd35127c8818">https://maya.technicalhub.io/owl-program-details/6686565530bfd35127c8818</a>   |
| 9      | Required Points              | <a href="https://maya.technicalhub.io/owl-program-details/66865b1130bfd35127c8a04">https://maya.technicalhub.io/owl-program-details/66865b1130bfd35127c8a04</a>   |
| 10     | Instant Noodles              | <a href="https://maya.technicalhub.io/owl-program-details/66865ddb30bfd35127c8c0a">https://maya.technicalhub.io/owl-program-details/66865ddb30bfd35127c8c0a</a>   |

|    |                                               |                                                                                                                                                                   |
|----|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11 | Find Second Number                            | <a href="https://maya.technicalhub.io/owl-program-details/668660a530bfd35127c8cde">https://maya.technicalhub.io/owl-program-details/668660a530bfd35127c8cde</a>   |
| 12 | Kmph to Mps                                   | <a href="https://maya.technicalhub.io/owl-program-details/668663ce30bfd35127c8dfb">https://maya.technicalhub.io/owl-program-details/668663ce30bfd35127c8dfb</a>   |
| 13 | Inches to Centimeters                         | <a href="https://maya.technicalhub.io/owl-program-details/6686665e30bfd35127c8f3a">https://maya.technicalhub.io/owl-program-details/6686665e30bfd35127c8f3a</a>   |
| 14 | Capacity                                      | <a href="https://maya.technicalhub.io/owl-program-details/668678aa30bfd35127c95b9">https://maya.technicalhub.io/owl-program-details/668678aa30bfd35127c95b9</a>   |
| 15 | Average of Two Numbers                        | <a href="https://maya.technicalhub.io/owl-program-details/6687b002dfe02cea4b5389d6">https://maya.technicalhub.io/owl-program-details/6687b002dfe02cea4b5389d6</a> |
| 16 | Compound Interest                             | <a href="https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab">https://maya.technicalhub.io/owl-program-details/6687b498dfe02cea4b53e0ab</a> |
| 17 | Average Weight                                | <a href="https://maya.technicalhub.io/owl-program-details/6687b93edfe02cea4b54367a">https://maya.technicalhub.io/owl-program-details/6687b93edfe02cea4b54367a</a> |
| 18 | Arithmetic Operations                         | <a href="https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1">https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1</a> |
| 19 | Distance Between Two Points                   | <a href="https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a">https://maya.technicalhub.io/owl-program-details/6687c4e9fd042085d9ec254a</a> |
| 20 | Days into Years, Weeks                        | <a href="https://maya.technicalhub.io/owl-program-details/6687cad1fd042085d9ec95a8">https://maya.technicalhub.io/owl-program-details/6687cad1fd042085d9ec95a8</a> |
| 21 | Convert Seconds to Hours, Minutes and Seconds | <a href="https://maya.technicalhub.io/owl-program-details/6688c926e467bfe336f8007b">https://maya.technicalhub.io/owl-program-details/6688c926e467bfe336f8007b</a> |
| 22 | Hours and Minutes                             | <a href="https://maya.technicalhub.io/owl-program-details/6688e4f0e467bfe336f89673">https://maya.technicalhub.io/owl-program-details/6688e4f0e467bfe336f89673</a> |
| 23 | Romeo and Juliet                              | <a href="https://maya.technicalhub.io/owl-program-details/6688e068e467bfe336f87a8b">https://maya.technicalhub.io/owl-program-details/6688e068e467bfe336f87a8b</a> |
| 24 | Gross Salary of an Employee                   | <a href="https://maya.technicalhub.io/owl-program-details/6688dd95e467bfe336f87682">https://maya.technicalhub.io/owl-program-details/6688dd95e467bfe336f87682</a> |
| 25 | Surface Area and Volume of a Cube             | <a href="https://maya.technicalhub.io/owl-program-details/6688d909e467bfe336f872ca">https://maya.technicalhub.io/owl-program-details/6688d909e467bfe336f872ca</a> |
| 26 | Area of Trapezium                             | <a href="https://maya.technicalhub.io/owl-program-details/6688d637e467bfe336f86c5e">https://maya.technicalhub.io/owl-program-details/6688d637e467bfe336f86c5e</a> |
| 27 | Swap Two Numbers                              | <a href="https://maya.technicalhub.io/owl-program-details/6688d2d0e467bfe336f84f55">https://maya.technicalhub.io/owl-program-details/6688d2d0e467bfe336f84f55</a> |
| 28 | Last Two Digits of a Given Year               | <a href="https://maya.technicalhub.io/owl-program-details/6688ccfae467bfe336f81f90">https://maya.technicalhub.io/owl-program-details/6688ccfae467bfe336f81f90</a> |
| 29 | Arithmetic Operations                         | <a href="https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1">https://maya.technicalhub.io/owl-program-details/6687bda0dfe02cea4b5488a1</a> |
| 30 | Uppercase Letters in a String                 | <a href="https://maya.technicalhub.io/owl-program-details/669a2453c03fc56b320b215c">https://maya.technicalhub.io/owl-program-details/669a2453c03fc56b320b215c</a> |
| 31 | Factors Finding                               | <a href="https://maya.technicalhub.io/owl-program-details/66866c4a30bfd35127c90b4">https://maya.technicalhub.io/owl-program-details/66866c4a30bfd35127c90b4</a>   |
| 32 | String Copy                                   | <a href="https://maya.technicalhub.io/owl-program-details/669a03ded62716a9c6d4fa9a">https://maya.technicalhub.io/owl-program-details/669a03ded62716a9c6d4fa9a</a> |
| 33 | Recursive Digit Sum                           | <a href="https://www.hackerrank.com/challenges/recursive-digit-sum/problem">https://www.hackerrank.com/challenges/recursive-digit-sum/problem</a>                 |

|                            | <b>Basic Programs</b> | <b>Aditya's Internal Coding Platform (Maya)</b> | <b>Code chef</b> | <b>Hacker rank</b> | <b>Leet code</b> | <b>Total</b> |
|----------------------------|-----------------------|-------------------------------------------------|------------------|--------------------|------------------|--------------|
| <b>Unit-1</b>              | 4                     | 8                                               | 2                | 5                  | 0                | <b>19</b>    |
| <b>Unit-2</b>              | 4                     | 4                                               | 1                | 4                  | 0                | <b>13</b>    |
| <b>Unit-3</b>              | 8                     | 7                                               | 0                | 2                  | 0                | <b>17</b>    |
| <b>Unit-4</b>              | 5                     | 0                                               | 0                | 7                  | 0                | <b>12</b>    |
| <b>Unit-5</b>              | 9                     | 0                                               | 0                | 0                  | 0                | <b>9</b>     |
| <b>Additional Practice</b> | 0                     | 33                                              | 22               | 5                  | 68               | <b>128</b>   |
| <b>Total</b>               | <b>26</b>             | <b>52</b>                                       | <b>29</b>        | <b>23</b>          | <b>68</b>        | <b>198</b>   |

### Business Intelligence Lab

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

(Syllabus for the batch admitted in the year 2025)

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501IT01</b> | <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

#### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Utilize Excel and Power BI for data analysis, visualization, and reporting.
- CO2:** Apply various data analysis techniques in Excel and Power BI to extract meaningful insights from datasets
- CO3:** Create clear and compelling visualizations using Excel and Power BI to communicate data-driven insights.
- CO4:** Develop data models in Power BI to organize and analyze data efficiently.
- CO5:** Design interactive dashboards in Power BI to facilitate data exploration and decision-making.

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | -    | -    | 2    | -    | -    | -    | 1    | 1     | 1     |
| <b>CO2</b> | 2    | 3    | -    | -    | 2    | -    | -    | -    | 1    | 1     | 2     |
| <b>CO3</b> | 2    | 2    | -    | -    | 2    | -    | -    | -    | 1    | 1     | 2     |
| <b>CO4</b> | 1    | 2    | 1    | -    | 2    | -    | -    | -    | 1    | 1     | 2     |
| <b>CO5</b> | 1    | 2    | 1    | -    | 2    | -    | -    | -    | 1    | 1     | 2     |

#### Practice:

##### 1.Introduction to Excel

- a. Overview of Excel and its capabilities for data analysis
- b. Basics of Excel: Navigating the interface, entering data, formatting cells
- c. Introduction to functions and formulas: SUM, AVERAGE, IF, VLOOKUP, etc.
- d. Importing data into Excel from different sources: CSV, text files.

##### 2. Data Analysis with Excel

- a. Data manipulation techniques: Sorting, filtering, and grouping data
- b. Advanced functions and formulas: INDEX/MATCH, SUMIFS, COUNTIFS, etc.
- c. Data visualization with Excel: Creating charts and graphs
- d. Using PivotTables for data summarization and analysis

##### 3.Advanced Excel Features

- a. Introduction to Excel tables and structured references
- b. Working with named ranges and dynamic ranges
- c. Excel data validation techniques

**4. Introduction to Power BI**

- a. Overview of Power BI and its advantages over Excel for large datasets
- b. Installing Power BI Desktop
- c. Understanding the Power BI interface: Navigation, ribbons, and panes
- d. Importing data into Power BI Desktop from various sources

**5. Data Preparation in Power BI**

- a. Introduction to Power Query for data transformation
- b. Cleaning, shaping, and filtering data in Power Query Editor

**6. Data Preparation in Power BI**

- a. Combining data from different sources
- b. Loading data into Power BI model.

**7. Data Modeling in Power BI**

- a. Understanding relationships between tables
- b. Creating calculated columns and measures using DAX

**8. Data Modeling in Power BI**

- a. Introduction to DAX functions: CALCULATE, FILTER, RELATED, etc.
- b. Working with date and time functions in DAX

**9. Visualization Basics in Power BI**

- a. Creating basic visualizations: Bar charts, line charts, pie charts, etc.
- b. Customizing visualizations: Formatting, titles, legends, etc.

**10. Visualization Basics in Power BI**

- a. Using slicers and filters to interact with visualizations
- b. Adding drill-down capabilities to visualizations

**11. Advanced Visualizations and Dashboards in Power BI**

- a. Exploring advanced visualizations: TreeMap, Waterfall chart, KPIs, etc.
- b. Creating custom visuals from the marketplace

**12. Advanced Visualizations and Dashboards in Power BI**

- a. Designing effective dashboards: Layout, arrangement, and organization
- b. Adding interactivity with bookmarks and drill-through

**Additional Practice:**

1. **Basic Data Analysis:** Import a dataset into Excel and perform basic data analysis tasks such as sorting, filtering, and creating simple charts to visualize the data.
2. **Expense Tracker:** Create a spreadsheet to track your expenses. You can have columns for date, item description, category, and amount. Use formulas to calculate totals and analyze your spending habits.
3. **Data modeling and extracting statistics from dataset:** Connecting Power BI to local data files and cloud servers (COVID19 dataset will be imported into the Power BI for visualization).

**Text Books:**

1. Learn Power BI - Second Edition: A comprehensive, step-by-step guide for beginners to learn real-world business intelligence 2<sup>nd</sup> Edition, ISBN: 9781801811958.
2. Power BI Beginner: Zero to Hero in Power BI Desktop by Philip Seamark, ISBN 1691641227.

**Reference Books:**

1. Power BI Quick Start Guide: Build dashboards and visualizations to make your data come to life by Devin Knight and Siddharth Mehta.
2. Learn Power BI: A Beginner's Guide to Analyzing Data and Creating Reports with Power BI by Murilo Miranda.

**Web Links:**

1. <https://learn.microsoft.com/en-us/power-bi/>
2. <https://support.microsoft.com/en-us/excel>
3. <https://cce.sydney.edu.au/course/MSE1>
4. <https://cce.sydney.edu.au/course/PBBA>

### **Business Intelligence and AI Tools Lab**

(Common to CE, EEE, ME, ECE, CSE, AIML, CSE(DS), PT & Min.E)

( Revised Syllabus for batches admitted from 2026 onwards)

|                              |          |          |          |          |
|------------------------------|----------|----------|----------|----------|
| <b>Course Code: 2601AI01</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|                              | <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

#### **Course Outcomes**

At the end of the course, the student will be able to:

- CO1** Use Excel for data entry, formulas and built-in functions to perform basic data analysis.
- CO2** Apply data-analysis and visualization techniques in Excel (PivotTables, charts) to extract meaningful insights from datasets.
- CO3** Build data models and interactive dashboards in Power BI to support reporting and decision-making.
- CO4** Use generative AI tools (ChatGPT, Claude, Gemini, Perplexity) through well-structured prompts to solve everyday academic and analytical tasks.
- CO5** Apply AI tools responsibly to research, verify, summarize and create content and presentations.
- CO6** Integrate AI assistance with Excel and Power BI to accelerate data analysis and reporting.

#### **MODULE A — Spreadsheet Analytics with Microsoft Excel**

##### **1. Excel Fundamentals**

- a. Navigating the Excel interface; entering and formatting data; cell referencing (relative, absolute, mixed).
- b. Core functions and formulas: SUM, AVERAGE, COUNT, IF, VLOOKUP.
- c. Importing data into Excel from CSV and text files.

##### **2. Data Analysis in Excel**

- a. Data manipulation: sorting, filtering and grouping data.
- b. Advanced functions: INDEX/MATCH, SUMIFS, COUNTIFS, nested IF.
- c. Creating charts and graphs to visualize data.

##### **3. PivotTables and Summarization**

- a. Building PivotTables and PivotCharts for data summarization.
- b. Using slicers and timelines to interact with summaries.
- c. Calculated fields and grouping within PivotTables.



#### **4. Advanced Excel Features**

- a. Excel tables and structured references; named and dynamic ranges.
- b. Data-validation techniques (drop-down lists, input rules).
- c. What-if analysis: Goal Seek and Data Tables.

### **MODULE B — Business Intelligence with Microsoft Power BI**

#### **5. Getting Started with Power BI**

- a. Overview of Power BI and its advantages over Excel for large datasets.
- b. Installing Power BI Desktop; understanding the interface (ribbons, panes, views).
- c. Importing data from multiple sources (Excel, CSV, web).

#### **6. Data Preparation with Power Query**

- a. Cleaning, shaping and filtering data in the Power Query Editor.
- b. Combining data from different sources (append and merge).
- c. Loading the prepared data into the Power BI model.

#### **7. Data Modeling and DAX**

- a. Creating relationships between tables; star-schema basics.
- b. Calculated columns and measures using DAX.
- c. Key DAX functions: CALCULATE, FILTER, RELATED, and date/time functions.

#### **8. Visualizations and Interactive Dashboards**

- a. Basic and advanced visuals: bar, line, pie, TreeMap, KPI cards.
- b. Slicers, filters and drill-down for interactivity.
- c. Designing an interactive dashboard with bookmarks and drill-through.

### **MODULE C — Working with AI Tools**

#### **9. Exploring the AI Tool Landscape**

- a. Introduction to popular AI assistants: ChatGPT, Claude, Gemini, Perplexity.
- b. Comparing tools across tasks — summarizing, simple coding, and reasoning.
- c. Building a comparison matrix and choosing the right tool for a task.

#### **10. Prompt Engineering Essentials**

- a. Anatomy of a good prompt; clarity, context and constraints.
- b. Prompt patterns: persona, few-shot, chain-of-thought, and structured (JSON) output.
- c. Iterating and refining prompts for better results.

#### **11. AI for Research and Verification**

- a. Using AI for topic research, explanations and quick literature scans.
- b. Three-step verification chain: cross-check claims against primary sources.
- c. Recognizing hallucinations, bias and link-rot; the limits of AI.

#### **12. Responsible and Ethical Use of AI**

- a. Academic integrity, plagiarism and proper acknowledgement of AI use.
- b. Privacy, data safety and never sharing sensitive information.
- c. Drafting a simple personal/class “AI use policy”.

#### **13. AI for Content and Presentations**

- a. Summarizing documents and Q&A over your own notes (e.g., NotebookLM).
- b. Generating outlines, write-ups and email drafts with AI assistance.
- c. Auto-creating slide decks from a brief (e.g., Gamma) and refining them.

#### **14. AI-Assisted Data Analysis (Capstone)**

- a. Using AI to write/explain Excel formulas and draft DAX measures.
- b. Cleaning and interpreting a dataset and explaining charts with AI help.
- c. Mini-project: clean a dataset in Excel, build a Power BI dashboard, and use AI to generate insights and a short summary report.

#### **Additional Practice / Suggested Activities**

- Expense Tracker (Excel): build a spreadsheet with date, item, category and amount; use formulas to total and analyze spending.
- Sales Dashboard (Power BI): import a sample sales dataset and build an interactive dashboard with slicers and KPIs.
- COVID-19 Data Story (Power BI): connect to a public dataset and create visuals that tell a clear data story.
- AI Study Buddy: pick one subject topic and use prompt patterns to generate notes, a quiz and flashcards, then verify the facts.
- Capstone Showcase: present the Module-C mini-project — dataset → cleaned in Excel → visualized in Power BI → insights drafted with AI.

#### **Text Books**

- 1 Learn Power BI – Second Edition: A comprehensive, step-by-step guide for beginners to learn real-world business intelligence, ISBN: 9781801811958.
- 2 Power BI Beginner: Zero to Hero in Power BI Desktop, Philip Seamark, ISBN: 1691641227.
- 3 Excel 2021 / Microsoft 365 – The Step-by-Step Guide to Mastering Excel, (latest edition).

#### **Reference Books**

- 1 Power BI Quick Start Guide: Build dashboards and visualizations to make your data come to life, Devin Knight and Siddharth Mehta.
- 2 Learn Power BI: A Beginner's Guide to Analyzing Data and Creating Reports with Power BI, Murilo Miranda.
- 3 Co-Intelligence: Living and Working with AI, Ethan Mollick (for responsible AI use).

#### **Web Links / e-Resources**

- 1 <https://learn.microsoft.com/en-us/power-bi/>
- 2 <https://support.microsoft.com/en-us/excel>
- 3 <https://aistudio.google.com/>

- 4 <https://notebooklm.google.com/>
- 5 <https://www.perplexity.ai/>

## Engineering Graphics

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

**Course Code: 2501ME01**

| L | T | P | C |
|---|---|---|---|
| 1 | 0 | 2 | 3 |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Apply the principles of engineering drawing to construct Engineering curves.
- CO2:** Construct projections of points and lines.
- CO3:** Demonstrate visualization skills of projections of planes.
- CO4:** Demonstrate visualization skills of projections of solids and development of surfaces.
- CO5:** Construct isometric and orthographic views of simple solids.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | 1    | -    | 2    | -    | -    | 1    | 1    | -     | -     |
| CO2   | 3    | 2    | 1    | -    | 2    | -    | -    | 1    | 1    | -     | -     |
| CO3   | 3    | 2    | 1    | -    | 2    | -    | -    | 1    | 1    | -     | -     |
| CO4   | 3    | 2    | 1    | -    | 2    | -    | -    | 1    | 1    | -     | -     |
| CO5   | 3    | 2    | 1    | -    | 2    | -    | -    | 1    | 1    | -     | -     |

### Practice:

#### 1. Introduction to Engineering Graphics

Introduction to AutoCAD, Dimensioning, elements of dimensioning, system of dimensioning, and Conventions in Drawing.

#### 2. Construction of Cycloids and Involute

- a) Construction of Cycloid, Epicycloid and Hypocycloid
- b) Involute of a pentagon and circle

#### 3. Introduction to Orthographic Projection

- a) Principles of Projection
- b) Orthographic Projection – Four Quadrants.
- c) First angle & Third angle Projection with examples, reference plane, importance of reference lines or Plane.
- d) Projections of a point situated in any one of the four quadrants.

#### 4. Projection of straight lines-I:

- a) Projections of straight lines parallel to both reference planes.

- b) Projections of straight lines perpendicular to one reference plane and parallel to other reference plane
- c) Projections of straight line parallel to one plane & inclined to another plane

**5. Projection of straight lines-II:**

- a) Projections of straight line inclined to both reference planes

**6. Projection of planes:**

- a) Regular planes perpendicular to both reference planes, Parallel to one reference plane and inclined to the other reference plane  
Ex: Rectangle, Pentagon, Hexagon and Rhombus

**7. Projection of planes**

- a) Projections of Planes inclined to both reference planes Ex: Rectangle, Pentagon, Hexagon and Rhombus.

**8. Projection of solids**

- a) Axis Perpendicular to H.P and Axis Perpendicular to V.P  
Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone
- b) Axis Parallel to H.P and V.P  
Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

**9. Projection of solids**

- a) Projection of Solids with axis inclined to one reference plane and parallel to another plane  
Ex: Pentagonal and Hexagonal Prisms, Pyramids, Cylinder and Cone

**10. Development of Surfaces**

- a) Development of Prisms and Cylinder simple cases

**11. Development of Surfaces**

- a) Development of Pyramids and Cone simple cases

**12. Conversion of Isometric views to Orthographic views**

- a) Practice figure - 1
- b) Practice figure – 2

**Additional Practice:**

**1. Conversion of Isometric views to Orthographic views**

- a) Practice figure - 3
- b) Practice figure – 4

**2. Conversion of Orthographic views to Isometric views**

- a) Practice figure - 1
- b) Practice figure - 2

**Text Books:**

1. Engineering Drawing, N. D. Bhatt, Charotar Publishing House, 54<sup>th</sup> Edition, 2024, ISBN : 9789385039706.
2. Engineering Drawing and Graphics , Venugopal, New Age Publications, 2<sup>nd</sup> Edition, 2019, ISBN: 9788122415452.

**Reference Books:**

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2021, ISBN: 978-9385983177.
2. Computer Aided Engineering Graphics, T. Jeyapoovan, Vikas Publishing house, New Delhi, 1<sup>st</sup> Edition, 2023, ISBN : 9789356743199.

**Web Links:**

1. <https://nptel.ac.in/courses/112103019/>
2. <https://academy.autodesk.com/authenticated-home-user>
3. <https://www.sciencedirect.com/book/9780080108391>

**Engineering Workshop**  
(Common to CE, EEE, ME, ECE, PT & Min.E)

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501ME03</b> | <b>0</b> | <b>0</b> | <b>1</b> | <b>1</b> |
| <b>Course Outcome:</b>      |          |          |          |          |

**At the end of the course, student will be able to:**

- CO1:** Prepare various wooden joints.
- CO2:** Demonstrate various sheet metal models.
- CO3:** Develop the basic knowledge of house wiring.
- CO4:** Develop the basic knowledge of plumbing.
- CO5:** Practice various welded joints.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 1    | 1    | -    | -    | -    | 1    | 1    | 2    | 1    | -     | 1     |
| <b>CO2</b> | 1    | 1    | -    | -    | -    | 1    | 1    | 2    | 1    | -     | 1     |
| <b>CO3</b> | 2    | 2    | -    | -    | -    | 1    | 1    | 2    | 1    | -     | 1     |
| <b>CO4</b> | 1    | 2    | -    | -    | -    | 1    | 1    | 2    | 1    | -     | 1     |
| <b>CO5</b> | 2    | 2    | -    | -    | -    | 1    | 1    | 2    | 1    | -     | 1     |

**Practice:**

- To make a T-Lap joint from the given wooden workpieces.
- To make a dovetail lap joint from the given wooden workpieces.
- To make a taper tray using the given sheet metal.
- To make a funnel using the given sheet metal.
- To make a square tin using the given sheet metal.
- To connect three bulbs by using series and parallel connections.
- To give connection to a bulb by using staircase wiring.
- To prepare wiring for a tube light with switch control.
- To prepare a PVC pipe joint by using the given circuit1.
- To prepare a PVC pipe joint by using the given circuit2.
- To make a butt joint using the given M.S pieces by arc welding.
- To make a lap joint using given M.S pieces by arc welding

**Additional Practice:**

- To make a crosslap joint from the given wooden workpieces.
- To make an open scoop using the given sheet metal.
- To make a T-joint using given M.S pieces by arc welding.

**Text Books:**

1. Work shop Manual, P.Kannaiah & K.L.Narayana/ SciTech Publishers, 2<sup>nd</sup>Edition, ISBN: 978-8183711302.
2. Elements of Workshop Technology, VolII by S.K. Hajra Choudhury, S.K. Hajra. Choudhury & Nirjhar Roy, Media Promoters and Publishers PvtL imited, 14<sup>th</sup>Edition, ISBN: 8185099146.

**Reference Books:**

1. Workshop Technology, Part 1, W.A.J. Chapman, 5<sup>th</sup>Edition, ISBN 9780415503020.
2. Engineering Practices Lab Manual, T. Jeyapoovan& M. Saravanapandian, Vikas Publishing House Pvt Limited, 4<sup>th</sup>Edition, ISBN: 8125929037.
3. Engineering Practices Laboratory Manual, Ramesh Babu.V., VRB Publishers Private Limited, Chennai, Revised Edition, 2019-20, ISBN: 978-81-935993-8.

**Web Links:**

1. <https://bharatskills.gov.in>
2. <https://www.gopracticals.com/basic-engineering/workshop/>



**Basic Electrical & Electronics Engineering**  
(Common to CE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501EE01</b> | <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO 1:** Analyze the concepts associated to AC and DC circuits.
- CO 2:** Explain the operating principles of motors, generators and measuring instruments.
- CO 3:** Analyze the Different Energy Resources and Equipment Safety Measures.
- CO 4:** Explain the concept and the applications of semiconductor Diodes.
- CO 5:** Analyze the Basic Electronic Circuits and interpret numeric information in different code formats.

**Mapping of course outcomes with program outcomes:**

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

**Mapping of course outcomes with program Specific Outcomes:**

| CO\PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 1    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 1    | -    |
| <b>CO5</b> | 1    | -    |

**UNIT-I**

**DC and AC Circuits:**

**DC circuits:** Ohm's and Kirchhoff's laws, analysis of series, parallel and series-parallel circuits excited by independent voltage sources for R, L, C parameters, current division, voltage division

**AC circuits:** Generation of sinusoidal voltage, frequency of generated voltage, average value, RMS value, form, and peak factors. Real power, reactive power, apparent power, and Power factor.

**Practice:**

1. Verification of Ohm's Law.
2. Verification of KCL and KVL.
3. Verification of KCL, KVL and ohm's law using simulation.

**UNIT-II**

**Machines and Measuring Instruments:** Principles and operation of DC machines, Transformers – Synchronous Machines - three Phase and single phase induction motors - Moving coil and moving iron instruments, Wheatstone bridge and Megger.

**Practice:**

1. To study Magnetisation Characteristics of DC shunt generator.
2. Measurement of Power and Power factor using Single-phase wattmeter.
3. Measurement of Resistance using Wheat stone bridge.
4. Measurement of Earth Resistance using Megger.

**UNIT-III****Energy Resources, Electricity Bill & Safety Measures**

Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Thermal, Solar & Wind power generation. Calculation of electricity bill for domestic appliances. Working principle of Fuse and Miniature circuit breaker (MCB). Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

**Practice:**

1. Calculation of Electrical Energy for Domestic Premises.

**UNIT-IV****Semiconductor Devices**

Intrinsic semiconductors, Extrinsic semiconductors, P type and N type, P-N junction characteristics of P N Junction Diode, Zener Effect, Zener Diode and its Characteristics. working of simple Zener Voltage Regulator and Amplifier. Bipolar Junction Transistor - CB, CE, CC Configurations and Characteristics.

**Practice:**

1. Sketch the V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias.
2. Sketch the V-I characteristics of Zener Diode and its application as voltage Regulator.
3. Plot Input & Output characteristics of BJT in CE and CB configurations.
4. Obtain Frequency response of CE amplifier.

## UNIT-V

### Basic Electronic Circuits

Block diagram description of a dc power supply, working of a half and full wave, bridge rectifier, filters.

### Digital Electronics

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adders.

### Practice:

1. Implementation of half wave and full wave rectifiers.
2. Design Half Adder and Full Adder circuits.
3. Verification of truth table for Logic gates using ICs.

### Text Books:

1. Basic Electrical and Electronics Engineering, Salivahanan, S, Tata McGraw Hill Education (India) Private Limited, New Delhi, ISBN: 9789389691801.
2. Principles of Electrical Engineering, V. K. Mehta, R. Mehta, S. Chand & Company Ltd., New Delhi, ISBN-13: 9788121930888.
3. Digital Fundamentals, Thomas Floyd, Prentice Hall, 10<sup>th</sup> Edition, ISBN: 9780132737968.

### Reference Books:

1. Electronic Devices & Circuit Theory, Robert L. Boylestad and Louis Nashelsky, Pearson, 11<sup>th</sup> Edition, ISBN: 9780135026496.
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, ISBN: 9788177000207.

### Web Links:

1. <https://nptel.ac.in/courses/108/101/108101091/> (NPTEL Video by Dr. Mahesh B. Patil from IIT Bombay)
2. <https://nptel.ac.in/courses/117/106/117106108/> (NPTEL Video by Prof. Nagendra Krishnapura from IIT Madras)

## Network Analysis

**Course Code:2501EC02**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>1</b> | <b>0</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course student will be able to:**

- CO1:** Apply mesh and nodal analysis to DC and AC circuits.
- CO2:** Analyze the circuit using network theorems.
- CO3:** Analyze transient behaviour of RL,RC and RLC circuits with DC excitation.
- CO4:** Outline the characteristics of resonant circuits.
- CO5:** Model a two port network in terms of Z, Y, h & T parameters.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 1    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | -    | 2    |

## UNIT – I

**D.C.Circuits:**Types of circuit elements, Types of Sources and Source Transformation, Mesh analysis and Nodal analysis, problem solving with resistances only including dependent sources also, principle of Duality with examples.

**Steady State Analysis of A.C Circuits:** Impedance concept, phase angle and phasor notation for series R-L, R-C, and R-L-C circuits, mesh and nodal analysis,Star-Delta conversion, problem solving.

## UNIT – II

**Network Theorems:** Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem, Reciprocity theorem, Tellegen's theorem, Miller's theorem.

### UNIT – III

**Transient Analysis:** Introduction, Initial & Final conditions for basic passive elements, Transient response of Source free series RL and RC circuits, Transient response of series RL and RC circuits for DC excitation, Transient response of series RLC circuits for DC excitation.

### UNIT – IV

**Resonance:** Introduction, Series resonance -Impedance, Resonant frequency, Quality factor, Bandwidth, Parallel resonance-Condition for maximum impedance, Current, Bandwidth, and General case resistance present in both branches.

### UNIT – V

**Two-Port Networks:** Introduction to two port networks, Z-parameters, Y-parameters, ABCD-parameters, h-parameters, Reciprocity and Symmetry in two port network, Relationship between Parameters, Interconnection of two port networks.

#### Text Books:

1. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips, Steven M. Durbin, 9<sup>th</sup> Edition, 2020, ISBN:978-9390185139.
2. Joseph Edminister and Mahmood Nahvi, Electric Circuits, Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, 7<sup>th</sup> Edition, ISBN: 978-1260011968.

#### Reference Books:

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, revised 3<sup>rd</sup> Edition, 2019, ISBN: 978-9353433123.
2. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N. O. Sadiku, McGraw-Hill Education, 7<sup>th</sup> Edition, 2022, ISBN:978-9355320162.

#### Web Links:

1. <https://www.falstad.com>
2. <https://ocw.mit.edu/high-school/physics/exam-prep/electric-circuits/>
3. [www.allaboutcircuits.com](http://www.allaboutcircuits.com)
4. <https://nptel.ac.in/courses/117106108/> Prof. Gajendranath Chowdary /IIT Madras.
5. <https://asnm-iitkgp.vlabs.ac.in/List%20of%20experiments.html>

## Digital Electronics

**Course Code: 2501EC01**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1:** Interpret Boolean theorems and De Morgan's laws.
- CO2:** Minimize Boolean expressions using algebraic, Karnaugh Map, and tabular techniques.
- CO3:** Implement various combinational logic circuits.
- CO4:** Design, analyse, and implement sequential logic circuits using flip-flops and registers.
- CO5:** Design and implement counters and finite state machines using Mealy and Moore models.

**Mapping of Course Outcomes with Program Outcomes:**

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

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 3    |
| <b>CO4</b> |      | 3    |
| <b>CO5</b> |      | 3    |

### UNIT – I

**Boolean Algebra:** Boolean theorems, principle of duality and complementation, De-Morgan's theorems, Review of basic logic gates, Basic logic gate realization and Boolean function realization using universal gates (NAND, NOR).

#### Practice:

1. Implement logic gate circuits (NOT, NAND, and NOR) using Verilog and verify their functionality through FPGA Kit using Simulation tools Such as Xilinx Vivado or Intel Quartus Prime.

2. Apply De Morgan's laws for Boolean expression,  $F = \overline{(AB + C)}$  and realize it using NAND/NOR gates in Verilog, and verify their functionality through FPGA Kit using Simulation tools Such as Xilinx Vivado or Intel Quartus Prime.

## UNIT – II

**Minimization Techniques:** Minimization of logic functions using Boolean theorems, minimization of switching functions using Karnaugh Maps (K-Maps) up to 5 variables, Don't-care conditions in practical designs, tabular minimization (Quine-McCluskey).

### Practice:

1. Minimize a Boolean function  $F(A, B, C, D) = \sum m(0, 2, 5, 7, 8, 10, 13, 15)$  and Implement the minimized expressions in Verilog, and verify functionality through simulation in Xilinx Vivado or Intel Quartus Prime.
2. Minimize the Boolean function with don't-care conditions  $F(A, B, C, D) = \sum m(1, 3, 7, 11, 15) + d(0, 2, 5)$  using K-map. Implement the minimized expression in Verilog and verify its functionality through simulation in Xilinx Vivado or Intel Quartus Prime.

## UNIT – III

**Combinational Logic Circuits:** Review of Adders, Half Subtractor, Full Subtractor, 4-bit Ripple Carry Adder, 4-bit Carry Look-Ahead Adder circuit, 4-bit binary Adder/Subtractor circuit, BCD adder, Decoders (up to 3-to-8), Encoders (up to 8-to-3), Multiplexers (up to 8:1), De-multiplexers (up to 1:8), 1-bit Comparator, Code converters (Binary to Gray and Gray to Binary), and realization of Boolean functions using Decoders & Multiplexers.

### Practice:

1. Implement 3x8 Decoder Circuit using digital ICs.
2. Implement 8:1 Multiplexer using digital ICs.

## UNIT – IV

**Sequential Circuits I:** Latches and Flip-Flops (SR, JK, D, T), Truth tables and excitation tables, Flip-Flops with Preset and Clear, Flip-flop conversion, 4-bit Shift Register (SISO, SIPO, PISO, PIPO), 4-bit Bi-directional Shift Register, 4-bit Universal Shift Register.

**Practice:**

1. Implement SR, JK, D, and T-Flip-flop using digital ICs.
2. Implement 4-bit Universal Shift Register using digital ICs.

**UNIT – V**

**Sequential Circuits II:** 4-bit Ripple Counter (Asynchronous), 4-bit Synchronous Binary Counter, Mod-10 (Decade) Counter, 4-bit Johnson Counter, 4-bit Ring Counter, Finite State Machines (FSM), capabilities and limitations, Mealy and Moore models, State diagram, state table, state assignment.

**Practice:**

1. Implement 3-bit Asynchronous Counter using digital IC trainer kit.
2. Design a Mealy sequence detector for the input sequence “1011” (overlapping allowed).
  - Draw state diagram and state table.
  - Perform state assignment.
  - Implement using Verilog and verify using simulation in Xilinx Vivado or Intel Quartus Prime.
3. Design a Moore sequence detector for the input sequence “1101” (overlapping allowed).
  - Draw state diagram and state table.
  - Compare number of states with Mealy implementation.
  - Implement using Verilog and verify functionality through simulation in Xilinx Vivado or Intel Quartus Prime.

**Text Books:**

1. **Digital Design** – M. Morris Mano, Michael D. Ciletti, 6<sup>th</sup> Edition, Pearson Education, 2018, ISBN: 978-0134549897.
2. **Switching & Finite Automata Theory**, Zvi Kohavi, 3<sup>rd</sup> Edition, McGraw-Hill (TMH), ISBN: 9780074514863.
3. **Switching and Logic Design**, C. V. S. Rao, Pearson, 2017, ISBN: 9788131701836.



### Reference Books:

1. **Fundamentals of Logic Design**, Charles H. Roth, Larry L. Kinney, 7<sup>th</sup> Edition, Cengage Learning, ISBN: 9781133628477.
2. **A Verilog HDL Primer**, J. Bhasker, 3<sup>rd</sup> Edition, BS Publications, 2018, ISBN: 9788178001425.
3. **Introduction to Switching Theory and Logic Design**, F. J. Hill and G. R. Peterson 4<sup>th</sup> Edition, Wiley.
4. **Digital Logic: Applications and Design**, John M. Yarbrough, 1<sup>st</sup> Edition, Thomson.
5. **Digital Fundamentals**, Thomas L. Floyd, 11<sup>th</sup> Edition, Pearson, ISBN: 9780132737968.
6. **FPGA Prototyping by Verilog Examples**, Pong P. Chu, 2<sup>nd</sup> Edition, Wiley, ISBN: 9781119282662.

### Web Links:

#### Tutorials & Learning:

1. **NPTEL – Digital Circuits and Systems**  
<https://nptel.ac.in/courses/108/105/108105103/>.
2. **MIT OpenCourseWare – Digital Circuits**  
<https://ocw.mit.edu/courses/6-111-introduction-to-digital-systems-spring-2018/>.
3. **GeeksforGeeks – Digital Logic Design**  
<https://www.geeksforgeeks.org/digital-logic-design/>.
4. **TutorialsPoint – Digital Logic Design**  
[https://www.tutorialspoint.com/digital\\_electronics/digital\\_electronics\\_logic\\_gates.htm](https://www.tutorialspoint.com/digital_electronics/digital_electronics_logic_gates.htm).

#### Simulation & Verification:

1. **ChipVerify – Verilog Quick Reference & Examples**  
[https://www.chipverify.com/verilog/verilog\\_quick\\_ref](https://www.chipverify.com/verilog/verilog_quick_ref).

#### Synthesis & FPGA Tools:

1. **Xilinx Vivado Design Suite Documentation**  
[https://www.xilinx.com/support/documentation/sw\\_manuals.html](https://www.xilinx.com/support/documentation/sw_manuals.html).
2. **Intel (Altera) Quartus Prime Resources**  
<https://www.intel.com/content/www/us/en/programmable/support/support-resources/design-software.html>.

## Electronic Devices & Circuits

**Course Code: 2501EC03**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Interpret the characteristics of semiconductor diodes.
- CO2:** Compare the characteristics of rectifiers with and without filters.
- CO3:** Explain the characteristics of BJT and FET in different configurations.
- CO4:** Apply biasing methods for stabilization of BJT and FET amplifiers.
- CO5:** Construct a small signal low frequency equivalent model of BJT and FET.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | 1    | -    | -    | -    | 2    | 1    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| <b>CO4</b> | 2    | 2    | -    | 2    | -    | -    | -    | 2    | 1    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 1    | 2    | -    | -    | -    | 2    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 3    |
| <b>CO2</b> | -    | 3    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

## UNIT – I

**Junction Diode Characteristics:** Introduction to semiconductors, energy band structure of open circuited PN junction, forward and reverse bias of PN junction, current components in PN junction diode, drift and diffusion currents, law of junction, diode current equation, temperature dependence of V-I characteristics, Breakdown mechanisms, diffusion and transition capacitances.

**Special Semiconductor Devices:** LED, Photo diode, Tunnel Diode, Varactor Diode and UJT.

### Practice:

- V-I characteristics of LED and Varactor Diode.
- Draw the V-I characteristics of UJT and Identify the negative resistance region.

## UNIT – II

**Diode applications:** Types of rectifiers and their operation, input and output waveforms, derivations of parameters of rectifiers. Filters: Inductor filter, Capacitor filter, L-section filter,  $\pi$ -section filter, multiple L-section and multiple  $\pi$ - section filters, clipper and clamper circuits.

**Practice:**

1. Non Linear wave shaping – Series Clippers.
2. Non Linear wave shaping – Clampers.
3. Measure the Ripple factor and Percentage of Regulation of Full Wave Rectifier with and without  $\pi$  filter.

## UNIT – III

**Transistor Characteristics:** BJT: Construction and operation of a transistor, transistor current components, transistor current equation, transistor as a switch and amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, transistor parameters, relation between  $\alpha$  and  $\beta$ , comparison of BJT transistor configurations. FET: Construction, operation, characteristics and parameters of JFET, depletion and enhancement mode MOSFETs, comparison between JFET and MOSFET.

**Practice:**

1. Transistor as a switch.
2. Obtain the Drain and Transfer Characteristics of FET-CS Configuration also find  $\mu$ ,  $g_m$  and  $r_d$ .
3. Plot the output and transfer characteristics of an N-channel Enhancement Mode MOSFET. And obtain the threshold voltage  $V_{th}$  beyond which conduction starts.

## UNIT – IV

**Transistor Biasing and Thermal Stabilization:** Need for biasing, load line analysis, basic stability and stability factors ( $S$ ,  $S'$ ,  $S''$ ), BJT biasing methods, fixed bias, collector to base bias, self-bias, Stabilization against variations in  $V_{BE}$ ,  $I_{C0}$  and  $\beta$ , Bias compensation, FET voltage divider biasing method. MOSFET Voltage divider biasing method.

**Practice:**

1. Transistor biasing- Design of self-bias circuit
2. Design a voltage divider bias circuit for an n-channel enhancement MOSFET. And establish a stable operating point (Q-point) with proper gate voltage ( $V_{gs}$ ) and drain current ( $I_d$ ).

## UNIT – V

**Small Signal Analysis of Transistor Amplifiers at Low Frequency:** Transistor as a two-port network, Transistor hybrid model, determination of h-parameters, generalized analysis of

transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis.

FET: Generalized analysis of small signal model, Analysis of CG, CS and CD amplifiers.

**Practice:**

1. Obtain the frequency response of CC amplifier using BJT.
2. Obtain the frequency response of CS Amplifier using FET.

**Additional Practice:**

1. Implementation of half wave and full wave rectifiers with  $\pi$  filter.
2. Determine the Q point of given voltage divider bias circuit.
3. Non Linear wave shaping – Shunt Clippers with reference voltage.
4. Non Linear wave shaping – Double ended Clipping with reference voltage.

**Capstone project:**

*"Design and Development of a Mobile Phone Charger Circuit using Full-Wave Rectifier and  $\pi$ -Section Filter with Overvoltage Clipping Protection".*

This project involves designing a DC power supply circuit suitable for mobile phone charging by implementing a full-wave bridge rectifier, followed by a  $\pi$ -section filter for ripple reduction. The circuit will include a voltage clipper stage to protect against overvoltage conditions. The output will be tested for voltage regulation, ripple factor, and charging compatibility with USB-powered mobile devices.

**Text Books:**

1. Electronic Devices and Circuits, J. Millman, Christos C. Halkias, Satyabrata Jit, Tata McGraw Hill, 4<sup>th</sup> Edition, ISBN: 978-9339219543.
2. Electronic Devices and Circuits, David A. Bell, Oxford University Press, 5<sup>th</sup> Edition, 2018, ISBN: 978-0195693409 .

**Reference Books:**

1. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, Pearson Publications, 10<sup>th</sup> Edition, 2020, ISBN: 9788131727003.
2. Electronic Devices and Circuits, GK Mithal, Khanna Publishers, 23<sup>rd</sup> Edition, ISBN: 978-8174091772.
3. Electronic Circuits, D. A. Neamen, Tata McGraw Hill Education, ISBN: 978-0070634336 .

**Web Links:**

1. [https://www.electronics-tutorials.ws/diode/diode\\_2.html](https://www.electronics-tutorials.ws/diode/diode_2.html)
2. <http://fourier.eng.hmc.edu/e84/lectures/ch4/node3.html>
3. <http://nptel.ac.in/courses/117103063/11>
4. <https://nptel.ac.in/courses/122106025/> by Prof. T. S. Natarajan, IIT Madras .
5. <https://www.circuitlab.com/editor/#?id=6syafk>
6. <https://www.falstad.com/circuit/circuitjs.html>

## Random Variables & Stochastic Processes

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501EC04</b> | <b>3</b> | <b>1</b> | <b>0</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the properties of single Random variables
- CO2:** Infer the characteristics of multiple random variables.
- CO3:** Interpret the characteristics of random process in time domain.
- CO4:** Interpret the characteristics of random process in frequency domain.
- CO5:** Summarize the types and characteristics of Noise

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

**Single Random Variable:** Definition, Discrete and Continuous Random variables, Distribution and density function of Random variable and their properties, Expected value of Function of random variable, Moments, Mean and Variance and their properties, Binomial, Poisson, Uniform, Exponential, Gaussian distributions, Transformation of random variable.

## UNIT – II

**Multiple Random Variables:** Joint Distribution and density function of multiple random variables, Joint Moments, Marginal and conditional distributions, Covariance, Correlation, Sum of independent random variables, Central limit theorem, Statistical Independence of Random Variables.

### UNIT – III

**Random Processes-Temporal characteristics:** Random Process- Definition, Types of Random Processes, First-Order, Second-order, Strict Sense Stationary Random Process, Wide sense stationary and Ergodic processes, Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties, Covariance Functions, Random Signal Response of Linear Systems: Linear Time Invariant System, System Response – Convolution, Mean and Mean-squared Value of System Response.

### UNIT – IV

**Random Processes – Spectral Characteristics:** The Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function, The Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function.

### UNIT – V

**Noise Sources:** Definitions, Resistive/Thermal Noise Source, Arbitrary Noise Sources, Effective Noise Temperature, Noise equivalent bandwidth, Average Noise Figures, Spectral characteristic of system response for Noise, Narrow Band Noise, Quadrature representation of Narrow Band Noise & its properties.

#### Text Books:

1. Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, TMH Publications, 4<sup>th</sup> Edition, ISBN:978-0-07-047428-4.
2. Probability-Random Variables and Stochastic Processes, Athanasios Papoulis and S. Unnikrishna, PHI Publications, 4<sup>th</sup> Edition, ISBN:978-0070486584.

#### Reference Books:

1. Probability Theory and Stochastic Processes, Y. Mallikarjuna Reddy, Universities Press (India) Pvt. Ltd., 4<sup>th</sup> Edition, ISBN:9788173718878.
2. Probability and Random Processes with Applications to Signal Processing, Henry Stark and John W. Woods, Pearson Education, International Edition, ISBN:9780131784574.

#### Web Links:

1. <http://nptel.ac.in/courses/117105085/> - by Prof.M.Chakraborty, IIT Khargpur
2. <https://ocw.mit.edu/courses/18-445-introduction-to-stochastic-processes-spring-2015/> - Offered by MIT

## Signals & Systems

**Course Code: 2501EC14**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>1</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Analyze the Signal Classification and Fourier series representation of periodic signals.
- CO2:** Analyze the spectral characteristics of continuous-time periodic and aperiodic signals using Fourier analysis.
- CO3:** Apply Laplace and Z-transform techniques on signals.
- CO4:** Utilize the concept of convolution and sampling theorem in signal processing.
- CO5:** Analyze the response of continuous time LTI system.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 2    | 3    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 2    | 3    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 2    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

**Signals:** Definitions of a signal , Classification of signals, Elementary signals, Basic operations on signals.

**Fourier Series:** Representation of Fourier series for continuous time periodic signals, Trigonometric and Exponential Fourier series, Symmetry conditions , Dirichlet's conditions, Properties of Fourier series, Complex Fourier spectrum.

### Practice :

1. Generation of various signals such as unit impulse, unit step, ramp, exponential and sinewave.



2. Perform Operations on signals such as Addition, Multiplication, Scaling, Shifting, and Folding.
3. Perform Fourier synthesis of square wave.

## UNIT – II

**Fourier Transform:** Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signals, Fourier transform of standard signals, Fourier transform of periodic signals, Properties of Fourier transforms

**Practice:**

1. Calculate the Fourier Transform and Inverse Fourier Transform of a given continuous time signal.

## UNIT – III

**Laplace Transform:** Bilateral and unilateral Laplace Transforms, Region of convergence and its properties, Constraints on ROC for various classes of continuous time signals, Properties of Laplace Transform, Inverse Laplace Transform.

**Z-Transform:** Concept of Z- Transform of a Discrete Sequence, Region of convergence in Z-Transform, Constraints on ROC for various classes of discrete time signals, Properties of Z-Transform, Inverse Z-Transform.

**Practice:**

1. Obtain Laplace Transform and inverse Laplace Transform of a given continuous time signal.
2. Calculate the Z-Transform and Inverse Z-Transform of a given discrete time signal.

## UNIT – IV

**Convolution of Signals:** Convolution and its properties, Graphical representation of convolution, Convolution of signals through transforms.

**Sampling:** Introduction to Sampling, Sampling theorem, Nyquist rate, Nyquist duration, Types of Sampling, Reconstruction of signal from its samples, Effect of under sampling,

**Practice:**

1. Perform convolution of given continuous time signals.
2. Generate oversampled, Nyquist and undersampled discrete time signals for the given Analog signal.

## UNIT – V

**Signal Transmission Through LTI Systems:** Definitions of a system, Classification of Systems, Transfer function of a LTI system, Impulse response and step response of LTI

systems, Distortion less transmission through a system, Ideal LPF, HPF, BPF and BSF characteristics, Signal bandwidth, System bandwidth.

**Practice:**

Obtain Impulse and step response of given LTI system.

**Additional Practice:**

1. Finding the even and odd parts, real and imaginary parts of signal.
2. Analyze the effect of increasing the number of terms in the Fourier series on the Gibbs phenomenon.
3. Verification of linearity and time invariance properties of a given system.

**Capstone project:**

1. Spectral Decomposition and Analysis of Complex Signals.

**Text Books:**

1. Signals & Systems by Simon Haykin and Van Veen, Wiley, 2<sup>nd</sup> Edition, ISBN:978-8126512652.
2. Signals and Systems by A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI, 2<sup>nd</sup> Edition, Reprint, ISBN:978-7560509709.

**Reference Books:**

1. Signals, Systems & Communications - B.P. Lathi, BS Publications, ISBN:978-8178000169.
2. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, Reprint, ISBN: 978-0070702219.
3. Signals and Systems – A. Anand Kumar, PHI, 3<sup>rd</sup> Edition, 2022, ISBN: 978-8120348400.
4. Signals & Systems by Tarun Kumar Rawat, Oxford Publication, 1<sup>st</sup> Edition, ISBN:978-0198066798.
5. Signals & Stochastic Processes by Y Mallikarjuna Reddy and Giri Babu Kande, The Orient Blackswan Publication, 1<sup>st</sup> Edition, ISBN:978-9386235312.

**Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_ee28/preview](https://onlinecourses.nptel.ac.in/noc21_ee28/preview)
2. <http://acl.digimat.in/nptel/courses/video/108106163/L16.html>
3. <https://ocw.mit.edu/courses/res-6-007-signals-and-systems-spring-2011/pages/lecture-notes/>

## Electromagnetic Waves & Transmission Lines

**Course Code:2501EC05**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course student will be able to:**

- CO1:** Interpret the properties of electric fields and magnetic fields.
- CO2:** Infer the Maxwell's equations for electric fields and magnetic fields.
- CO3:** Analyze the characteristics of uniform plane waves.
- CO4:** Interpret the fundamentals of transmission lines.
- CO5:** Apply impedance matching techniques for the transmission lines.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO4   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| CO5   | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 1    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

## UNIT – I

**Electrostatics:** Review of Co-ordinate Systems and Vector Calculus, Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss Law and Applications, Electric Potential, Maxwell's Two Equations for Electrostatic Fields, Convection and Conduction Currents, Dielectric Constant, Continuity Equation, Capacitance, Energy Density in Electrostatic Fields.

## UNIT – II

**Magnetostatics:** Biot-Savart Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Two Equations for Magneto static Fields, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Inductance, Magnetic Energy.

**Maxwell's Equations(Time Varying Fields):** Faraday's Law and Transformer emf, Inconsistency of Ampere's Law and Displacement Current Density, Maxwell's Equations in Differential, Integral, Final Forms and Word Statements.

### UNIT – III

**EM Wave Characteristics-I:** Uniform Plane Waves – Definition, Wave equations for Conducting and Perfect Dielectric media, Wave propagation in Lossy dielectrics, Lossless dielectrics and Free space, Wave propagation in good conductors, Skin depth, Polarization & Types.

**EM Wave Characteristics-II:** Reflection and Refraction of Plane Waves – Normal and Oblique Incidences for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total internal reflection, Surface Impedance, Poynting Vector and Poynting Theorem.

### UNIT – IV

**Transmission lines-I:** Transmission Line Equations, Primary & Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line, Lossless lines, Distortion less lines.

### UNIT – V

**Transmission lines-II:** SC and OC Lines, Reflection Coefficient, VSWR, Impedance Transformations of  $\lambda/4$ ,  $\lambda/2$ ,  $\lambda/8$  Lines, Smith Chart-Construction and Applications, Quarter wave transformer, Stub Matching-single & double.

#### Text Books:

1. Principles of Electromagnetics, Matthew N.O. Sadiku, and S.V. Kulkarni, Oxford University Press, 6<sup>th</sup> Edition, ISBN: 978-0199461851.
2. Electromagnetic Waves and Radiating Systems, E.C. Jordan and K.G. Balmain, PHI, 2<sup>nd</sup> Edition, ISBN: 978-9332551770.

#### Reference Books:

1. Engineering Electromagnetics, William H. Hayt, John A. Buck, Jaleel M. Akhtar, TMH, 9<sup>th</sup> Edition, 2020, ISBN: 978-9353169725.
2. Transmission Lines and Networks, Umesh Sinha and Satya Prakashan, Technical India Publications, 2<sup>nd</sup> Edition, ISBN: 8176841889.
3. Electromagnetic Waves and Transmission Lines, Y Mallikarjuna Reddy, Universities Press, 1<sup>st</sup> Edition, ISBN: 978-8173719776 .

**Web Links:**

1. <https://nptel.ac.in/courses/108106157>
2. <https://www.damtp.cam.ac.uk/user/tong/em.html>
3. <https://nptel.ac.in/courses/117103065>

## Analog Electronics

**Course Code:2501EC06**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Build the high frequency transistor amplifier circuits.
- CO2:** Analyze the frequency response of multi stage circuits.
- CO3:** Summarize the performance metrics of feedback amplifiers.
- CO4:** Construct low and high frequency oscillators for given specifications.
- CO5:** Analyze the performance of power and tuned amplifiers.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | 1    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO4   | 3    | 2    | 1    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 1    | -    |
| CO2    | 1    | -    |
| CO3    | 1    | -    |
| CO4    | 1    | -    |
| CO5    | 1    | -    |

### UNIT – I

**Small Signal Analysis of Transistor Amplifiers at High Frequency:** Two-Port network Approach, The transistor pi Model, Hybrid-  $\pi$  common emitter transistor model, Hybrid  $\pi$  conductance, Hybrid  $\pi$ -capacitances, validity of hybrid  $\pi$  model, CE short circuit current gain, current gain with resistive load, cut-off frequencies.

FET: Analysis of common Source and common drain Amplifier circuits at high frequencies.

#### Practice :

1. Introduction to OrCAD Software.

### UNIT – II

**Multistage Amplifiers:** Classification of amplifiers, methods of coupling, analysis of CE amplifier, two stage RC coupled amplifier, cascode amplifier, High input resistance circuits: Darlington pair amplifier, Boot-strap emitter follower.

**Practice:**

1. Simulate a two stage RC coupled amplifier to obtain frequency response, voltage Gain and Bandwidth. (OrCAD Software).
2. Construct a two stage RC coupled amplifier to obtain frequency response, voltage gain and bandwidth.

**UNIT – III**

**Feedback Amplifiers:** Feedback concept, types of feedback, classification of amplifiers, feedback topologies, Characteristics of negative feedback amplifiers, Generalized analysis of feedback amplifiers, Performance comparison of feedback amplifiers, Method of analysis of voltage and current series feedback amplifiers.

**Practice:**

1. Simulate voltage series feedback amplifier to obtain frequency response, voltage gain and bandwidth (OrCAD Software).
2. Construct voltage series feedback amplifier to obtain frequency response, voltage gain and bandwidth.

**UNIT – IV**

**Oscillators:** Oscillator principle, condition for oscillations, types of oscillators, RC-phase shift and Wein bridge oscillators with BJT and FET and their analysis, Generalized analysis of LC Oscillators, Hartley and Colpitt's oscillators with BJT and FET and their analysis, Frequency and amplitude stability of oscillators.

**Practice:**

1. Simulate a RC phase shift oscillator using BJT to generate a sinusoidal signal. (OrCAD Software)
2. Construct a RC phase shift oscillator using BJT to generate a sinusoidal signal.

**UNIT – V**

**Power Amplifiers:** Classification of amplifiers, Class A power Amplifiers and their analysis, Harmonic Distortions, Class B Push-pull amplifiers and their analysis, Complementary symmetry push pull amplifier, Class AB power amplifier, Class-C power amplifier, Class-D power amplifier, Class-E power amplifier, Class-F power amplifier, Class-G power amplifier, Class-H power amplifier.

**Tuned Amplifiers:** Introduction, Q-Factor, single tuned amplifier, double tuned amplifiers, staggered tuned amplifiers.

**Practice:**

1. Simulate a class-A power amplifier to obtain power efficiency. (OrCAD Software)
2. Construct a class-A power amplifier to obtain Q-point and power efficiency.
3. Simulate a single tuned amplifier to obtain frequency response, voltage gain and bandwidth. (OrCAD Software)
4. Construct a single tuned amplifier to obtain frequency response, voltage gain and bandwidth.

**Additional Practice:**

1. Construct three stage RC coupled amplifier and compare with two stage RC coupled amplifiers.
2. Construct Darlington pair amplifier to obtain frequency response, voltage gain and bandwidth.
3. Construct a Colpitt's oscillator using BJT to generate a sinusoidal signal.

**Capstone project:**

1. Design and test Audio Amplifier.

**Text Books:**

1. Electronic Devices and Circuits , Jacob Millman & Christos. C. Halkias, Satyabrata Jit, Tata McGraw Hill, 4<sup>th</sup> Edition, ISBN: 9789352601080.
2. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, Pearson Publications, 10<sup>th</sup> Edition, 2020, ISBN: 9788131727003\_U.

**Reference Books:**

1. Electronic Devices & Circuits, David A. Bell, Prentice Hall of India/Pearson Education, 5<sup>th</sup> Edition, 2018, ISBN: 019569340X.
2. Electronic Devices and Circuits, Anil Kumar Maini, Varsha Agrawal, John Wiley & Sons, ISBN: 9788126578085.
3. Electronic Circuit Analysis and Design, Donald A. Neaman, McGrawHill, ISBN: 9780072409574.

**Web Links:**

1. [http://onlinecourses.nptel.ac.in/noc21\\_ee89](http://onlinecourses.nptel.ac.in/noc21_ee89)
2. <http://nptel.ac.in/courses/108/102/108102095>
3. <http://www.iitg.ac.in/apvajpeyi/ph218.html>.
4. <http://nptel.ac.in/courses/108/102/108102095>.



## Integrated Circuits & Applications

**Course Code:2501EC07**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Construct Op-Amps using the differential amplifier and related circuitry.
- CO2:** Illustrate the parameters related to measurement of Op-Amp characteristics.
- CO3:** Construct the circuits for linear and non-linear applications using Op-Amp.
- CO4:** Build the data conversion circuits and construct the circuits for filtering applications using Op-Amp.
- CO5:** Analyse 555 Timer circuits and Phase Locked Loops.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT – I

**Introduction to Integrated Circuits:** Integrated Circuits: Basic Concepts, Package Types, Temperature ranges and it's Power supplies. Differential Amplifier- DC and AC analysis of differential amplifier configurations, Cascaded Differential Amplifier Stages and Level translator.

### UNIT – II

**Characteristics of Op-Amps:** Block Diagram, Pin diagram and Equivalent Circuit of an Op-Amp, Ideal and practical characteristics of an Op-Amp, DC and AC characteristics, Op-Amp Configurations: Inverting, Non-inverting and Difference amplifiers.

**Practice:**

1. Construct basic Applications of Op-Amp – Adder, and Subtractor Circuits.

**UNIT – III**

**Linear and Non-Linear Applications of Op- Amps:** Linear Applications - Integrator and Differentiator, Instrumentation amplifier, AC amplifier, Non-Linear Applications- Comparators, Schmitt trigger, Waveform Generators: Sine wave generator - RC phase shift oscillator, Free-running Oscillator, One-shot Multivibrators, Triangular wave and Sawtooth wave generators, Logarithmic Amplifiers, Precision rectifiers.

**Practice:**

1. Design Integrator and Differentiator Circuits using Op-Amp 741.
2. Construct Waveform Generator using single Op-Amp with variable duty cycle.
3. Design Schmitt Trigger Circuits using Single OP-Amp with Reference voltage.
4. Design a Function Generator using Op-Amp 741.

**UNIT – IV**

**D-A and A-D Converters: Introduction, Basic DAC techniques:** Weighted Resistor DAC, R-2R and Inverted R-2R ladder DAC, Basic ADC techniques: Parallel Comparator type, Successive Approximation type and Dual Slope ADC. Active Filters: Introduction, Butter worth filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and All pass filter.

**Practice:**

1. Design an Active Filters 1 – LPF, HPF (First order) using Op-Amp 741.
2. Design an Active Filters 2 – BPF and Band Reject (First order) filters using Op-Amp 741.

**UNIT – V**

**Timers & Phase Locked Loops:** Introduction to IC 555 timer, Functional diagram, Monostable and Astable operations and applications, PLL - Introduction, Block schematic, Principles and Description of individual blocks, IC 565 PLL and its Applications, IC 566 VCO Internal Diagram and Applications.

**Practice:**

1. Construct Astable multivibrator using IC 555 Timer.
2. Construct Mono stable multivibrator using IC 555 Timer.
3. Evaluate Capture range and Lock range using PLL IC565

**Additional Practice:**

1. Design a 4-bit R-2R Ladder network with Op-Amp Buffer and Measure the output waveform for various input combinations.
2. Design and Construct DC Power Supply using three terminal Voltage Regulators 78XX and 79XX
3. Construct Precision half-wave rectifier and full-wave rectifier using Op-Amp 741.

**Capstone project:**

1. Design and build a digital timer and frequency divider

**Text Books:**

1. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, Pearson Education, 4<sup>th</sup> Edition, ISBN: 978-9332549913.
2. Linear Integrated Circuits, D. Roy Chowdhury and Shail B. Jain, New Age International Ltd, 4<sup>th</sup> Edition, 2021, ISBN: 9788122472127.

**Reference Books:**

1. Design with Operational Amplifiers & Analog Integrated Circuits, Sergio Franco, McGraw Hill, 4<sup>th</sup> Edition, ISBN: 978-9352601943.
2. Op-Amps and Linear Integrated Circuits: Concepts and Applications, James M Fiore, Cengage Learning India Ltd, 1<sup>st</sup> Edition, ISBN: 978-8131512340.

**Web Links:**

1. <http://nptel.ac.in/courses/117108038>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-/op-amps>
3. <http://www.creativeworld9.com/2011/02/learn-linear-ic-applications>

## Linear Control Systems

**Course Code:2501EC08**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Develop the overall transfer function using block diagram algebra and signal flow graphs.
- CO2:** Identify time response specifications, error constants of second order systems.
- CO3:** Analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- CO4:** Analyze the stability of LTI systems using frequency response methods.
- CO5:** Develop state models for physical systems.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 3    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

**Mathematical Modeling of Control Systems:** Classification of control systems, Open Loop and closed loop control systems and their differences, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula. Transfer Function of DC Servo motor.

## UNIT – II

**Time Response Analysis:** Standard test signals, Time response of first and second order systems, Time domain specifications, Steady state errors and error constants, Effects of proportional derivative, proportional integral systems.

### UNIT – III

**Stability and Root locus Technique:** The concept of stability, Routh's stability criterion, limitations of Routh's stability, Root locus concept, construction of root loci.

### UNIT – IV

**Frequency Response Analysis:** Introduction to Frequency domain specifications-Bode diagrams- transferfunction from the Bode Diagram-Phase margin and Gain margin stability Analysis from Bode Plots, Polar Plots,Nyquist Stability criterion, Lag, Lead, Lag-Lead compensators.

### UNIT – V

**State Space Analysis of LTI Systems:** Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the time invariant state equations- State Transition Matrix and its Properties – Concepts of Controllability and Observability.

#### Text Books:

1. Control Systems Engineering, I.J.Nagarath and M.Gopal, Newage International Publications, 7<sup>th</sup> Edition, 2021, ISBN: 978-8195175581.
2. Automatic control systems, Benjamin C.Kuo, Prentice Hall of India, 7<sup>th</sup> Edition, ISBN: 978-8120309685.

#### Reference Books:

1. Control Systems principles and design, M.Gopal, Tata McGraw Hill education Pvt Ltd., 4<sup>th</sup> Edition, ISBN: 978-0071333269.
2. Control Systems, Manik Dhanesh N, Cengage publications, 4<sup>th</sup> Edition, ISBN: 978-8131518120.
3. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India, 5<sup>th</sup> Edition, ISBN: 978-9332550162.

#### Web Links:

1. <https://www.electrical4u.com/state-space-analysis-of-control-system>
2. <https://nptel.ac.in/courses/107/106/107106081>

## Analog & Digital Communications

**Course Code:2501EC09**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>1</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Interpret the modulation and demodulation techniques of AM.
- CO2:** Explain the concepts of Angle modulation and demodulation.
- CO3:** Interpret the transmitter and receiver sections.
- CO4:** Infer Pulse analog modulation and demodulation Techniques.
- CO5:** Inspect the characteristics of Pulse Digital Modulation Techniques.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO4   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | 2    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT – I

**Amplitude Modulation:** Need for modulation, Amplitude Modulation - Time and frequency domain description, single tone modulation, power relations in AM waves, Switching modulator, Envelope detector, DSBSC modulation - time and frequency domain description, Balanced Modulator, Coherent detection, COSTAS Loop, SSB modulation - time and frequency domain description, frequency discrimination method, Demodulation of SSB Waves, VSB modulation and Demodulation.

#### Practice:

1. Generate amplitude modulated signal, determine the percentage modulation and demodulate the modulated signal using envelope detector.
2. Generate AM-DSBSC modulated signal and demodulate the modulated signal.

## UNIT – II

**Angle Modulation:** Basic concepts of Phase Modulation, Frequency Modulation: Single tone Frequency modulation, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave - Generation of FM Signal- Armstrong Method, Direct method- Reactance Modulator, Detection of FM Signal: Balanced slope detector, Phase locked loop, Comparison of FM and AM., Concept of Pre-emphasis and de-emphasis.

**Practice:**

1. Generate frequency modulated signal, determine the modulation index and bandwidth, also demodulate the frequency modulated signal.
2. Plot the frequency response of pre-emphasis and de-emphasis circuits.

## UNIT – III

**Transmitters and Receivers:** Classification of Transmitters, AM Transmitters, FM Transmitters Receivers: Radio Receiver - Receiver Types - Tuned radio frequency receiver, Superheterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, Image frequency, AGC, Amplitude limiting, FM Receiver, Comparison of AM and FM Receivers.

**Practice:**

1. Verify the characteristics of mixer.
2. Experimentally study the characteristics of a given AGC circuit.

## UNIT – IV

**Pulse Modulation:** Types of Pulse modulation- Generation and Reconstruction of PAM, PWM and PPM.

**Pulse Code Modulation:** PCM Generation and Reconstruction, Non- Uniform Quantization and Companding, DPCM, DM and Adaptive DM, Noise in PCM and DM.

**Practice:**

1. Analyze the process of pulse amplitude modulation and demodulation.
2. Analyze the process of pulse position modulation and demodulation.

## UNIT – V

**Digital Modulation Techniques:** ASK, FSK, BPSK and QPSK Modulators and Detectors, Differential PSK, QAM, Baseband Signal Receiver, Optimum Receiver, Calculation of Probability of Error.

**Practice:**

1. Observe the process of Frequency Shift Keying Modulation and Demodulation.
2. Verify the process of Phase Shift Keying Modulation and Demodulation.

**Additional Practice:**

1. Verify the characteristics of receiver.
2. Verify the process of Differential Pulse Code Modulation and Demodulation.

**Case Study:**

1. Performance Comparison of Modulation Techniques

Students can implement and compare both analog and digital modulation techniques.

**Text Books:**

1. Modern digital and analog communication systems by B.P.Lathi, Zhi Ding, Oxford, 4<sup>th</sup> Edition, ISBN:978-0199476282.
2. Introduction to Analog and Digital Communications by Simon Haykin, Wiley, 2<sup>nd</sup> Edition, ISBN:978-0-471-43222-7.
3. Analog and Digital Communication – K. Sam Shanmugam, Wiley, 2018, ISBN:9788126509140.

**Reference Books:**

1. Principles of Communication Systems - Herbert Taub, Donald L Schilling, Goutam Saha, McGraw-Hill, 4<sup>th</sup> Edition, ISBN:978-1259029851.
2. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, Pearson, 5<sup>th</sup> Edition, 30 August 2019, ISBN:978-0130494924.

**Web Links:**

1. <https://archive.nptel.ac.in/courses/117/105/117105143/>
2. [https://onlinecourses.nptel.ac.in/noc21\\_ee74](https://onlinecourses.nptel.ac.in/noc21_ee74)
3. <https://archive.nptel.ac.in/courses/108/102/108102096>
4. <https://archive.nptel.ac.in/courses/117/101/11710105>



## Digital Signal Processing

**Course Code: 2501EC10**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize discrete time signals and systems in time and frequency domain.
- CO2:** Compute the DFT using FFT algorithms.
- CO3:** Design IIR filters using different techniques.
- CO4:** Design FIR filters using different techniques.
- CO5:** Extend the concept of single-rate signal processing to multi-rate signal processing.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      | 1    | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO2</b> | 3    | 2    |      | 1    | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO3</b> | 3    | 2    | 3    | 1    | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO4</b> | 3    | 2    | 3    | 1    | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO5</b> | 3    | 2    |      | 1    | 2    |      |      | 2    | 2    |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    |      |
| <b>CO2</b> | 2    |      |
| <b>CO3</b> | 2    |      |
| <b>CO4</b> | 2    |      |
| <b>CO5</b> | 2    |      |

## UNIT – I

**Introduction:** Introduction to Digital Signal Processing: Discrete-time signals & sequences, Classification of discrete-time systems, stability and causality of LTI systems. Discrete-time Fourier Transform (DTFT), Frequency domain representation of discrete-time signals and systems. Linear Convolution, System function.

### Practice:

1. Generation of basic signals (impulse, step, ramp, exponential, sine square, triangle).
2. Perform addition of two or more sinusoidal signals with different frequencies.

## UNIT – II

**Discrete Fourier Series & Fourier Transforms:** Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT, Fast Fourier transforms (FFT)-Radix-2 decimation-in-time and decimation-in-frequency FFT Algorithms, Inverse FFT, Linear Convolution using Circular Convolution.

**Practice:**

1. Calculate the Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT) of a given discrete signal.
2. Perform circular and linear convolution using DFT.

## UNIT – III

**Design of IIR Digital Filters & Realizations:** Analog filter approximations- Butterworth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Direct form -I, Direct form -II, Cascade form and Parallel form realization of IIR systems.

**Practice:**

1. Obtain frequency response of IIR Low Pass Butterworth filters.
2. Obtain frequency response of IIR Low Pass Chebyshev filters.

## UNIT – IV

**Design of FIR Digital Filters & Realizations:** Characteristics of FIR Digital Filters, Frequency response, Design of FIR Digital Filters using Window technique, Comparison of IIR & FIR filters, Direct form, Cascade form and Parallel form realization of FIR systems.

**Practice:**

1. Obtain frequency response of FIR Low Pass filter using Rectangular Window.
2. Obtain frequency response of FIR Low Pass filter using Hamming Window.

## UNIT – V

**Multirate Digital Signal Processing:** Introduction, Decimation, Interpolation Sampling rate conversion, Implementation of Sampling rate converters, Applications: Sub-band Coding of Speech Signals, Implementation of Digital Filter Banks, Trans-multiplexers.

**Practice:**

1. Perform decimation and interpolation on signals.
2. Perform Sampling rate conversion on signals.

## **Cornerstone Projects:**

### **1. Noise Cancellation System for Real-Time Audio Signals**

- Concept: Adaptive filtering (LMS / NLMS)
- Working:
  - Capture noisy voice
  - Remove background noise in real time
- Output: Clean audio through speaker
- Applications: Call centres, hearing aids

### **2. Real-Time FFT Spectrum Analyzer**

- Concept: FFT
- Working:
  - Capture signal
  - Display frequency spectrum live (GUI/LCD)
- Output: Peaks showing dominant frequencies
- Applications: Communication, audio analysis

### **3. Real-Time ECG Signal Monitoring & Filtering**

- Concept: FIR/IIR filtering
- Working:
  - Capture ECG signals
  - Remove noise (baseline wander, powerline)
- Output: Clean ECG waveform on display
- Applications: Healthcare monitoring

### **4. Smart Audio Equalizer System**

- Concept: Digital filters (FIR/IIR)
- Working:
  - Adjust bass, treble in real time
- Output: Modified audio output
- Applications: Music systems

### **5. Vehicle Engine Fault Detection using Vibration Signals**

- Concept: FFT + Frequency analysis
- Working:
  - Capture vibration signals
  - Detect abnormal frequencies
- Output: Fault alert
- Applications: Automotive diagnostics

## **6. Real-Time Digital Communication Receiver**

- Concept: Modulation/Demodulation (ASK/FSK/PSK)
- Working:
  - Receive signal
  - Demodulate in real time
- Output: Recovered message
- Applications: Wireless communication

## **7. Real Time Number Plate Detection System**

- Concept: DSP in images
- Working:
  - Capture live image/video
  - Apply filtering (edge detection, smoothing)
- Output: Processed image/video
- Applications: Surveillance, vision systems

## **8. Real-Time Sampling Rate Converter (Audio)**

- Concept: Multirate DSP
- Working:
  - Change sampling rate of live audio
- Output: Resampled audio
- Applications: Audio streaming

## **9. Real-Time Convolution/Reverb Audio Processor**

- Concept: Convolution (FFT-based)
- Working:
  - Apply echo/reverb effects
- Output: Enhanced audio
- Applications: Music production

## **10. Noise Removal System for EEG Signal**

- Concept: Adaptive filtering
- Working:
  - Capture brain signals
  - Remove noise/artifacts
- Output: Clean EEG signals
- Applications: Neurotech, BCI

## **11. Real-Time Spectrum Sensing for Cognitive Radio**

- Concept: FFT + Energy detection
- Working:

- Detect free frequency bands
- Output: Spectrum usage graph
- Applications: 5G, wireless systems

## 12. Speech Recognition Preprocessing System

- Concept: DSP + Feature extraction (MFCC)
- Working:
  - Extract features from speech
- Output: Feature vectors
- Applications: AI assistants

**Note:** All the projects should be implemented using hardware like Raspberry Pi, DSP Boards, Arduino etc

### Guidelines for Cornerstone Project:

- The Cornerstone Project is to be carried out batch-wise with a minimum of two students in each batch.
- Each batch may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The selected project must be implemented strictly using DSP techniques learned in the laboratory.
- The project must be fully completed and ready for demonstration on the day of the external examination.
- The Lab Test (LT) shall be evaluated for 25 marks based on video presentation, project demonstration, project report, and viva-voce as follows.

| Component             | Description                                                                                                                                                           | Marks     |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Video Presentation    | The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.                     | 5         |
| Project Demonstration | During the lab test, the batch shall demonstrate their working model in proper working condition and explain it using charts, posters, or other suitable visual aids. | 10        |
| Project Report        | Submission of project report in the prescribed format.                                                                                                                | 5         |
| Viva-Voce             | Oral examination based on the project work and DSP fundamentals.                                                                                                      | 5         |
| <b>Total Marks</b>    |                                                                                                                                                                       | <b>25</b> |

**Text Books:**

1. Digital Signal Processing, Principles, Algorithms and Applications, John G. Proakis, Dimitris G. Manolakis, Pearson Education/PHI, ISBN: 978-9332535893.
2. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, 1<sup>st</sup> Edition, ISBN: 978-0198081937.

**Reference Books:**

1. Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, PHI, ISBN: 978-0131988422.
2. Multirate Systems and Filter Banks, P.P.Vaidyanathan, Pearson, 1<sup>st</sup> Edition, ISBN: 978-0136057185.

**Web Links:**

1. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing by Prof. S.C. Dutta Roy, IIT Delhi)
2. [https://nptel.ac.in/courses/117/102/117102060/\(Digital Signal Processing - Video course, Coordinator BY Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi\).](https://nptel.ac.in/courses/117/102/117102060/(Digital%20Signal%20Processing%20-%20Video%20course,%20Coordinator%20BY%20Prof.%20S.C.%20Dutta%20Roy%20Department%20of%20Electrical%20Engineering%20IIT%20Delhi).)
3. <http://www.dspguide.com/pdfbook.htm>
4. <http://vlabs.iitkgp.ernet.in/dsp/>

## VLSI Design

**Course Code: 2501EC11**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the Course, Students will be able to:**

- CO1:** Outline the fundamental concepts related to MOS and Bi-CMOS Circuits fabrication.
- CO2:** Analyze the electrical properties of MOS and Bi-CMOS Circuits.
- CO3:** Make use of design rules for developing stick and layout diagrams.
- CO4:** Infer the physical circuit parameters in terms of scaling.
- CO5:** Interpret the issues related to subsystem design.

### Mapping of Course Outcomes with Program Outcomes:

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

### Mapping of Course Outcomes with Program-Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

## UNIT – I

**Introduction:** Introduction to IC Technology, MOS and related VLSI Technology, Basic MOS Transistors, Enhancement and Depletion modes of transistor action, IC production process, MOS and CMOS Fabrication processes, BiCMOS Technology, Comparison between CMOS and Bipolar technologies.

### Practice:

1. Digital circuit Simulation overview.
2. Digital circuits simulation and functional response verification of basic gates.
3. V-I Characteristics of nMOSFET & pMOSFET.

## UNIT – II

**Basic Electrical Properties Of MOS and Bi-CMOS Circuits:**  $I_{ds}$  versus  $V_{ds}$  Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance, and Figure of Merit. The Pass transistor, NMOS Inverter, Pull-up to Pull-down Ratio for NMOS inverter driven by another NMOS inverter. Alternative forms of pull-up include the CMOS Inverter, MOS transistor circuit model, Bi-CMOS Inverter, Latch-up in CMOS circuits. Realization of gates using NMOS, PMOS, and CMOS technologies.

**Practice:**

1. Digital circuits simulation and functional response verification of combinational circuits.
2. Realization of schematics and functional response verification of complex gates.

## UNIT – III

**MOS and Bi-CMOS Circuit Design Processes:** MOS Layers, Stick Diagrams, Design Rules and Layout, General Observations on the Design rules,  $2\mu\text{m}$  Double Metal, Double Poly, CMOS/BiCMOS rules,  $1.2\mu\text{m}$  Double Metal, Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter, Symbolic Diagrams-Translation to Mask Form

**Practice:**

1. Layout extraction of basic gates.
2. Layout Extraction of combinational circuits.

## UNIT – IV

**Basic Circuit Concepts:** Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, The Delay Unit, Inverter Delays, Propagation Delays, Wiring Capacitances, Fan-in and fan-out characteristics, Choice of layers, Transistor switches,

**Practice:**

1. Performing DRC for basic gates and combinational circuits.
2. Performing LVS/Netlist extraction for logic gates.

## UNIT – V

**Scaling of MOS Circuits:** Scaling models, Scaling factors for device parameters, Limits due to sub-threshold currents, current density limits on logic levels, and supply voltage due to noise. Subsystem Design: Architectural issues, switch logic, Gate logic, examples of structured design, clocked sequential circuits, system considerations, general considerations of subsystem design processes, and an illustration of design processes.

**Practice:**

1. Performing LVS/Netlist extraction for complex gates and combinational circuits.
2. PEX estimation for the given logic circuits.



**Additional Practice:**

1. Layout design for specific constraints (delay, power dissipation).
2. DRC/LVS/PEX verification of the Multiplexer.
3. DRC/LVS/PEX verification of given SOP ( $Z = (AB + C)D$ )'.

**Software Tools Used:**

1. Cadence Virtuoso - Schematic & Layout Design.
2. Cadence Spectre - Circuit Simulation.
3. Cadence ViVA - Waveform Analysis.
4. Cadence Assura (or Pegasus) - DRC, LVS, PEX.

**Practice:**

1. Introduction to Cadence Environment (1 Week).
  - a. Introduction to VLSI design flow.
  - b. Overview of Cadence Virtuoso interface.
  - c. Library creation, schematic entry.
  - d. Basic Linux commands for Cadence.
2. MOS Device Simulation (1 Week).
  - a. Simulation of nMOS and pMOS characteristics using Cadence Spectre.
  - b.  $I_{ds}$ - $V_{ds}$  and  $I_{ds}$ - $V_{gs}$  plots.
  - c. Waveform visualization using Cadence ViVA.
3. CMOS Circuit Design (2 Weeks).
  - a. CMOS inverter design using Cadence Virtuoso.
  - b. Design of NAND, NOR gates.
  - c. Transient and DC analysis using Spectre.
4. Combinational Circuit Design (2 Weeks).
  - a. Design of complex CMOS gates.
  - b. Multiplexer and SOP realization.
  - c. Functional verification using Spectre + ViVA.
5. Layout Design (2 Weeks).
  - a. Stick diagram to layout conversion.
  - b. Layout design using Cadence Virtuoso.
  - c. Layout of inverter, NAND, and NOR gates.
6. Physical Verification (2 Weeks).
  - a. DRC (Design Rule Check) using Cadence Assura.
  - b. LVS (Layout vs Schematic) verification.
  - c. PEX (Parasitic Extraction).
7. Performance Analysis (1 Week).
  - a. Delay and propagation analysis.
  - b. Power estimation using Spectre.
  - c. Fan-in and fan-out effects.

**Mini Tasks:**

1. CMOS inverter sizing (pull-up/pull-down ratio).
2. Stick diagram to layout conversion.
3. Delay calculation using simulation.
4. Parasitic capacitance impact analysis.

**Cornerstone Projects:****1. CMOS Half Adder Design**

**Description:** Design and implement a CMOS half adder using basic logic gates in the Cadence environment. Perform schematic design, simulate the circuit, generate layout, and verify using DRC, LVS, and PEX. Compare its performance with a full adder.

**Expected Outcome:** A fully functional CMOS half adder with verified layout and correct output waveforms, along with analysis of delay and power consumption.

**2. CMOS Full Adder Design (Multiple Styles)**

**Description:** Design and implement a CMOS full adder using different logic styles such as conventional CMOS and transmission gate logic. Perform schematic design, simulation, layout generation, and verification using DRC, LVS, and PEX. Compare the designs based on power, delay, and area.

**Expected Outcome:** A verified CMOS full adder layout with comparative analysis showing trade-offs between different design styles in terms of performance metrics.

**3. 4-bit Ripple Carry Adder**

**Description:** Design and implement a 4-bit ripple carry adder by cascading full adders. Perform schematic design, simulate the circuit, generate layout, and analyze propagation delay due to the carry chain.

**Expected Outcome:** A working 4-bit adder with verified layout and demonstrated understanding of delay propagation in cascaded arithmetic circuits.

**4. Multiplexer Design (2:1, 4:1, 8:1)**

**Description:** Design and implement multiplexers of different sizes using CMOS logic. Perform schematic design, simulation, layout generation, and verification. Analyze fan-in and fan-out effects on performance.

**Expected Outcome:** A functional multiplexer design with verified layout and analysis of scalability, delay, and switching behavior.

#### 5. **SR Latch and D Flip-Flop Design**

**Description:** Design and implement SR latch and D flip-flop circuits using CMOS logic. Perform schematic design, simulate sequential behavior, generate layout, and verify using DRC and LVS.

**Expected Outcome:** A correctly functioning sequential circuit with verified layout and timing behavior observed through simulation.

#### 6. **Ring Oscillator Design**

**Description:** Design a ring oscillator using an odd number of CMOS inverters. Perform schematic design, simulate oscillations, generate layout, and analyze oscillation frequency and delay.

**Expected Outcome:** A working ring oscillator with measurable frequency and a validated relationship between delay and oscillation frequency.

#### 7. **CMOS Comparator Design**

**Description:** Design and implement a CMOS comparator circuit. Perform schematic design, simulate comparison operation, generate layout, and verify using DRC and LVS.

**Expected Outcome:** A functional comparator circuit capable of distinguishing input levels with proper switching characteristics.

#### 8. **Clock Buffer / Driver Design**

**Description:** Design a CMOS buffer/driver circuit capable of driving large capacitive loads. Perform schematic design, simulate performance, generate layout, and analyze fan-out effects.

**Expected Outcome:** A buffer circuit with improved driving capability and reduced delay, validated through simulation and layout verification.

#### 9. **Low Power CMOS Inverter Design**

**Description:** Design a CMOS inverter optimized for low power consumption by adjusting transistor sizing. Perform simulation, layout, and analysis of static and dynamic power.

**Expected Outcome:** A power-optimized inverter design with measurable reduction in power consumption and acceptable delay performance.

#### 10. Carry Look-Ahead Adder Design

**Description:** Design and implement a carry look-ahead adder to improve speed over ripple carry architecture. Perform schematic design, simulation, layout, and timing analysis.

**Expected Outcome:** A high-speed adder with reduced propagation delay compared to the ripple carry adder, validated through simulation.

#### 11. Power vs Delay Trade-off Study

**Description:** Design a CMOS circuit with different transistor sizing configurations. Perform simulations to study the trade-off between power consumption and delay.

**Expected Outcome:** A comparative analysis demonstrating the relationship between power and delay, supported by simulation results.

#### 12. Parasitic-Aware Design (PEX Based)

**Description:** Design a CMOS circuit and perform both pre-layout and post-layout simulations. Analyze the effect of parasitic elements extracted using PEX.

**Expected Outcome:** A clear comparison showing the impact of parasitics on circuit performance, including delay degradation.

#### 13. Area-Optimized Layout Design

**Description:** Design a compact layout for a given CMOS circuit using techniques like shared diffusion and optimal placement.

**Expected Outcome:** A minimized area layout with correct functionality and adherence to design rules.

#### 14. Design Rule Violation Study

**Description:** Create a layout with intentional design rule violations and correct them using the DRC tool.

**Expected Outcome:** A corrected layout demonstrating understanding of design rules and their importance in fabrication.

#### 15. LVS Debugging Project

**Description:** Design a circuit with mismatches between schematic and layout, then identify and fix errors using LVS.

**Expected Outcome:** A verified layout matching the schematic, demonstrating debugging capability.

#### 16. Custom Standard Cell Design

**Description:** Design basic standard cells like inverter, NAND, NOR with fixed height and optimized layout.

**Expected Outcome:** A set of standard cells suitable for digital design with a consistent layout structure.

#### 17. Mini Standard Cell Library Creation

**Description:** Create a small library of standard cells and characterize them for delay and power.

**Expected Outcome:** A basic standard cell library with documented performance metrics.

#### 18. Mini Chip Design Project

**Description:** Design a small functional block (e.g., ALU or controller) and implement a complete flow, including schematic, layout, and verification.

**Expected Outcome:** A fully verified mini VLSI design demonstrating complete design flow.

#### Guidelines for Cornerstone Project:

- The Cornerstone Project shall be carried out batch-wise with a minimum of three students in each batch.
- Each batch may select any one of the prescribed projects or a project of their own choice with prior permission of the Course Instructor.
- The selected project must be implemented strictly using VLSI design techniques, including schematic design, simulation, layout generation, and physical verification using EDA tools such as Cadence Virtuoso.
- The project must include DRC, LVS, and PEX verification, along with performance analysis such as delay and power estimation.
- The project must be fully completed and ready for demonstration during the external examination.
- The Semester End Examination (SEE) – Lab shall be evaluated for 25 marks based on video presentation, project demonstration, project report, and viva-voce as follows.

| Component             | Description                                                                                             | Marks     |
|-----------------------|---------------------------------------------------------------------------------------------------------|-----------|
| Video Presentation    | Working procedure explanation, along with the contribution of each student, for a minimum of 2 minutes. | 5         |
| Project Demonstration | During the external examination, the batch shall demonstrate its working model with an explanation.     | 10        |
| Project Report        | Submission of the project report in the prescribed format                                               | 5         |
| Viva-Voce             | Oral examination based on the project work                                                              | 5         |
| <b>Total Marks</b>    |                                                                                                         | <b>25</b> |

### Text Books:

1. Essentials of VLSI Circuits and Systems by Kamran Eshraghian, Douglas, and A. Pucknell, and Sholeh Eshraghian, Prentice-Hall of India Private Limited, ISBN:978-8120327726.
2. VLSI Design-Black Book By Dr. K.V.K.K. Prasad, Kattula Shyamala, Kogent Learning Solutions Inc, ISBN: 978-9350048047.

### Reference Books:

1. VLSI Design, A. Albert Raj & T. Latha, PHI Learning Private Limited, ISBN:978-8120334311.
2. VLSI Design, A. Shanthi and A. Kavita, New Age International Private Limited, First Edition, ISBN:978-8122418668.
3. VLSI Design By Debaprasad Das, Oxford University Press, ISBN: 978-0198067665.

### Web Links:

1. <https://www.southampton.ac.uk/~bim/notes/cad/>
2. [http://www.ece.utep.edu/courses/web5392/Lab\\_7.html](http://www.ece.utep.edu/courses/web5392/Lab_7.html)
3. <http://www.ece.utep.edu/courses/web5392/Notes.html>
4. <http://www.ittc.ku.edu/~jstiles/312/handouts/>
5. <https://www.mepits.com/tutorial/384/vlsi/steps-for-ic-manufacturing>
6. **NPTEL** - <https://www.youtube.com/@IITRoorkeeJuly/videos>
7. [https://www.youtube.com/@VLSIDesign\\_SSG/videos](https://www.youtube.com/@VLSIDesign_SSG/videos)
8. <https://www.youtube.com/@dr.hariprasadnaikbhattu/videos>
9. <https://www.youtube.com/@vlsiclassses/videos>
10. <https://www.youtube.com/@electronicechos/videos>

## Microprocessors & Microcontrollers

Course Code: 2501EC12

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Interpret the architecture of microcomputer systems.
- CO2:** Develop assembly language program for 8086.
- CO3:** Demonstrate the interfacing of peripherals to microprocessor.
- CO4:** Infer the architecture of 8051 microcontroller.
- CO5:** Demonstrate the interfacing of peripherals to 8051 microcontrollers.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|-----|------|------|------|-------|-------|
| CO1   | 3    | 1    | 2    | 1    | 1    | -   | -    | -    | -    | -     | 1     |
| CO2   | 3    | 2    | 2    | 1    | 2    | -   | -    | -    | -    | -     | 1     |
| CO3   | 3    | 2    | 2    | 1    | 2    | -   | -    | -    | -    | -     | 1     |
| CO4   | 3    | 1    | 2    | 1    | 2    | -   | -    | -    | -    | -     | 1     |
| CO5   | 3    | 1    | 2    | 1    | 2    | -   | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | 2    |
| CO2    | -    | 2    |
| CO3    | -    | 2    |
| CO4    | -    | 2    |
| CO5    | -    | 2    |

### Unit – I

**Introduction:** Overview of microcomputer systems and their building blocks, Basic Microprocessor architecture, 8086 Microprocessor, Main features, 8086 internal architecture, Register Organization of 8086. Memory Segmentation. Pin description of 8086, Physical Memory Organization, system timing, minimum mode and maximum mode configuration, interrupt structure and Interrupt Vector table.

#### Practice:

1. Introduction to MASM Software.

### Unit – II

**8086 Programming:** Instruction set, addressing modes, assembler directives, writing programs with an assembler, assembly language program development tools.

#### Practice:

1. Write an Assembly language program to perform Arithmetic operations on 8-bit data.
2. Write an Assembly language program to perform Multi byte addition and subtraction.
3. Write an Assembly language to sort the given numbers in an ascending order.
4. Write an Assembly language program to move block of data.

5. Write an Assembly language program to compare the given strings.

### Unit – III

**8086 Interfacing:** Memory Interfacing: Semiconductor memories interfacing (RAM, ROM).

**I/O Interfacing:** 8255 programmable peripheral interface- Interfacing of switches and LEDs, keyboard interfacing, Interfacing of stepper motor, Interfacing of A/D and D/A converters. 8237 DMA controller, 8259 programmable interrupt controller.

**Practice:**

1. Interface DAC to 8086 using 8255 to generate square wave and triangular wave.
2. Interface stepper motor to 8086 using 8255 to rotate clockwise and anti-clockwise directions.

### Unit – IV

**Intel 8051 Microcontroller:** Features, pin description, architecture, external memory connection, counters and timers, serial data input/output ports, interrupts, instruction set, addressing modes, programs.

**Practice:**

1. Introduction to KEIL Software.
2. Write an ALP to find Number of 1's and number of 0's in a given 8-bit.
3. Write an ALP to generate square wave using Timer control.

### Unit – V

**8051 Interfacing:** Interfacing of A/D and D/A converters, keyboard, displays (LED, 7-segment display unit and LCD) and Stepper motor.

**Practice:**

1. Interface 7-Segment Display to 8051 using proteus software.

### Text Books:

1. Microprocessors & Interfacing, Douglas V Hall, McGraw Hill, Revised 3rd Edition, ISBN: 978-1259006159.
2. The 8051 Micro Controller Architecture, Programming and Applications, Kenneth J Ayala, Thomson Publishers, 2nd Edition, ISBN: 978-0314201881.

### Reference Books:

1. Advanced Microprocessors and Interfacing, K.M. Bhurchandi, A.K. Ray, Tata McGraw Hill, 3rd Edition, ISBN: 978-1259006135.
2. The 8051 Microcontrollers and Embedded systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2nd Edition, ISBN: 978-8131758991.

### Web Links:

1. <https://archive.nptel.ac.in/courses/108/103/108103157/>
2. <https://archive.nptel.ac.in/courses/106/108/106108100/>



## Cornerstone Projects:

### 1. Temperature Monitoring System

**Description:** This project uses the LM35 temperature sensor to measure temperature. The sensor sends analog signals to the 8051 microcontrollers, which processes and displays the temperature on an LCD.

**Expected Outcome:** Real-time temperature measurement displayed on LCD, useful in industrial monitoring.

### 2. Water Level Monitoring & Control System

**Description:** Water level sensors detect the water level in a tank. The 8051 microcontroller processes the sensor data and indicates the water level through LEDs or an LCD.

**Expected Outcome:** Displays current water level, prevents overflow, and reduces water wastage.

### 3. Smart Irrigation System

**Description:** A soil moisture sensor detects soil dryness. The 8051 microcontroller switches ON the water pump when soil is dry and turns it OFF when sufficient moisture is reached.

**Expected Outcome:** Automatic watering of plants, saving water and improving irrigation efficiency.

### 4. Gas Leakage Detection System

**Description:** The MQ-2 gas sensor detects LPG or gas leakage. When leakage is detected, the 8051 microcontroller activates a buzzer alarm.

**Expected Outcome:** Quick detection of gas leakage with buzzer alert, improving home safety.

### 5. Automatic Room Light Controller

**Description:** Using IR sensors at the entrance, the system counts the number of people entering and leaving the room. Based on occupancy, the 8051 microcontroller turns the room lights ON or OFF.

**Expected Outcome:** Lights turn ON when someone enters and OFF when the room is empty, saving electricity.

### 6. Automatic Street Light Controller

**Description:** This project uses an LDR sensor to detect ambient light intensity. During daytime, the street lights remain OFF, and during nighttime, the lights automatically

turn ON. The 8051 microcontroller reads the sensor value and controls the street light through a relay.

**Expected Outcome:** Street lights automatically turn ON in darkness, turn OFF in daylight, and save electrical energy.

#### **7. Digital Visitor Counter**

**Description:** This system counts the number of visitors entering a room using IR sensors placed at the entrance. The 8051 microcontroller increments the count and displays it on an LCD.

**Expected Outcome:** Accurate counting of visitors with real-time display on LCD, useful for halls, malls, and offices.

#### **8. Traffic Light Controller**

**Description:** The 8051 microcontroller controls red, yellow, and green LEDs in sequence using programmed timing delays to simulate traffic signals.

**Expected Outcome:** Sequential traffic light operation demonstrating timer-based control.

#### **9. Automatic Car Parking System**

**Description:** To automate the process of monitoring and managing vehicle parking spaces. It uses IR sensors placed at the entry and exit points of the parking area to detect vehicles. These sensor signals are sent to the 8051 Microcontroller, which keeps track of the number of cars entering and leaving the parking lot.

**Expected Outcome:** Automatically detects vehicles entering and exiting the parking area.

#### **10. Password-Based Door Lock System**

**Description:** A keypad is used to enter a password. The 8051 microcontroller verifies the password and activates a relay or motor to unlock the door.

**Expected Outcome:** Door opens only for valid password, enhancing security and preventing unauthorized access.

#### **11. Digital Clock**

**Description:** Displays current time using timers and LCD.

**Expected Outcome:** Real-time clock display.

#### **12. Ultrasonic Distance Measurement**

**Description:** The Ultrasonic Distance Measurement System measures the distance between an object and the sensor using an ultrasonic sensor such as the HC-SR04

Ultrasonic Sensor. The sensor transmits ultrasonic waves and receives the reflected echo from the object.

**Expected Outcome:**

Measures the distance between the sensor and an object accurately. Displays the measured distance on the LCD screen.

**Guidelines for Cornerstone Project:**

- The Cornerstone Project is to be carried out in batches with a minimum of three students in each batch.
- Each batch may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The selected project must be implemented strictly using 8051-based programs learned in the course.
- The project must be fully completed and ready for demonstration on the day of the internal examination.
- The Internal Lab shall be evaluated for 25 marks based on project demonstration and project report as follows.

| Component             | Description                                                                                                                                                                       | Marks     |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Project Demonstration | During the internal examination, the batch shall demonstrate their working model in proper working condition and explain it using charts, posters, or other suitable visual aids. | 15        |
| Project Report        | Submission of project report in the prescribed format.                                                                                                                            | 10        |
| <b>Total Marks</b>    |                                                                                                                                                                                   | <b>25</b> |

## Antenna & Microwave Engineering

**Course Code:2501EC13**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Make comment on various antenna performance parameters.
- CO2:** Infer the fields and patterns of different antennas.
- CO3:** Explain the behavior of different RF and Microwave antenna structures.
- CO4:** Explain the characteristics of wave guide structures and its performance.
- CO5:** Apply different measurement techniques at Microwave range on Active and Passive devices to determine their properties.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | 1    | -    | -    | -    | -    | 1    | 1    | -     | -     |
| CO2   | 3    | 2    | 1    | -    | -    | -    | -    | 2    | 2    | -     | -     |
| CO3   | 2    | 2    | -    | -    | -    | -    | -    | 2    | 2    | -     | -     |
| CO4   | 3    | 2    | -    | 1    | -    | -    | -    | 1    | 1    | -     | -     |
| CO5   | 3    | 2    | 1    | -    | -    | -    | -    | 1    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 3    | -    |
| CO2    | 2    | -    |
| CO3    | 3    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT – I

**Antenna Fundamentals:** Introduction, Radiation Mechanism, Single wire and Two wire antenna, Half wave dipole, Basic Antenna Parameters, Radiation Pattern, Beam width, Radiation Intensity, Directivity and Gain, Antenna aperture, Beam efficiency, Effective antenna height, Antenna bandwidth, Input impedance, Antenna temperature and Friis transmission equation.

#### Practice:

1. Measurement of radiation pattern of an antenna.

### UNIT – II

**Antenna Arrays:** Introduction-2-element arrays – different cases, Principle of Pattern Multiplication, N-element Uniform Linear Arrays – Broadside, End-fire Arrays, EFA with Increased Directivity (no derivations).

### UNIT – III

**VHF, UHF and Microwave Antennas:** Folded Dipoles and their characteristics, Arrays with Parasitic Elements, Yagi - Uda Arrays. Helical Antennas – Significance, Geometry, Design Parameters; Parabolic Reflector Antenna, Horn Antennas–Types and analysis. **Antenna Measurements:** Set up, Pattern measurement, Impedance measurement, Directivity and Gain measurements.

**Practice:**

1. Measurement of gain of an antenna

### UNIT – IV

**Microwave transmission lines:** History of microwaves, Microwave Frequency bands, Characteristics, advantages, disadvantages and applications, Analysis of Microwave Transmission Lines- Rectangular waveguide.

**Multipoint networks:** Overview on wave guide discontinuities-Iris, Tuning Screws, Posts and Matched loads. S-Matrix calculations and analysis for E-plane and H-plane Tees, Magic Tee and Directional Coupler.

**Practice:**

1. Measurement of Directional Coupler characteristics.
2. Measurement of Circulator characteristics.

### UNIT – V

**Microwave Tubes:** Limitations and Losses of conventional tubes at microwave frequencies, Two Cavity Klystron - Velocity Modulation and Applegate Diagram, Bunching Process. Reflex Klystron - Applegate Diagram and Principle.

**Microwave Measurements:** Measurement of Power, Impedance, Attenuation, and VSWR.

**Practice:**

1. S/N & C/N measurement by using Satellite Tx. and Rx. Set up.
2. Frequency Measurement by using Doppler RADAR Set up.
3. Measurement of VSWR using microwave bench.
4. Measurement of Reflex Klystron Characteristics.
5. Measurement of Attenuation of a given RF Slot.
6. Measurement of GUNN Diode (TED) V-I Characteristics.

**Additional Practice:**

1. Measurement of waveguide parameters.
2. Measurement of antenna parameters by using Antenna Trainer.
3. Measurement of transmission/reception characteristics by using Satellite Tx. and Rx. Set up.
4. Measurement of transmission/reception characteristics by using Satellite Tx and Rx Set up.

**Text Books:**

1. Antenna Theory analysis and design, Constantine A. Balanis, John Wiley publication, 4<sup>th</sup> Edition, ISBN:978-1118642061.
2. Microwave Devices and circuits, Samuel Y. Liao, PHI, 3<sup>rd</sup> Edition, ISBN: 978-8177583533.

**Reference Books:**

1. Antenna & Wave Propagation, K. D. Prasad, Khanna Publication, Revised and enlarged Edition, 2021, ISBN: 978-8176840255.
2. Antennas and Wave Propagation, John D. Kraus and Ronald J. Marhefka, TMH, 5<sup>th</sup> Edition, ISBN: 978-9352606184.
3. Microwave Engineering, Sushrut Das, Oxford University Press, ISBN:9780198094746.
4. Microwave Engineering, David M Pozar, John Wiley, 4<sup>th</sup> Edition, ISBN: 978-1119770619.

**Web Links:**

1. <http://www.amanogawa.com/antenna.html>
2. [http://nptel.ac.in/courses/117107035/byDr. Amalendu Patnaik](http://nptel.ac.in/courses/117107035/byDr.AmalenduPatnaik)
3. <http://www.radio-electronics.com/info/antennas/>
4. <http://www.radartutorial.eu/index.en.html>

### Multi-Disciplinary Courses (MDC)

| Course Code           | Course Name                                         | Level | L        | T | P        | C        | CIE | SEE | Total | Pre-requisite |
|-----------------------|-----------------------------------------------------|-------|----------|---|----------|----------|-----|-----|-------|---------------|
| 2501CS03/<br>2601DS02 | Data Structures* /<br>Data Structures using<br>C++# | FC    | 2        |   | 2        | 4        | 50  | 50  | 100   | PPSC          |
| 2501MB02              | Engineering<br>Economics &<br>Management            | FC    | 3        |   |          | 3        | 50  | 50  | 100   | -             |
|                       | <b>Total</b>                                        |       | <b>7</b> |   | <b>2</b> | <b>9</b> |     |     |       |               |

**Data Structures**  
(Common to EEE, ECE, CSE, IT, AIML & CSE(DS))  
(Syllabus for the batch admitted in the year 2025)

|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|-----------------------------|----------|----------|----------|----------|
| <b>Course Code:2501CS03</b> | <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO1:** Utilize structure, union to handle heterogeneous data.
- CO2:** Illustrate Time and Space complexities for different sorting Algorithms
- CO3:** Demonstrate various operations on Linked Lists
- CO4:** Explain different operations on Stack and Queue with applications.
- CO5:** Demonstrate the importance and various operation on non-linear data structures

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 1    | 1    | 2    |      |      |      |      | 1    | 1    |       |       |
| <b>CO2</b> | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |
| <b>CO3</b> | 1    | 2    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| <b>CO4</b> | 1    | 1    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| <b>CO5</b> | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 3    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

**UNIT – I**

**Structures and Unions:** Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type - enum variables, Using Typedef keyword, Bit Fields.

**Data Structures:** Introduction to Data Structures, Types of Data Structures.

**Practice:**

4. Write a C program to find the total, average of n students using structures
5. Copy one structure variable to another structure of the same type.
6. Read student name and marks from the command line and display the student details along with the total.

**UNIT – II**

**Introduction to Linear Data Structures:** Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation, Overview of time and space complexity analysis for linear data structures.

Sorting Techniques: Quick sort, Merge sort, Radix sort



**Practice:**

1. Implement Merge sort using arrays.  
<https://www.hackerrank.com/contests/hw1/challenges/merge-sort>
2. Implement Quick sort using arrays  
<https://www.hackerrank.com/challenges/quicksort1/problem>
3. Implement Radix Sort using arrays  
[https://www.hackerrank.com/contests/hw1/challenges/radix-sort?utm\\_source](https://www.hackerrank.com/contests/hw1/challenges/radix-sort?utm_source)

**UNIT – III**

**Linked Lists:** Singly linked lists: representation and operations, doubly linked lists and its operations and circular linked lists and its operations, Comparing arrays and linked lists, Applications of linked lists.

**Practice:**

1. Single Linked List: Perform different operations in single linked list.  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
2. Perform different operations in double linked list  
[https://leetcode.com/problems/design-linked-list/?utm\\_source](https://leetcode.com/problems/design-linked-list/?utm_source)
3. Circular Linked List  
[https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm\\_source](https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm_source)

**UNIT – IV**

**Stacks:** Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, applications of stacks.

**Queues:** Introduction to queues: properties and operations, Types of Queues, implementing queues using arrays and linked lists, applications of queues.

**Practice:**

1. Stack and its operations using arrays and Linked List  
<https://www.hackerrank.com/challenges/balanced-brackets/problem>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
2. Implement a program to evaluate a postfix expression.  
<https://leetcode.com/problems/evaluate-reverse-polish-notation/description/>
3. Queue and its operations using arrays and Linked List  
<https://leetcode.com/problems/implement-queue-using-stacks/description/>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
4. Implement Circular Queue using Arrays  
<https://leetcode.com/problems/design-circular-queue/description/>

**UNIT – V****Non-linear Data Structures:**

Trees: Definition of tree, Tree Terminology, types of trees, Binary tree traversals, Binary Search Tree – Insertion, Deletion.

Graphs: Definition and Terminology – Representation of Graphs-Adjacency Matrix and Linked list, Graph Traversals (BFT & DFT)

**Practice:**

1. Implement Binary search tree (BST).  
<https://leetcode.com/problems/insert-into-a-binary-search-tree/description/>

- <https://leetcode.com/problems/delete-node-in-a-bst/description/>
2. Implement Binary search Tree (BST) Traversals.  
<https://www.hackerrank.com/challenges/tree-inorder-traversal/problem>  
<https://www.hackerrank.com/challenges/tree-preorder-traversal/problem>  
<https://www.hackerrank.com/challenges/tree-postorder-traversal/problem>
3. Graph Traversal using Breadth First Search (BFS)  
<https://www.hackerrank.com/challenges/bfsshortreach/problem>
4. Graph Traversal using Depth First Search (DFS)  
<https://leetcode.com/problems/number-of-islands/description/>

#### Text Books:

1. Data Structures using C, Rema Theraja, Oxford University Press, 3rd Edition. ISBN: 978-9354979453
2. Data Structures, KV Sambasivarao, S Rama Sree, S.Chand. ISBN: 978-9358704730

#### Reference Books:

1. The Algorithm Design Manual, Steven S. Skiena, Springer Publication, Second Edition. ISBN: 978-1849967204
2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Silicon Press, ISBN: 978-0716782506
3. Data Structures and Algorithms by Maganti Venkatesh, Naresh. ISBN: 9780929306407
4. Data Structures Using C, Reema Thareja, Oxford University Press, 2nd Edition. ISBN: 978-0198099307

#### Web Links:

1. <https://nptel.ac.in/courses/106102064>
2. <https://archive.nptel.ac.in/courses/106/105/106105225/>
3. <https://www.udemy.com/topic/data-structures/>
4. <https://www.coursera.org/specializations/data-structures-algorithms>
5. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>

#### Additional Practice:

| SNO | Difficulty | Problem Name      | URL                                                                                                                                                                       |
|-----|------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Easy       | Structs and enums | <a href="https://www.hackerrank.com/challenges/too-high-boxes/problem">https://www.hackerrank.com/challenges/too-high-boxes/problem</a>                                   |
| 2   | Easy       | Structs and enums | <a href="https://www.codechef.com/problems/HS08TEST?tab=statement">https://www.codechef.com/problems/HS08TEST?tab=statement</a>                                           |
| 3   | Medium     | Structs and enums | <a href="https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem">https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem</a> |

|    |        |                       |                                                                                                                                                                                                   |
|----|--------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4  | Easy   | Arrays and Hashtables | <a href="https://leetcode.com/problems/two-sum/description/">https://leetcode.com/problems/two-sum/description/</a>                                                                               |
| 5  | Easy   | Arrays and Pointers   | <a href="https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source">https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source</a> |
| 6  | Medium | Arrays and Pointers   | <a href="https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source">https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source</a>       |
| 7  | Easy   | Linked List           | <a href="https://leetcode.com/problems/merge-two-sorted-lists/description/">https://leetcode.com/problems/merge-two-sorted-lists/description/</a>                                                 |
| 8  | Medium | Arrays and Matrix     | <a href="https://leetcode.com/problems/diagonal-traverse/description/">https://leetcode.com/problems/diagonal-traverse/description/</a>                                                           |
| 9  | Easy   | Linked List           | <a href="https://www.hackerrank.com/challenges/compare-two-linked-lists/problem">https://www.hackerrank.com/challenges/compare-two-linked-lists/problem</a>                                       |
| 10 | Medium | Stack applications    | <a href="https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm">https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm</a>                                       |
| 11 | Medium | Binary Tree           | <a href="https://leetcode.com/problems/binary-tree-right-side-view/description/">https://leetcode.com/problems/binary-tree-right-side-view/description/</a>                                       |
| 12 | Medium | Stack applications    | <a href="https://leetcode.com/problems/remove-k-digits/description/">https://leetcode.com/problems/remove-k-digits/description/</a>                                                               |
| 13 | Medium | Graph Theory          | <a href="https://www.hackerrank.com/challenges/journey-to-the-moon/problem">https://www.hackerrank.com/challenges/journey-to-the-moon/problem</a>                                                 |
| 14 | Medium | Graph Traversals      | <a href="https://leetcode.com/problems/number-of-provinces/description/">https://leetcode.com/problems/number-of-provinces/description/</a>                                                       |
| 15 | Medium | Graph Theory          | <a href="https://www.hackerrank.com/challenges/torque-and-development/problem">https://www.hackerrank.com/challenges/torque-and-development/problem</a>                                           |

|                            | Basic Programs | Aditya's Internal coding Platform(Maya) | Code chef | Hacker rank | Leet code | Geek for Geeks |
|----------------------------|----------------|-----------------------------------------|-----------|-------------|-----------|----------------|
| <b>Unit-1</b>              | 3              | 0                                       | 0         | 0           | 0         | 0              |
| <b>Unit-2</b>              | 0              | 0                                       | 0         | 3           | 0         | 0              |
| <b>Unit-3</b>              | 0              | 0                                       | 1         | 0           | 2         | 0              |
| <b>Unit-4</b>              | 0              | 0                                       | 0         | 1           | 5         | 0              |
| <b>Unit-5</b>              | 0              | 0                                       | 0         | 4           | 3         | 0              |
| <b>Additional Practice</b> | 0              | 0                                       | 1         | 5           | 8         | 1              |
| <b>Total</b>               | <b>3</b>       | <b>0</b>                                | <b>2</b>  | <b>13</b>   | <b>18</b> | <b>1</b>       |

## Data Structures using C++

(Common to EEE, ECE, CSE, AIML & CSE (DS))  
(Revised Syllabus for batches admitted from 2026 Onwards)

|                              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|------------------------------|----------|----------|----------|----------|
| <b>Course Code: 2601DS02</b> | <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

### Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply C++ features for problem solving.
- CO2:** Apply various sorting techniques to solve computing problems.
- CO3:** Make use of linear data structures to solve real time problems.
- CO4:** Develop applications using Tree data structures.
- CO5:** Solve problems using Graph algorithms.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 1    | 1    | 1    |      |      |      |      | 1    | 1    |       |       |
| <b>CO2</b> | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |
| <b>CO3</b> | 1    | 2    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| <b>CO4</b> | 1    | 1    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| <b>CO5</b> | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT – I

**An Overview of C++:** Structure of C++ program, Input and output in C++, Class, Objects, Members Functions, Access Specifiers, Introduction to Constructors and Destructor.

**Overview of Standard Template Library:** Introduction, STL Programming Model, Containers, Sequence Containers, Associative Containers, Algorithms, Iterators, Vectors, Lists, Maps.

#### Practice:

- Find the roots of a quadratic equation.
- Find factorial of a given number using recursion
- Palindrome Number  
<https://leetcode.com/problems/palindrome-number/description/>
- Class and Objects  
<https://www.hackerrank.com/challenges/classes-objects/problem?isFullScreen=true>
- Program to illustrate the use of Constructors and Destructors.

6. C++ Class Templates

<https://www.hackerrank.com/challenges/cpp-class-template-specialization/problem?isFullScreen=true>

## UNIT – II

**Data Structures:** Introduction to Data Structures, Types of Data Structures.

**Linear Data Structures:** Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation.

**Linked Lists:** Singly linked lists: Representation and operations, Doubly linked lists and its operations and Circular linked lists and its operations, applications of linked list

### Practice:

1. Single Linked List: Perform different operations in single linked list.  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
2. Perform different operations in double linked list  
[https://leetcode.com/problems/design-linked-list/?utm\\_source](https://leetcode.com/problems/design-linked-list/?utm_source)
3. Circular Linked List  
[https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm\\_source](https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm_source)
4. Reversing a Linked List

## UNIT – III

**Stacks:** Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, applications of stacks.

**Queues:** Introduction to queues: properties and operations, Types of Queues, implementing queues using arrays and linked lists, applications of queues.

### Practice:

1. Stack and its operations using arrays and Linked List  
<https://www.hackerrank.com/challenges/balanced-brackets/problem>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
2. Implement a program to evaluate a postfix expression.  
<https://leetcode.com/problems/evaluate-reverse-polish-notation/description/>
3. Queue and its operations using arrays and Linked List  
<https://leetcode.com/problems/implement-queue-using-stacks/description/>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
4. Implement Circular Queue using Arrays  
<https://leetcode.com/problems/design-circular-queue/description/>

## UNIT – IV

**Trees:** Definition of tree, Tree Terminology, Representation of tree, Types of trees-Binary Tree, BST, Binary tree traversals-Inorder, Preorder, Postorder Traversals.

**Binary Search Trees** – Definition, Operations: Searching, Insertion, Deletion.

### Practice:

5. Implement Binary search tree (BST).  
<https://leetcode.com/problems/insert-into-a-binary-search-tree/description/>  
<https://leetcode.com/problems/delete-node-in-a-bst/description/>
6. Implement Binary search Tree (BST) Traversals.  
<https://www.hackerrank.com/challenges/tree-inorder-traversal/problem>  
<https://www.hackerrank.com/challenges/tree-preorder-traversal/problem>  
<https://www.hackerrank.com/challenges/tree-postorder-traversal/problem>

## UNIT – V

**Graphs:** Definition and Terminology, Types of Graph, Representation of Graphs-Adjacency Matrix and Adjacency list, Graph Traversals (BFS & DFS), Bi-Connected Components.

### Practice:

1. Graph Traversal using Breadth First Search (BFS)  
<https://www.hackerrank.com/challenges/bfsshortreach/problem>
2. Graph Traversal using Depth First Search (DFS)  
<https://leetcode.com/problems/number-of-islands/description/>

### Text Books:

1. The Complete Reference C++, Herbert Schildt, TMH, Fourth Edition, ISBN-10. 0070411832.
2. Fundamentals of Data Structures in C++, Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, ISBN: 81-7515-278-8
3. Data Structures, KV Sambasivarao, S Rama Sree, S.Chand. ISBN: 978-9358704730

### Reference Books:

1. The C++ Programming Language, Bjarne Stroustrup, Pearson, Fourth Edition, ISBN : 9780133522884.
2. Object oriented programming in C++, Joyce Farrell, Cengage, ISBN : 978-1418836269
3. Data structures and algorithms in C++, 3rd edition, Adam Drozdek, Thomson, ISBN: 9788131521267
4. The Algorithm Design Manual, Steven S. Skiena, Springer Publication, Second Edition. ISBN: 978-1849967204
5. Data Structures and Algorithms by Maganti Venkatesh, Naresh. ISBN: 9780929306407

### Web Links:

1. <http://nptel.ac.in/courses/106105151/>
2. <https://nptel.ac.in/courses/106102064>
3. <https://archive.nptel.ac.in/courses/106/105/106105225/>
4. <https://www.udemy.com/topic/data-structures/>

5. <https://www.coursera.org/specializations/data-structures-algorithms>
6. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>

#### Additional Practice:

| SNO | Difficulty | Problem Name          | URL                                                                                                                                                                                               |
|-----|------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Easy       | Arrays and Hashtables | <a href="https://leetcode.com/problems/two-sum/description/">https://leetcode.com/problems/two-sum/description/</a>                                                                               |
| 2   | Easy       | Arrays and Pointers   | <a href="https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source">https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source</a> |
| 3   | Medium     | Arrays and Pointers   | <a href="https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source">https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source</a>       |
| 4   | Easy       | Linked List           | <a href="https://leetcode.com/problems/merge-two-sorted-lists/description/">https://leetcode.com/problems/merge-two-sorted-lists/description/</a>                                                 |
| 5   | Medium     | Arrays and Matrix     | <a href="https://leetcode.com/problems/diagonal-traverse/description/">https://leetcode.com/problems/diagonal-traverse/description/</a>                                                           |
| 6   | Easy       | Linked List           | <a href="https://www.hackerrank.com/challenges/compare-two-linked-lists/problem">https://www.hackerrank.com/challenges/compare-two-linked-lists/problem</a>                                       |
| 7   | Medium     | Stack applications    | <a href="https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm">https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm</a>                                       |
| 8   | Medium     | Binary Tree           | <a href="https://leetcode.com/problems/binary-tree-right-side-view/description/">https://leetcode.com/problems/binary-tree-right-side-view/description/</a>                                       |
| 9   | Medium     | Stack applications    | <a href="https://leetcode.com/problems/remove-k-digits/description/">https://leetcode.com/problems/remove-k-digits/description/</a>                                                               |
| 10  | Medium     | Graph Theory          | <a href="https://www.hackerrank.com/challenges/journey-to-the-moon/problem">https://www.hackerrank.com/challenges/journey-to-the-moon/problem</a>                                                 |
| 11  | Medium     | Graph Traversals      | <a href="https://leetcode.com/problems/number-of-provinces/description/">https://leetcode.com/problems/number-of-provinces/description/</a>                                                       |
| 12  | Medium     | Graph Theory          | <a href="https://www.hackerrank.com/challenges/torque-and-development/problem">https://www.hackerrank.com/challenges/torque-and-development/problem</a>                                           |

|                     | Basic Programs | Aditya's Internal coding Platform(Maya) | Code chef | Hacker rank | Leet code | Geek for Geeks |
|---------------------|----------------|-----------------------------------------|-----------|-------------|-----------|----------------|
| Unit-1              | 3              | 0                                       | 0         | 2           | 1         | 0              |
| Unit-2              | 0              | 0                                       | 1         | 3           | 2         | 0              |
| Unit-3              | 0              | 0                                       | 0         | 1           | 5         | 0              |
| Unit-4              | 0              | 0                                       | 0         | 3           | 2         | 0              |
| Unit-5              | 0              | 0                                       | 0         | 1           | 1         | 0              |
| Additional Practice | 0              | 0                                       | 0         | 3           | 8         | 1              |
| Total               | 3              | 0                                       | 1         | 13          | 19        | 1              |

**Engineering Economics & Management**  
(Common to CE,EEE, ME, ECE,CSE, IT, AIML, CSE(DS), PT&Min.E)

**Course Code:**2501MB01

**L      T      P      C**  
**3      0      0      3**

**Course Outcomes:**

At the end of the Course, Student will be able to:

- CO1:** Explain the Business Economic concepts, law of demand and forecasting methods.
- CO2:** Identify the production, cost behavior for managerial decision making with Break Even Point (BEP).
- CO3:** Make use of financial accounting and capital budgeting techniques for decision making.
- CO4:** Summarize management and motivational theories to renovate the practice of Management.
- CO5:** Illustrate the functional management and project management using PERT and CPM.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | -    | -    | -    | -    | -    | -    | -    | -    | 2    | 2     | -     |
| CO2   | 1    | -    | -    | -    | -    | -    | -    | -    | -    | -     | 2     |
| CO3   | -    | -    | -    | -    | -    | -    | -    | -    | -    | -     | 3     |
| CO4   | 1    | -    | -    | -    | -    | -    | -    | -    | 1    | 1     | 2     |
| CO5   | -    | -    | -    | -    | -    | -    | -    | -    | -    | -     | 3     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

**UNIT – I**

**Introduction to Managerial Economics And Demand Analysis:**

Definition of Managerial Economics –Scope of Managerial Economics- Concept of Demand, Types of Demand, Determinants of Demand- Law of Demand and its limitations- Elasticity of Demand, Types- Demand forecasting and its Methods.



## **UNIT – II**

### **Production and Cost Analyses:**

Concept of Production function Law of Variable Proportions-Isoquants and Isocosts  
Producer Equilibrium-, cost concepts: opportunity costs, explicit and implicit costs- Fixed costs, Variable Costs – Cost –Volume-Profit Analysis-Determination of Breakeven point (simple problems).

## **UNIT – III**

Introduction to Markets And Financial Accounting:

Market Structures-Classification of markets, Introduction to Financial Accounting , Concepts and conventions, Accounting cycle, Journal entries and Ledger (Simple Problems), Methods of capital budgeting (Simple Problems).

## **UNIT – IV**

Operations Management :

Concept nature and importance of Management, Generic Functions of Management, Theories of Motivation, Plant location and layout, Principles of organization, SWOT analysis.

Material Management: Need for Inventory control, EOQ, ABC analysis

## **UNIT – V**

Functional Management and Project Management:

Concept of HRM , HRD and PMIR, Functions of HR Manager , Job Evaluation and Merit Rating , Marketing Management, Functions of Marketing , Channels of distributions - Development of Network , Difference between PERT and CPM, Finding Critical Path (Simple Problems).

### **Text Books:**

1. Managerial Economics and Financial Analysis, Dr. A. R. Aryasri, TMH, ISBN 9780070078031
2. Managerial Economics and Financial Analysis, Dr. N. Appa Rao, Dr. P. Vijay Kumar, Cengage Publications, New Delhi, ISBN 978-8131515952

### **Reference Books:**

1. Principles of Marketing: A South Asian Perspective by Kotler Philip, Gary Armstrong, Prafulla Y. Agnihotri, and Eshan ul Haque, Pearson Education/Prentice Hall of India, 13<sup>th</sup> Edition, ISBN 9788131731017
2. A Handbook of Human Resource Management Practice, Michael Armstrong Kogan, Page Publishers, ISBN 978-1789661033
3. Management Science, Aryasri, Tata McGraw Hill, ISBN 978-0070090279
4. Management, James Arthur, Finch Stoner, R. Edward Freeman, and Daniel R. Gilbert Pearson Education/Prentice Hall, 6<sup>th</sup> Edition, ISBN 978-0131087477

### **Web Links:**

1. <https://nptel.ac.in/courses/110105067>
2. <https://archive.nptel.ac.in/courses/112/107/112107143/>

### Ability Enhancement Courses (AEC)

| Course Code  | Course Name                                | Level | L        | T | P        | C        | CIE | SEE | Total | Pre-requisite |
|--------------|--------------------------------------------|-------|----------|---|----------|----------|-----|-----|-------|---------------|
| 2501EN01     | Essential Cognitive Skills for Engineering | FC    |          |   | 1        | 1        | 100 | -   | 100   | -             |
| 2501EN02     | Advanced Cognitive Skills for Engineering  | FC    |          |   | 1        | 1        | 100 | -   | 100   | -             |
| 2501UC07     | Design Thinking using AI                   | FC    |          |   | 1        | 1        | 100 | -   | 100   | -             |
| 2501UC08     | Universal Human Values                     | FC    | 2        |   |          | 2        | 100 | -   | 100   | -             |
| 2501UC09     | Technical Paper Publication                | AC    |          |   | 2        | 2        | 100 | -   | 100   | -             |
| 2501EC96     | Student Activity Based Learning            | AC    |          |   |          | 2        | 100 | -   | 100   | -             |
| <b>Total</b> |                                            |       | <b>2</b> |   | <b>5</b> | <b>9</b> |     |     |       |               |

## ESSENTIAL COGNITIVE SKILLS FOR ENGINEERS

(Common to CE, EEE, ME, ECE, CSE, IT, AITL, CSE(DS), PT & Min.E)

|                             | L        | T        | P        | C        |
|-----------------------------|----------|----------|----------|----------|
| <b>Course Code:2501EN01</b> | <b>0</b> | <b>0</b> | <b>1</b> | <b>1</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Recognize the different aspects of the English language proficiency with emphasis on LSRW skills.
- CO2:** Apply communication skills through various language learning activities
- CO3:** Analyze the English speech sounds, stress, intonation and syllable division for better listening and speaking comprehension.
- CO4:** Enable them to learn and apply fundamentals of English grammar concepts for improved language
- CO5:** Make use of various types of vocabulary in different academic and professional careers

### Mapping of Course Outcomes with Program Outcomes:

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

### Practice:

#### UNIT-I Outstanding people A/B/C/D

|               |                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Listening     | Conversation about Jocelyn Bell- Burnell, Podcast: The 30-day challenge, Starting a new job, Conversation about technology                                 |
| Speaking      | Discussing inspiring people, Asking and answering questions about challenges, Explaining a process; Checking understanding, Discussing technology.         |
| Reading       | Articles: <i>Protector of the sea</i> and <i>The woman who reinvented children's TV</i> , Interviews: <i>30-day challenge</i> , Article: <i>Tech free!</i> |
| Writing       | Article Organizing an article                                                                                                                              |
| Grammar       | Review of Tenses, Questions                                                                                                                                |
| Vocabulary    | Character adjectives, trying and succeeding                                                                                                                |
| Pronunciation | The letter e; Word stress, Rapid speech.                                                                                                                   |

|                 |                                                                                                                                                                                  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>UNIT-II</b>  | <b>Survival A/B/C/D</b>                                                                                                                                                          |
| Listening       | Conversation about a survival situation, Interview: The Tiger, Cooking for a friend, Talking about getting lost                                                                  |
| Speaking        | Telling a survival story, Giving advice; Asking questions, Giving compliments and responding, Discussing the natural environment                                                 |
| Reading         | Article: Lost at sea, Leaflet: <i>How to survive...an animal attack</i> , Leaflet: <i>Be wise and survive</i>                                                                    |
| Writing         | Guidelines, organizing guidelines in a leaflet                                                                                                                                   |
| Grammar         | Narrative tenses, Future time clauses and conditionals                                                                                                                           |
| Vocabulary      | Expressions with <i>get</i> , Animals and the environment                                                                                                                        |
| Pronunciation   | Sound and Spelling: g, Intonation in question tags                                                                                                                               |
| <b>UNIT-III</b> | <b>Talent A/B/C/D</b>                                                                                                                                                            |
| Listening       | Conversation: learning experiences, Radio Programme: The sports gene, Making wedding plans, Interviews about sport                                                               |
| Speaking        | Talking about something you have put a lot of effort into, Discussing sport and ways to improve performance, planning a party, Talking about popular sports                      |
| Reading         | Text about learning; <i>Learning to learn</i> , Article: <i>Born to be the best</i> ; Three articles about athletes, Article: <i>Fitness: Seattle snapshot</i>                   |
| Writing         | Article describing data                                                                                                                                                          |
| Grammar         | Multi-word verbs, Present perfect and present perfect continuous                                                                                                                 |
| Vocabulary      | Ability and achievement, word connected with sport                                                                                                                               |
| Pronunciation   | Word stress, sound and spelling consonant sounds                                                                                                                                 |
| <b>UNIT-IV</b>  | <b>Life Lessons A/B/C/D</b>                                                                                                                                                      |
| Listening       | Interview: Psychology of money; Two monologues: Life-changing events, Two monologues; training for a job, Presenting photos, Three monologues; living in different places        |
| Speaking        | Talking about how your life has changes, Discuss experiences of training and rules, Describing photos: Expressing careful disagreement, Discussing living in a different country |
| Reading         | Two texts about life-changing events that helped people become rich, Article: <i>Training for the emergency frontline</i> , Advert for being an international student 'buddy'    |
| Writing         | Job application, Giving a positive impression                                                                                                                                    |
| Grammar         | <i>Used to</i> and <i>would</i>                                                                                                                                                  |
| Vocabulary      | Cause and result, Talking about difficulty                                                                                                                                       |
| Pronunciation   | Sound and spelling: u                                                                                                                                                            |

**UNIT–V                      Chance A/B/C/D**

|               |                                                                                                                                                                                                                                                 |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Listening     | Monologue: What are your chances?, Conversation: Talking about work, Money problems, News reports: environmental problems                                                                                                                       |
| Speaking      | Discussing possible future events, Role Play: job interview, Explaining and responding to an idea for a café, Giving opinions on environmental problems                                                                                         |
| Reading       | Quiz: <i>Are you an optimist or a pessimist?</i> ; Article: <i>Why we think we're going to have a long and happy life</i> , Quiz: <i>The unknown continent</i> ; Article: <i>Cooking in Antarctica</i> , Essay about protecting the environment |
| Writing       | For and against essay, Arguing for and against an idea                                                                                                                                                                                          |
| Grammar       | Future probability, Future perfect and future continuous                                                                                                                                                                                        |
| Vocabulary    | Adjectives describing attitude, The natural world                                                                                                                                                                                               |
| Pronunciation | Sound and spelling : <i>th</i> , Intonation groups                                                                                                                                                                                              |

**Text Book:**

1. Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones, ISBN: 978-1107468726.

**Suggested Software:**

- Cambridge Empower
- Soft X (K-Van Solutions)

**Reference Books:**

1. M Ashraf Rizvi: Effective Technical Communication, ISBN: 9352605780.
2. Raymond Murphy: English Grammar in Use, Cambridge University Press. Fifth Edition, ISBN: 978-3125354241.
3. J. Sethi & P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle, ISBN: 9788120314955.

**Weblinks:**

1. <https://www.cambridgeone.org/login>
2. <https://www.britishcouncil.in/english/online>
3. [www.englishmedialab.com](http://www.englishmedialab.com)

**Advanced Cognitive Skills For Engineers**  
(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

**Course Code: 2501EN02**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>1</b> | <b>1</b> |

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO1:** Recognize the basics of communication and summarize formal and informal language expressions in all aspects.
- CO2:** Establish and maintain interpersonal relationships and transmit the message through different language activities.
- CO3:** Use language effectively to prepare and demonstrate proficiency in facing various types of interviews.
- CO4:** Demonstrate and exhibit professionalism in participating in various public speaking activities like debates, group discussions and presentation skills.
- CO5:** Identify the basic elements of writing and apply the fundamentals to compose e-mails catering to different professional needs.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | -     |
| CO2   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | -     |
| CO3   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | -     |
| CO4   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | -     |
| CO5   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | -     |

**Practice**

**UNIT – I     Around the globe A/B/C/D**

|               |                                                                                                                                          |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Listening     | Two monologues about sightseeing tours, Interview: disappearing languages, Asking for a favour, conversation: a trip to the Grand Canyon |
| Speaking      | Comparing different tourist destinations, Agreeing and disagreeing, Asking for a favour, Discussing local tourist destinations.          |
| Reading       | Website about four tourist destinations; Website: <i>Where to go?</i>                                                                    |
| Writing       | Travel blog, Using descriptive language                                                                                                  |
| Grammar       | Infinitives and <i>-ing</i> forms                                                                                                        |
| Vocabulary    | Travel and tourism, Describing changes                                                                                                   |
| Pronunciation | Consonant clusters, Consonant sounds                                                                                                     |

**UNIT – II**
**City living A/B/C/D**

|               |                                                                                                                                                                 |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Listening     | Interview: ‘Smart’ cities: Two monologues talking about ‘smart’ cities, Two monologues: house renovations, Flat hunting, Interviews about a new shopping centre |
| Speaking      | Discussing good and bad points about a city                                                                                                                     |
| Reading       | Article: <i>Quick-slow down!</i> , Article: <i>Who puts the ‘real’ in reality</i> TV? Email: Complaining about an important issue.                              |
| Writing       | Email of complaint, Using formal language                                                                                                                       |
| Grammar       | <i>Too/enough; so/such</i> , Causative <i>have/get</i>                                                                                                          |
| Vocabulary    | Describing life in cities, Film and TV; Houses                                                                                                                  |
| Pronunciation | Sound and spelling: o, Stress in compound nouns                                                                                                                 |

**UNIT – III**
**Dilemmas A/B/C/D**

|               |                                                                                                                                       |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Listening     | Radio programme: person finance, Three monologues about honesty, Going to the bank, Conversation about a TV programme                 |
| Speaking      | Giving opinions on financial matters, Discussing moral dilemmas, Talking about hopes and worries Discussing programmes about crime    |
| Reading       | Article: <i>Is it time to give up on cash?</i> , Newspaper article: <i>The honesty experiment</i> , Review: <i>Crime with a smile</i> |
| Writing       | Review, Organising a review                                                                                                           |
| Grammar       | First and second conditionals, Third conditional; <i>should have+past participle</i>                                                  |
| Vocabulary    | Money and finance, Crime                                                                                                              |
| Pronunciation | Stressed and unstressed words; Sound and spelling: <i>l</i> , Word groups                                                             |

**UNIT – IV**
**Discoveries A/B/C/D**

|               |                                                                                                                                            |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Listening     | Conversation about inventions, Conversation about an email hoax, Finding the perfect flat, Four monologues about alternative medicine      |
| Speaking      | Talking about inventions, Describing a hoax or a scam or a case of fraud, Giving and receiving surprises                                   |
| Reading       | Article: <i>Too good to be true?</i> , Article: <i>The rise and fall of Barry Minkow</i> , Essay: <i>The Value of alternative medicine</i> |
| Writing       | Opinion essay, Presenting a series of arguments                                                                                            |
| Grammar       | Relative clauses, Reported speech; Reporting verbs                                                                                         |
| Vocabulary    | Health, Verbs describing thought and knowledge                                                                                             |
| Pronunciation | Sound and spelling : <i>ui</i> , Linking and intrusion                                                                                     |

**UNIT – V Possibilities A/B/C/D**

|               |                                                                                                                                                     |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Listening     | Interview about Dan Cooper, Two monologues: pursuing a dream, Celebrating good news, conversation about goals                                       |
| Speaking      | Telling stories about coincidences, Describing and comparing brave or amazing people, Telling an important piece of news, Talking about performing  |
| Reading       | Story: The man who disappeared; Blog: <i>The Wreck of the Titan</i> , Article: <i>Dream to help</i> , Story: Rosa's diary: <i>The ultimate goal</i> |
| Writing       | Story, Making a story interesting                                                                                                                   |
| Grammar       | Past modals of deduction, Wishes and regrets                                                                                                        |
| Vocabulary    | Adjectives with prefixes, Verbs of effort                                                                                                           |
| Pronunciation | Word stress, Linking, Consonant clusters                                                                                                            |

**Text Book:**

3. Cambridge Empower – Second Edition B2 Level - Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis – Jones, ISBN: 978-1107468726.

**Suggested Software:**

- Cambridge Empower
- Soft X (K-Van Solutions)

**Reference Books:**

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford University Press.2018, ISBN: 9789354972256
2. Michael Swan- Practical English Usage,ISBN: 9780194202466.
3. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India,ISBN: 978-0070996038.

**Weblinks:**

1. <https://www.cambridgeone.org/login>
2. <https://www.coursera.org/>
3. <https://www.skillshare.com/>
4. <https://www.mindtools.com/cawh8bu/communication-tools>



## Design Thinking using AI

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

**Course Code:2501UC07**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>1</b> | <b>1</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Appreciate various design process procedure.
- CO2:** Generate and develop design ideas through different technique.
- CO3:** Identify the significance of reverse Engineering to Understand products.
- CO4:** Draw technical drawing for design ideas.
- CO5:** Illustrate design teams to create feasible and user-focused solutions to complex problems in design.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | -    | -    | -    | -    | -    | -    | -    | 2    | 2    | -     | -     |
| CO2   | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO4   | -    | -    | -    | -    | -    | -    | -    | 1    | 1    | 2     | -     |
| CO5   | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |

### UNIT – I

Process of Design Understanding Design thinking: Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

### UNIT – II

Tools for Design Thinking: Real-Time design interaction capture and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design

Practice using any AI tool:

Students are advised to use any AI tool like Otter AI etc for Transcribe interviews automatically and summarize user insights.

### UNIT – III

Design Thinking in IT: Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping

Practice using any AI tool:

Students are advised to use any AI tool like ChatGPT, Claude, Perplexity etc to define, synthesize, ideate and prototype.

## **UNIT – IV**

DT For strategic innovations: Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design.

Practice using any AI tool:

Students are advised to use any AI tool like looka, logomkr, canva and figma etc for logo, prototyping and sketching.

## **UNIT – V**

**Design thinking workshop:** Design Thinking Work shop Empathize, Design, Ideate, Prototype and Test.

### **Text Books:**

1. Engineering Design by John R. Karsnitz, Stephen O'Brien and John P. Hutchinson, Cengage Learning (International edition) Second Edition, ISBN: 9781133708766.
2. The Design of Business: Why Design Thinking is the Next Competitive Advantage Roger Martin by Harvard Business Press, ISBN: 9781422177808

### **Reference Books:**

1. Engineering Design Process by Yousef Haik and Tamer M. Shahin, Cengage Learning, Second Edition, ISBN: 978-8131529041.
2. Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author), ISBN: 978-0231163569.

### **Web Links:**

1. [www.tuto2.u.net/business/presentations/. /Product lifecycle/default.html](http://www.tuto2.u.net/business/presentations/. /Product lifecycle/default.html)
2. [https://docs.oracle.com/cd/E11108\\_02/otn/pdf/. /E11087\\_01.pdf](https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf)

## Universal Human Values

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

|                       | L | T | P | C |
|-----------------------|---|---|---|---|
| Course Code: 2501UC08 | 1 | 1 | 0 | 2 |

**Pre Requisites:** Universal Human Values (UHV-I) (desirable).

### Course Objectives:

This course input is intended

1. To help the students appreciate the complementarity between 'VALUES' and 'SKILLS' and understand how ethical foundations enhance technical competence to achieve sustainable happiness, prosperity, and responsible professional growth.
2. To develop a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a right understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values (UHV) and movement towards value-based living in a natural way.
3. To highlight real-world implications of Holistic understanding of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
4. To encourage the students to realise their full potential and act accordingly.
5. To assist the students to live with a feeling of relationship, harmony and co-existence.

Thus, this course is intended to provide a much-needed input in value education to the young enquiring minds.

## UNIT I INTRODUCTION TO VALUE EDUCATION

Lecture 1: Holistic Development and the Role of Education (Right Understanding, Relationship and Physical Facility)

Lecture 2: Understanding Value Education

Tutorial 1: Practice Session PS1 - Sharing about Oneself

Lecture 3: Self-Exploration as the Process for Value Education

Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2: Practice Session PS2 - Exploring Human Consciousness

Lecture 5: Happiness and Prosperity – Current Scenario

Lecture 6: Method to Fulfill the Basic Human Aspirations

Tutorial 3: Practice Session PS3 - Exploring Natural Acceptance.

## UNIT II HARMONY IN THE HUMAN BEING

Lecture 7: Understanding Human being as the Co-existence of the self and the body

Lecture 8: Distinguishing between the Needs of the self and the body

Tutorial 4: Practice Session PS4 - Exploring the difference of Needs of self and body

Lecture 9: The body as an Instrument of the self

Lecture 10: Understanding Harmony in the self

Tutorial 5: Practice Session PS5 - Exploring Sources of Imagination in the self

Lecture 11: Harmony of the self with the body

Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS6 - Exploring Harmony of self with the body.

### **UNIT III HARMONY IN THE FAMILY AND SOCIETY**

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS7 - Exploring the Feeling of Trust

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS8 - Exploring the Feeling of Respect

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order

Tutorial 9: Practice Session PS9 - Exploring Systems to fulfil Human Goal

### **UNIT IV HARMONY IN THE NATURE/EXISTENCE**

Lecture 19: Understanding Harmony in Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS10 - Exploring the Four Orders of Nature

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS11 - Exploring Co-existence in Existence.

### **UNIT V IMPLICATIONS OF THE HOLISTIC UNDERSTANDING A LOOK AT PROFESSIONAL ETHICS**

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 - Exploring Ethical Human Conduct

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 - Exploring Humanistic Models in Education

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case

Studies Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 - Exploring Steps of Transition towards Universal Human Order

#### **Course Outcomes:**

Upon successful completion of the course, students will be able to

**CO1:** Demonstrate an understanding of basic human aspiration and the concept of Natural Acceptance and apply them in personal and professional decision-making.

**CO2:** Develop self-awareness and practice self-regulation.

**CO3:** Recognize human-human relationship (Justice) and identify human goals in society.

**CO4:** Appreciate the harmony in nature and existence.

**CO5:** Develop as socially and ecologically responsible engineers in handling problems with sustainable solutions (user-friendly and eco-friendly).

#### **Text Books:**

1. R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 3<sup>rd</sup> Revised Edition, UHV Publications, Sarva Shubha Nyas, Kanpur, 2023. ISBN: 978- 81-957703-7-3 (Printed Copy) ISBN: 978-81-957703-6-6 (e-book)
2. R R Gaur, R Asthana, G P Bagaria, *Teachers' Manual for a Foundation Course in Human Values and Professional Ethics*, 3<sup>rd</sup> Revised Edition, UHV Publications, Sarva Shubha Nyas, Kanpur, 2023.

**Reference Books:**

1. *Jeevan Vidya: Ek Parichaya*, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book), Annie Leonard, Free Press, 2010.
4. *The Story of My Experiments with Truth*, Mohandas Karamchand Gandhi, Fingerprint! Publishing
5. *Small is Beautiful* - E. F Schumacher, Random House, 2011.
6. *Slow is Beautiful* - Cecile Andrews, New Society Publishers, 2006
7. *Economy of Permanence* - J C Kumarappa
8. *Vivekananda* - Romain Rolland

**Online Resources**

1. <https://fdp-si.aicte-india.org/index.php>
2. [https://onlinecourses.swayam2.ac.in/aic22\\_ge23/preview](https://onlinecourses.swayam2.ac.in/aic22_ge23/preview)
3. <https://uhv.org.in/>
4. <https://www.youtube.com/@UniversalHumanValues/playlists>

### Skill Enhancement Courses (SEC)

| Course Code  | Course Name                              | Level | L | T | P         | C         | CIE | SEE | Total | Pre-requisite |
|--------------|------------------------------------------|-------|---|---|-----------|-----------|-----|-----|-------|---------------|
| 2501EC21     | PCB Design                               | FC    |   |   | 2         | 2         | 50  | 50  | 100   | -             |
| 2501EC94     | Soft Computing Tools                     | IC    |   |   | 2         | 2         | 50  | 50  | 100   | -             |
|              | Object Oriented Programming through JAVA | AC    |   |   | 2         | 2         | 50  | 50  | 100   | -             |
| 2501EC16     | ECAD Tools                               | AC    |   |   | 2         | 2         | 50  | 50  | 100   | VLSI          |
| 2501EC17     | Verification using Verilog & UVM         | AC    |   |   | 2         | 2         | 50  | 50  | 100   | VLSI          |
| <b>Total</b> |                                          |       |   |   | <b>10</b> | <b>10</b> |     |     |       |               |

## **Skill Enhancement Courses (SEC)**

## PCB Design

**Course Code:2501EC21**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Illustrate the equipment and components used in PCB design.
- CO2:** Apply the procedural steps for PCB preparation.
- CO3:** Make use of chemicals for Etching process.
- CO4:** Make use of Soldering gun for components mounting.
- CO5:** Construct PCB for different circuits.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | 2    | 2    | -     | 1     |
| <b>CO2</b> | 2    | 2    | -    | -    | -    | -    | -    | 2    | 2    | -     | 1     |
| <b>CO3</b> | 2    | 2    | -    | -    | -    | -    | -    | 2    | 2    | -     | 1     |
| <b>CO4</b> | 2    | 2    | -    | -    | -    | -    | -    | 2    | 2    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 2    | -    | -    | -    | -    | 2    | 2    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 1    |
| <b>CO2</b> | -    | 1    |
| <b>CO3</b> | -    | 1    |
| <b>CO4</b> | -    | 1    |
| <b>CO5</b> | -    | 1    |

### Practice:

1. Study of Laboratory Equipments and Electronic components: (1 Week)
  - a) CRO
  - b) Digital Multimeter
  - c) Function Generator
  - d) Regulated Power Supply
  - e) Active Components (Diode, BJT, ICs)
  - f) Passive Components (Resistors, Capacitors, Inductors)
  - g) Breadboard
  - h) Soldering Gun
  - i) Sensors
2. Study of PCB Design and Fabrication Using Autodesk EAGLE Tool and Toner Transfer (Ironing) Method (1 Week)
  - a) Schematic Design in EAGLE software
  - b) PCB Layout Design
  - c) Artwork Generation



- d) Toner Transfer (Ironing) Method
- e) Etching and Drilling of PCB.
- f) Component Mounting & Soldering
- g) Continuity Check & Testing

**List of Experiments:**

1. Design, Fabrication and Verification of PCB for Diode as a Switch Circuit (2 Weeks)
2. Design, Fabrication and Verification of PCB for Bridge Rectifier Circuit (2 Weeks)
3. Design, Fabrication and Verification of PCB for Transistor as a Switch Circuit (1 Week)
4. Design, Fabrication and Verification of PCB for Common Emitter (CE) Amplifier (2 Weeks)
5. Design, Fabrication and Verification of PCB for Astable Multivibrator Using IC 555 (2 Weeks)
6. Design, Fabrication and Verification of PCB for 4-Bit Up Counter Using IC 74×393 (1 Week)

**Cornerstone Projects:****1. Touch-Based ON/OFF Switch**

**Description:** Design and fabricate a touch switch circuit using a touch sensor / transistor logic to turn a load ON or OFF by human touch. Implement the circuit on a PCB.

**Expected Outcome:** A working PCB-based touch switch that toggles output on every touch.

**2. Automatic Night Lamp using LDR**

**Description:** Design and fabricate an automatic night lamp circuit using an LDR to sense ambient light and a transistor/driver stage to switch an LED/lamp ON in darkness and OFF in daylight. Set the switching level using a preset/potentiometer and implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based night lamp that turns ON automatically at low light and OFF automatically in bright light, with proper demonstration and explanation of LDR sensing and switching operation.

**3. Clap-Activated Relay Switch**

**Task Description:** Design and fabricate a clap-activated relay switch using a microphone sensor, signal conditioning stage, and a 555 timer to toggle a relay when a clap sound is detected. Implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based clap switch in which the relay turns ON/OFF with each clap, suitable for controlling a small load, and students are able to explain the sensing, triggering, and relay operation during viva.

#### 4. Water Level Indicator with Buzzer

**Description:** Design and fabricate a water level indicator using level sensing probes and a simple transistor/IC-based switching circuit to detect water at preset levels and activate a buzzer/LED indication. Implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based water level indicator that gives a clear alarm/indication when water reaches the selected level(s), and students are able to explain the sensing method and buzzer operation.

#### 5. Rain Alarm Indicator

**Description:** Design and fabricate a rain alarm circuit using a rain sensor/probe plate to detect water droplets and a transistor/driver stage to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

**Expected Outcome:** a working PCB-based rain alarm that gives an alarm indication when rain is detected and students are able to explain the sensing and switching operation.

#### 6. Fire Alarm Indicator

**Description:** Design and fabricate a fire alarm circuit using a temperature sensor / thermistor to detect abnormal heat levels and a transistor/IC-based switching stage to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based fire alarm that produces an alarm indication when high temperature is detected, and students are able to explain the sensing and alarm operation.

#### 7. IR-Based Object Detection Alarm

**Description:** Design and fabricate an IR object detection alarm using an IR transmitter and IR receiver to sense the presence of an object and a driver stage to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based IR alarm that gives an alert when an object is detected, and students are able to explain the IR sensing and switching operation.

#### 8. Invisible Burglar Alarm

**Description:** Design and fabricate an invisible burglar alarm using an infrared beam pair (IR transmitter and receiver) placed across an entry path. Interruption of the invisible beam triggers a driver circuit to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

**Expected outcome:** A working PCB-based invisible burglar alarm that gives an alert when the IR beam is interrupted and students are able to explain the beam sensing and alarm operation.

## 9. Electronic Dice

**Description:** Design and fabricate an electronic dice circuit using a 555 timer / clock generator and counter or logic ICs to generate random numbers from 1 to 6, which are displayed using LEDs or 7-segment display. Implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based electronic dice that displays a random number between 1 and 6 on each trigger, and students are able to explain the clocking, counting, and display operation.

## 10. Simple Audio Amplifier

**Description:** Design and fabricate a simple audio amplifier using a transistor or audio amplifier IC to amplify a low-level audio signal from a microphone to drive a speaker. Implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based audio amplifier that produces a clear and audible output sound and students are able to explain the amplification principle and circuit operation.

## 11. Wireless Call Bell

**Description:** Design and fabricate a wireless call bell system with a transmitter unit (push button + RF module) and a receiver unit (RF module + buzzer/indicator). When the button is pressed at the transmitter, the receiver activates the bell/buzzer. Implement the circuit on a PCB.

**Expected Outcome:** A working PCB-based wireless call bell in which pressing the transmitter button produces a clear buzzer/alert at the receiver, and students are able to explain the transmitter–receiver operation and working during viva.

## 12. LED Chaser Circuit using 555 Timer and CD4017

**Description:** Design and fabricate an LED chaser circuit using a 555 timer to generate clock pulses and a CD4017 counter to switch LEDs sequentially. Control the chasing speed using RC components or a potentiometer and implement the complete circuit on a PCB.

**Expected Outcome:** A working PCB-based LED chaser in which LEDs glow one after another with adjustable speed, and students are able to explain the working of the 555 timer and CD4017.

### Guidelines for Cornerstone Project:

- The Cornerstone Project is to be carried out batch-wise with three students in each batch.
- Each batch may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The selected project must be implemented strictly using PCB design and fabrication techniques learned in the laboratory.
- The project must be fully completed and ready for demonstration on the day of the external examination.
- The Semester End Examination (SEE) – Lab shall be evaluated for 50 marks based on video presentation, project demonstration, project report, and viva-voce as follows.

| Component             | Description                                                                                                                                                                       | Marks     |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Video Presentation    | The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.                                 | 10        |
| Project Demonstration | During the external examination, the batch shall demonstrate their working model in proper working condition and explain it using charts, posters, or other suitable visual aids. | 20        |
| Project Report        | Submission of project report in the prescribed format.                                                                                                                            | 10        |
| Viva-Voce             | Oral examination based on the project work and PCB fundamentals.                                                                                                                  | 10        |
| <b>Total Marks</b>    |                                                                                                                                                                                   | <b>50</b> |

### Reference Books:

1. Printed Circuits Handbook, Clyde F. Coombs Jr., Happy T. Holden, Seventh Edition, McGraw Hill publications, ISBN: 978-0071833950.
2. PCB Design and Layout Fundamentals for EMC, Roger Hu, 2019, ISBN: 978-1082079252.
3. The Hitchhiker's Guide to PCB Design, David Ruff, Mike Brown, Cadence Documents, ISBN: 978-0368246968.

### Web Links:

1. <http://www.nptelvideos.com/lecture.php?id=14721> by Prof. Santhanu Bhattacharya, IIT, Kanpur

## Soft Computing Tools

**Course Code: 2501EC94**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

**At the end of the Course, Student will be able to:**

- CO1:** Perform basic matrix operations and random data manipulation using MATLAB.  
**CO2:** Make use of MATLAB to generate Gaussian noise and compute its basic statistical measures.  
**CO3:** Design filters with the help of Simulink toolbox.  
**CO4:** Apply the concepts of convolution and filters to remove noise.  
**CO5:** Utilize the Fuzzy tool box to perform different operations

### Mapping of Course Outcomes with Program Outcomes

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      |      | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO2</b> | 2    | 2    |      |      | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO3</b> | 2    | 2    |      |      | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO4</b> | 2    | 2    |      |      | 2    |      |      | 2    | 2    |       | 1     |
| <b>CO5</b> | 2    | 2    |      |      | 2    |      |      | 2    | 2    |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    |      |
| <b>CO2</b> | 1    |      |
| <b>CO3</b> | 1    |      |
| <b>CO4</b> | 2    |      |
| <b>CO5</b> | 1    |      |

### Practice:

1. Create a 10x10 random matrix with the command `A= rand (10)`. Now do the following operations.
  - a. Multiply all elements by 100 and then round off all elements of the matrix to integers with the command `A=fix(A)`.
  - b. Replace all elements of  $A < 10$  with Zeros.
  - c. Replace all elements of  $A > 90$  with infinity (int).
  - d. Extract all  $30 \leq a_{ij} \leq 50$  in a vector b, that is find all elements between 30 and 50 and put them in a vector b.
2. Generation of Gaussian noise (Real and Complex), Computation of its mean, Variance, Mean Square Value and Probability Distribution Function.
3. Removal of noise by Autocorrelation / Cross correlation.

4. Removal of noise by Filters (Wiener/LMS).
5. Introduction to Simulink toolbox
6. Design of Filters using Simulink (LPF, HPF, BPF, BRF)
7. Introduction to Fuzzy Logic toolbox
8. Write a program in MATLAB to perform Union, Intersection and Complement operations.
9. Write a program using Fuzzy Logic to perform arithmetic and Logic Operations
10. Write a program in MATLAB to implement De-Morgan's Law.
11. Write a program in MATLAB to plot various membership functions.
12. Implement Fuzzy Inference System (FIS)

**Additional Practice:**

1. Identify a relevant problem in your domain and develop an appropriate solution using the Simulink toolbox, applying the knowledge you have gained so far.
2. Identify a relevant problem in your domain and develop an appropriate solution using the Fuzzy Logic toolbox, applying the knowledge you have gained so far.

**Web Links:**

1. [Soft Computing Tools in Engineering \(iitkgp.ac.in\)](http://iitkgp.ac.in)

## Object Oriented Programming through JAVA (ECE)

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Develop Java programs using basic programming constructs.
- CO2:** Apply object-oriented concepts to design Java applications.
- CO3:** Implement inheritance and polymorphism in Java programs.
- CO4:** Use packages and file handling techniques in Java applications.
- CO5:** Develop Java programs using exception handling and multithreading concepts.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 1    | 1    | -    | 1    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 2    | 1    | -    | 1    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 2    | 1    | -    | 1    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 1    | 2    | 1    | 1    | 2    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 2    | 1    | 1    | 2    | -    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 1    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT-1

**Java Fundamentals and Problem Solving:** Introduction to Java, Features of Java, Java Program Structure, Data Types, Variables, Operators, Control Statements, Arrays.

1. Write a Java program to check whether a given number is an Armstrong Number.
2. Write a Java program to generate the Fibonacci series up to N terms.
3. Write a Java program to sort the elements of an array in ascending order.
4. Write a Java program to find the second largest element in an array.
5. Write a Java program to remove duplicate elements from an array.

### UNIT-2

**Classes, Objects and Strings:** Classes and Objects, Methods, Constructors, Constructor Overloading, Method Overloading, this, static, final, String class and its methods

1. Write a Java program to create a Student class and display student details using constructors.
2. Write a Java program to demonstrate constructor overloading.
3. Write a Java program to implement method overloading for adding values of different data types and varying numbers of arguments.
4. Write a Java program to check whether a given string is an anagram.
5. Write a Java program to check whether a given string is a pangram using String methods.

### UNIT-3

**Inheritance and Polymorphism:** Inheritance, Types of Inheritance, super keyword, Method Overriding, Abstract Classes, Dynamic Method Dispatch, Interfaces.

1. Write a Java program to demonstrate single inheritance using Student and Result classes.
2. Write a Java program to demonstrate multilevel inheritance.
3. Write a Java program to calculate the area of different shapes using abstract classes.
4. Write a Java program to demonstrate runtime polymorphism using method overriding.
5. Write a Java program to demonstrate multiple inheritance using interfaces.

### UNIT-4

**Packages, File Handling :** Packages, Access Specifiers, Wrapper Classes, File Handling (FileReader, FileWriter, BufferedReader, BufferedWriter)

1. Write a Java program to create and use a user-defined package.
2. Write a Java program to demonstrate the use of Wrapper Classes by converting primitive data types into wrapper objects and vice versa.
3. Write a Java program to read data from one file and write it into another file.
4. Write a Java program to count the number of characters, words, and lines in a text file.
5. Write a Java program to store even numbers in Even.txt and odd numbers in Odd.txt.

### UNIT-5

**Exception Handling and Multithreading:** Exception Handling (try, catch, throw, throws, finally), User-defined Exceptions, Thread Life Cycle, Thread Creation, Synchronization, Inter-thread Communication.

1. Write a Java program to demonstrate multiple catch blocks in exception handling.
2. Write a Java program to create and use a user-defined exception.
3. Write a Java program to create threads by extending the Thread class.
4. Write a Java program to create threads by implementing the Runnable interface.
5. Write a Java program to solve the Producer–Consumer problem using synchronization.

### Additional Practice:

1. Write a Java program to create a Calculator using methods to perform addition, subtraction, multiplication, and division.



2. Write a Java program to implement a simple Banking System using classes to perform deposit, withdrawal, and balance enquiry operations.
3. Write a Java program to maintain a Student Record System that allows adding student details and displaying the topper based on marks.
4. Write a Java program to implement a Phone Book Application that allows users to add, search, update, and delete contact details.

**Reference Books:**

1. The Complete Reference Java, Herbert Schildt, TMH ,8<sup>th</sup> Edition,ISBN 978-1260440232.
2. Java one step ahead, Anita seth, B.L.Juneja, Oxford, First Edition.ISBN: 9780199459643.
3. Introduction to java programming, by Y Daniel Liang, Seventh Edition, Pearson. ISBN: 978-8131729588
4. Core Java: An Integrated Approach, R.Nageswara Rao, Dream tech press.ISBN:978-9351199250

**Web Links:**

- 1 <https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Java%20Programming%20Course%20Description.pdf>
- 2 <https://nptel.ac.in/courses/106/105/106105191/>
- 3 <http://java.sun.com/docs/books/tutorial/>

## ECAD Tools

**Course Code:2501EC16**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Comprehend the insight of CAD Tools in modern design.
- CO2:** Develop combinational logic circuits by using CAD tools.
- CO3:** Build sequential logic circuits using Verilog HDL operators.
- CO4:** Analyze the performance of logic schematics using CAD simulation tools.
- CO5:** Infer the performance of logic circuits using DRC, LVS and PEX.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    |      | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 2    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### Practice:

- Understanding the working platform with Xilinx Vivado and its device, family and package Selection.
- Design and Implementation of Combinational Circuits Priority Encoder and Comparator using data flow & structural style.
- Design and Implementation of Sequential Circuits to detect a given sequence using with and without overlapping (Mealy & Moore machines).
- Design and Implementation of a traffic light controller in a three road & four road junctions.
- Exercise on Concatenation, Replication operators, Reduction and Conditional operators in Verilog HDL.
- Plotting the (i) output characteristics (ii) Transfer characteristics of an n-channel and p-channel MOSFET with Cadence.
- Working with Schematic for Ring Oscillator with variable amounts of Pull up to pull down ratios.

8. Design a full adder by instantiating the logic gates. Make a comment on design style on its performance.
9. Design a NAND gate by using NMOS, PMOS and CMOS technologies and make a comment on its performance.
10. Design a layout for given logic and test for its DRC, LVS and PEX. Make a note on change in propagation delay with respect to PEX data.

**Additional Practice:**

3. Design and plot the characteristics of a 4x1 digital multiplexer using pass transistor logic and TG logic.
4. Design and plot the characteristics of a positive and negative latch based on multiplexers

**Text Books:**

1. CMOS Digital Integrated Circuits : Analysis and Design, S. M. Kang and Y. Leblebici, McGraw-Hill Education, 3<sup>rd</sup> Edition, ISBN: 978-0071243421.
2. Silicon VLSI Technology: Fundamentals, Practice & Modeling, James D. Plummer, Micheal Deal , Peter B. Griffin, Pearson India, 1<sup>st</sup> Edition, ISBN: 978-0130850379.

**Reference Books:**

1. Microchip Fabrication: A Practical Guide to Semiconductor Processing, Peter Van Zant, McGraw-Hill Professional, 6<sup>th</sup> Edition, ISBN: 978-0071821018.
2. CMOS Circuit Design, Layout and Simulation, R. Jacob Baker, Wiley-IEEE Press, 4<sup>th</sup> Edition, ISBN: 978-0780334168.
3. J. M. Rabaey, A. P. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson Education India, 2<sup>nd</sup> Edition, ISBN: 978-9332573925.

**Web Links:**

1. [https://www.cadence.com/en\\_US/home/company/cadence-academic-network/educators/vlsi-fundamentals.html](https://www.cadence.com/en_US/home/company/cadence-academic-network/educators/vlsi-fundamentals.html), Cadence Design Systems.
2. <https://www.xilinx.com/video/hardware/getting-started-vivado-high-level-synthesis.html> , Xilinx Vivado High Level Synthesis.
3. [https://onlinecourses.nptel.ac.in/noc23\\_ee137/preview](https://onlinecourses.nptel.ac.in/noc23_ee137/preview).

## Verification Using Verilog & UVM

**Course Code:2501EC017**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Develop Basic Testbench using UVM.
- CO2:** Apply assertion based and Coverage – Driven verification techniques to the testbench.
- CO3:** Implement Functional Coverage models and verify complex protocols like AXI, PLle etc.,
- CO4:** Implement TLM interfaces for communication and advanced constrained Networks.
- CO5:** Verify designs using multiple interfaces and mixed signals.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 2    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### Practice:

1. Basic Testbench:
  - a. Develop a simple Verilog testbench to simulate a digital design.
  - b. Create stimuli and check responses manually.
2. Basic UVM Testbench
  - a. Develop a simple UVM testbench framework.
  - b. Implement basic UVM components: env, agent, driver, sequencer, and monitor.
3. Stimulus Generation:
  - a. Use UVM sequences to generate stimuli.
  - b. Create constrained random test cases.
4. Score boarding:
  - a. Implement a scoreboard in UVM to compare expected vs. actual results.

- b. Use functional coverage to track verification progress.
- 5. Assertion-Based Verification:
  - a. Write System Verilog assertions to check protocol compliance.
  - b. Integrate assertions into a UVM testbench.
- 6. Coverage-Driven Verification:
  - a. Develop coverage models using cover groups and cover points.
  - b. Analyse coverage results to identify untested scenarios.
- 7. VIP Integration:
  - a. Integrate UVM Verification IP (VIP) into the testbench.
  - b. Verify complex protocols like AXI, PCIe, etc.
- 8. Functional Coverage:
  - a. Define and implement functional coverage models.
  - b. Analyse coverage data to ensure all design functionalities are tested.
- 9. Reusable UVM Components:
  - a. Create reusable UVM components for different testbenches.
  - b. Parameterize components for flexibility.
- 10. Transaction-Level Modelling (TLM):
  - a. Implement TLM interfaces for communication between UVM components.
  - b. Use TLM for high-level transaction Modelling.
- 11. Advanced Stimulus Generation:
  - a. Implement advanced constrained random techniques.
  - b. Use UVM sequences to control stimulus generation dynamically.
- 12. Debugging and Logging:
  - a. Utilize UVM reporting mechanisms for debugging.
  - b. Implement custom error and status messages.

### **Additional Practice:**

- 1. Multiple Interface Verification:
  - a) Verify designs with multiple interfaces.
  - b) Develop agents and drivers for each interface.
- 2. Mixed-Signal Verification:
  - a) Integrate Analog models with digital testbenches.
  - b) Use Real-number modelling (RNM) techniques.
- 3. Performance and Timing Verification:
  - a) Measure and verify timing constraints.
  - b) Use UVM to simulate and check timing behaviours
- 4. Interoperability Testing:
  - a) Test interoperability between different modules or IP blocks.
  - b) Use UVM to create complex test scenarios.

**Text Books:**

1. A Practical Guide to Adopting the Universal Verification Methodology (UVM) Second Edition, ISBN: 978-1300535935.
2. The UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology by Ray Salemi, ISBN: 978-0974164939.

**Reference Books:**

1. A Practical Guide for System Verilog Assertions by Srikanth Vijayaraghavan & Meyyappan Ramanathan, ISBN: 978-1489992796.
2. Getting Started with UVM: A Beginner's Guide by Vanessa R. Coppe, ISBN: 978-0615819976.

**Web Links:**

1. [https://www.cadence.com/en\\_US/home/training/all-courses/86070.html](https://www.cadence.com/en_US/home/training/all-courses/86070.html)
2. <https://www.chipverify.com/tutorials/uvm>
3. <https://verificationacademy.com/forums/t/systemverilog-or-uvm/39566>

### Value Added Courses (VAC)

| Course Code  | Course Name                                   | Level | L | T | P         | C        | CIE | SEE | Total | Pre-requisite |
|--------------|-----------------------------------------------|-------|---|---|-----------|----------|-----|-----|-------|---------------|
| 2501CS04     | Internet of Things                            | FC    |   |   | 1         | 1        | 50  | 50  | 100   | -             |
| 2501CS02     | Data Analysis Using Python                    | IC    |   |   | 2         | 2        | 50  | 50  | 100   | PPSC          |
| 2501UC11     | Employability Skills-I                        | FC    |   |   | 3         | 0        | 100 | -   | 100   | -             |
| 2501UC13     | Employability Skills-II                       | FC    |   |   | 3         | 0        | 100 | -   | 100   | ES-I          |
| 2501UC14     | Employability Skills-III                      | IC    |   |   | 3         | 0        | 100 | -   | 100   | ES-II         |
| 2501UC15     | Employability Skills-IV                       | IC    |   |   | 3         | 0        | 100 | -   | 100   | ES-III        |
| 2501UC16     | Employability Skills-V                        | AC    |   |   | 3         | 1        | 100 | -   | 100   | ES-IV         |
| 2501AC06     | Advanced Data Structures & Algorithm Analysis | AC    | 2 |   | 1         | 0        | 100 | -   | 100   | DS            |
| <b>Total</b> |                                               |       |   |   | <b>18</b> | <b>4</b> |     |     |       |               |

### **Value Added Courses (VAC)**



## Internet of Things

**Course Code: 2501CS04**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>1</b> | <b>1</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Analyze IoT architecture and apply embedded system fundamentals to implement digital and analog interfacing using Arduino UNO.
- CO2:** Interface and acquire data from various analog and digital sensors and process real-time data using appropriate techniques.
- CO3:** Design and implement sensor-based automation systems by integrating sensors and actuators with decision-making logic for real-time applications.
- CO4:** Implement communication protocols and develop multi-sensor systems using serial and I2C communication, and integrate IoT devices such as NodeMCU ESP8266 / ESP32 for data transmission.
- CO5:** Design, develop, and demonstrate complete IoT-based solutions for real-time applications involving cloud connectivity, remote monitoring, and control as part of cornerstone projects.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    |      |      | 2    |      |      |      |      |       |       |
| <b>CO2</b> | 3    | 2    | 1    | 1    | 2    |      |      |      |      |       |       |
| <b>CO3</b> | 3    | 2    | 2    |      | 3    |      |      |      | 1    | 1     |       |
| <b>CO4</b> | 3    | 2    | 2    | 1    | 3    |      |      |      | 1    | 1     |       |
| <b>CO5</b> | 2    | 2    | 3    | 1    | 3    |      |      |      | 2    | 2     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 3    | 1    |
| <b>CO2</b> | 3    | 2    |
| <b>CO3</b> | 3    | 2    |
| <b>CO4</b> | 2    | 3    |
| <b>CO5</b> | 2    | 3    |

### List of Experiments:

1. Analyze the architecture, features, GPIO interfaces, and communication protocols (UART, I2C, SPI, and Wi-Fi) of IoT hardware platforms such as ESP32, NodeMCU ESP8266, and Arduino UNO for real-time embedded IoT applications.
2. Study the working principles and interfacing of IoT sensors such as LDR, DHT11, MQ2/MQ135 gas sensor, soil moisture sensor, ultrasonic sensor, rain sensor, RFID,

sound sensor LM393, touch sensor, PIR sensor, and IR sensor, along with actuators such as LED, buzzer, relay, and servo motor.

3. Design and implement digital output control using Arduino UNO to generate LED blinking patterns with fixed and variable delays for understanding timing control.
4. Interface an analog sensor (LDR) with Arduino using a voltage divider, acquire real-time data through ADC, display values on Serial Monitor, and implement threshold-based logic to control an LED or buzzer based on light intensity.
5. Develop a temperature-based automation system by interfacing LM35 sensor with Arduino and controlling an external device through a relay module based on predefined temperature thresholds.
6. Interface an ultrasonic sensor with Arduino UNO to measure distance by generating trigger pulses and calculating echo response time, and implement distance-based control of an actuator (LED/buzzer).
7. Design and implement a multi-sensor data acquisition system by interfacing multiple sensors with Arduino/ESP module, process and display combined sensor data.
8. Interface an I2C-based sensor such as BMP180 with Arduino UNO or NodeMCU ESP8266 to acquire environmental data and analyze I2C communication.
9. Establish Wi-Fi connectivity using NodeMCU ESP8266 to acquire sensor data and transmit it to an IoT cloud platform for remote monitoring.
10. Design and implement a complete IoT system using ESP8266 for real-time sensor data acquisition, cloud-based visualization, and remote control of an actuator (LED/relay) through a web or mobile dashboard.

### **Cornerstone Projects:**

#### **1 Smart Room Automation System**

##### **Description**

Develop an IoT-based room automation system that automatically controls lighting based on occupancy and ambient light conditions.

##### **Expected Outcome**

Automatic energy-saving room lighting system.

##### **Optional Advanced Feature Integration (Implement Any One)**

- Mobile app control
- Voice assistant integration
- Energy analytics dashboard
- Automatic scheduling

## **2 IoT Weather Monitoring System**

### **Description**

Design a weather monitoring system that measures temperature and humidity and uploads data to the cloud.

### **Expected Outcome**

Real-time environmental monitoring system.

Optional Advanced Feature Integration (Implement Any One)

- Weather trend analysis
- Mobile dashboard
- Data logging
- Alert notifications

## **3 Smart Plant Monitoring System**

### **Description**

Develop a soil moisture monitoring system that alerts users when plants require watering.

### **Expected Outcome**

Automated plant monitoring and water-saving system.

Optional Advanced Feature Integration (Implement Any One)

- Cloud monitoring
- Water usage analytics
- Mobile notifications
- Predictive irrigation alerts

## **4 IoT Gas Leakage Alert System**

### **Description**

Create a gas leakage detection system that generates alerts during hazardous gas conditions.

### **Expected Outcome**

Real-time gas leakage detection and alert system.

Optional Advanced Feature Integration (Implement Any One)

- Cloud alert notifications
- Emergency alarm system
- Gas level analytics
- SMS/email alerts

## **5 Smart Dustbin Monitoring System**

### **Description**

Design a smart waste monitoring system capable of detecting garbage levels in a dustbin.

### **Expected Outcome**

Smart waste-level monitoring system.

Optional Advanced Feature Integration (Implement Any One)

- Overflow notifications
- Cloud dashboard
- Waste collection analytics
- Mobile monitoring

## **6 Smart Parking Slot Detection System**

### **Description**

Develop a parking occupancy monitoring system using IR sensors.

### Expected Outcome

Automatic parking slot availability indication system.

Optional Advanced Feature Integration (Implement Any One)

- Parking analytics
- Web dashboard
- Vehicle count monitoring
- Mobile slot status display

## **7 IoT-Based Fire Detection System**

### Description

Develop a fire detection system capable of identifying flame conditions and generating alerts.

### Expected Outcome

Real-time fire detection and warning system.

Optional Advanced Feature Integration (Implement Any One)

- Cloud notifications
- Incident logging
- Emergency alert system
- Mobile monitoring

## **8 IoT-Based Noise Pollution Monitoring System**

### Description

Design a noise monitoring system to measure and visualize environmental sound levels.

### Expected Outcome

Noise pollution monitoring and analysis system.

Optional Advanced Feature Integration (Implement Any One)

- Sound level analytics
- Noise trend visualization
- Alert notifications
- Cloud data logging

## **9 IoT-Based Digital Notice Board System**

### Description

Develop a wireless digital notice board capable of displaying real-time notices through the internet.

### Expected Outcome

Wireless real-time digital announcement system.

Optional Advanced Feature Integration (Implement Any One)

- Multi-user access
- Emergency alert mode
- Scrolling text display
- Mobile/web portal integration

## **10 Smart Medicine Reminder System**

### Description

Develop a medicine reminder system that alerts users according to predefined schedules.

### Expected Outcome

Automated medicine reminder and monitoring system.

Optional Advanced Feature Integration (Implement Any One)

- Voice reminder support
- Mobile notifications
- Medicine intake logging
- Caretaker alert system

## **11 Smart Water Level Monitoring System**

### **Description**

Design a water level monitoring system that continuously measures tank water levels and generates alerts.

### **Expected Outcome**

Real-time water level monitoring and alert system.

### **Optional Advanced Feature Integration (Implement Any One)**

- Mobile alerts
- Water usage analytics
- Overflow prediction
- Cloud dashboard visualization

## **12 Smart Intruder Alert System**

### **Description**

Develop an IoT-enabled security system capable of detecting unauthorized movement and generating alerts.

### **Expected Outcome**

Real-time intrusion detection and alert system.

### **Optional Advanced Feature Integration (Implement Any One)**

- Mobile notifications
- Cloud event logging
- Security analytics
- Alarm activation system

## **Guidelines for Cornerstone Project :**

- The Cornerstone Project shall be carried out batch-wise with a minimum of three students in each batch.
- Each batch may select any one of the prescribed IoT-based projects or propose a project of their own choice related to real-time IoT applications, with prior approval from the course instructor.
- The selected project must be implemented using IoT hardware platforms such as Arduino UNO, NodeMCU ESP8266, or ESP32, along with appropriate sensors, actuators, and communication modules studied in the laboratory.
- The project should demonstrate end-to-end IoT functionality, including data acquisition, processing, communication, and remote monitoring/control using a web or mobile-based dashboard.
- The project must be fully implemented, tested, and ready for demonstration during the external examination.

- Each batch shall submit a project report in the prescribed format including problem statement, system architecture, circuit diagrams, algorithm/flowchart, implementation details, results, and conclusions.
- The Semester End Examination (SEE) – Lab shall be evaluated for 50 marks based on video presentation, project demonstration, project report, and viva-voce as per the prescribed evaluation scheme.

| Component             | Description                                                                                                                                                                       | Marks     |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Video Presentation    | The video presentation shall demonstrate the working procedure of the project along with the contribution of each student, with a minimum duration of 2 minutes per student.      | 10        |
| Project Demonstration | During the external examination, the batch shall demonstrate the project in proper working condition and explain the system using charts, posters, or other suitable visual aids. | 20        |
| Project Report        | Submission of the project report in the prescribed format, including system design, circuit diagrams, implementation details, results, and conclusions.                           | 10        |
| Viva-Voce             | Oral examination based on the project work, IoT concepts, sensors, communication, and system integration.                                                                         | 10        |
| <b>Total Marks</b>    |                                                                                                                                                                                   | <b>50</b> |

#### Reference Books:

1. Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, First Edition, Universities Press, ISBN: 978-8173719547.
2. Getting Started with Arduino, Massimo Banzi, Michael Shiloh, Third Edition, Maker Media (O'Reilly), ISBN: 978-9352130047.
3. Programming the Internet of Things: An Introduction to Building Integrated, Device-to-Cloud IoT Solutions, Andy King, First Edition, O'Reilly Media, ISBN: 978-1492081418.
4. Designing the Internet of Things, Adrian McEwen, Hakim Cassimally, First Edition, Wiley, ISBN: 978-1118430620.

#### Web Links:

1. <https://nptel.ac.in/courses/106105166>
2. <https://docs.arduino.cc/>
3. <https://arduino-esp8266.readthedocs.io/>
4. <https://docs.arduino.cc/arduino-cloud/>
5. <https://randomnerdtutorials.com/projects-esp32/>

## Data Analysis Using Python

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

|                              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|------------------------------|----------|----------|----------|----------|
| <b>Course Code: 2501CS02</b> | <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Make use of control statements and data structures to solve problems
- CO2:** Apply OOPs concepts and files to develop applications.
- CO3:** Explain the data collection, management and storage for processing using Numpy
- CO4:** Make use of Pandas to create and manipulate data structures like Series and DataFrames.
- CO5:** Create plots using Matplotlib library for better visualization.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | 1    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 1    | 2    | 3    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 1    | 3    | 2    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 1    | 2    | 3    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 1    | 2    | 3    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |

## UNIT-I

### Introduction:

History of Python, Applications of Python, Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation, Operators and Expressions, Control Flow- if, if-elif-else, for, while, break, continue, Data Structures Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions, Defining Functions, Calling Functions, Passing Arguments.

- 1.1) Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
- 1.2) Write a program that uses a for loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89.
- 1.3) Split a string into array of characters in Python.
- 1.4) write a Python program to get the largest number from a list.
- 1.5) Write a Python program to calculate the nth Fibonacci number using a function.

## UNIT -II

### Object Oriented Programming:

Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using OOPS support

Design with Classes: Objects and Classes, Data modeling Examples, Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, Userdefined Exceptions.

- 2.1) Write a Python program that defines a Car class with attributes like make, model, and year, and methods like start() to start the car and stop() to stop it.
- 2.2) Write a Python program that demonstrates inheritance by creating a base class Animal and derived classes like Dog, Cat, etc., each with their specific behaviors.
- 2.3) Define a base class called Animal with a method make\_sound(). Implement derived classes like Dog, Cat, and Bird that override the make\_sound() method to produce different sounds. Demonstrate polymorphism by calling the method on objects of different classes.
- 2.4) Write a Python program that demonstrates error handling using the try-except block to handle division by zero.

### UNIT -III

#### **Numpy:**

Introduction to numpy, creating arrays, using arrays and scalars, Indexing Arrays, Array transposition, Universal array function, Array Processing, Array Input and Output, Examples.

- 3.1) Write a NumPy program using methods – info, add, array, all, greater, greater\_equal, less and less\_equal, equal, allclose, zeros, ones, linspace, tolist.
  - a. To get help on the add function
  - b. To test whether none of the elements of a given array is zero.
  - c. To create an element-wise comparison (greater, greater\_equal, less and less\_equal, equal, equal within a tolerance) of two given arrays.
- 3.2) Write a NumPy program using NumPy methods - max, min, argmax, argmin, argmax, repr, count, bincount, unique.
  - a. To extract all numbers from a given array which are less and greater than a specified number.
  - b. To find the indices of the maximum and minimum numbers along the given axis of an array.

### UNIT -IV

#### **Pandas:**

Exploring Data using Series, Exploring Data using DataFrames, Index objects, Re index, Drop Entry, Selecting Entries, Data Alignment, Rank and Sort, Summary Statistics, Data Munging in Python using Pandas, Index Hierarchy, Example Problem.

#### 4.1) Pandas DataFrame:

- i) Write a Pandas program to create and display a one-dimensional array-like object containing an array of data using Pandas module.
- ii) Write a Pandas program to convert a Panda module Series to Python list and its type.

#### 4.2) Pandas DataFrames:

Consider Sample Python dictionary data and list labels:

```
exam_data = {'name': ['Anastasia', 'Dima', 'Katherine', 'James', 'Emily', 'Michael', 'Matthew', 'Laura', 'Kevin', 'Jonas'],  
'score': [12.5, 9, 16.5, np.nan, 9, 20, 14.5, np.nan, 8, 19],
```



'attempts': [1, 3, 2, 3, 2, 3, 1, 1, 2, 1],

'qualify': ['yes', 'no', 'yes', 'no', 'no', 'yes', 'yes', 'no', 'no', 'yes']}]}

labels = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j']

i) Write a Pandas program to create and display a Data Frame from a specified dictionary data which has the index labels.

ii) Write a Pandas program to change the name 'James' to 'Suresh' in name column of the Data Frame.

iii) Write a Pandas program to insert a new column in existing Data Frame

iv) Write a Pandas program to get list from Data Frame column headers.

v) Write a Pandas program to get list from Data Frame column headers.

## UNIT-V

### Introduction to Matplotlib:

Introduction to Matplotlib Library, Plotting Data: Line Plots, Scatter Plots, Customizing Plots, Common Types of Plots Bar Charts: Simple Bar Plot, Horizontal Bar Plot, Advanced Plot Customizations.

5.1) Create a series of plots to analyze a given dataset.

5.2) Generate a subplot layout with various plot types (scatter, line, bar).

5.3) Visualize time-series data and customize axis labels and date formats.

5.4) Create a 3D plot.

### Additional Practice:

1. Write a program to find the greatest number that can be formed by using given set of numbers.
2. Write a Python program to develop a GUI based Calculator application.
3. Write a Python program to develop a GUI based todo list application for adding, deleting and updating tasks.

### Reference Books:

1. Python for Everybody Exploring Data in Python 3, Charles Russell Severance, SueBlumenberg. ISBN:978-1530051120.
2. Code with Python: Suresh Sundaradasu, S.Rama Sree ISBN: 978-9355017574
3. Python Programming, Dr. Maganti Venkatesh, Monelli Ayyavaraiah, Niveditha Ravindra Pandey, Neethumol Sabu, Charulatha Publications ISBN:978-93-5577-695-6.
4. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, Wes McKinney, O'Reilly Media, ISBN: 978-1491957660.

### Web Links:

1. <https://www.hackerrank.com/>
2. <https://www.codechef.com/>
3. <https://www.topcoder.com/>
4. <https://code-cracker.github.io/>

## Employability Skills- I

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E & Agri.E)

**Course Code:2501UC11**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>3</b> | <b>0</b> |

### Course Outcome:

**At the end of the course, student will be able to :**

- CO1:** Apply fundamental arithmetic concepts such as number systems, LCM & HCF, ratio & proportion, and averages to solve quantitative problems efficiently.
- CO2:** Analyze number and letter series to identify logical patterns and predict subsequent elements.
- CO3:** Select the option by evaluating relationships in analogy-based problems and detecting inconsistencies in logical sequences
- CO4:** Demonstrate effective verbal communication skills by using appropriate parts of speech and tone in various interpersonal and professional contexts.

### Mapping with Program Outcomes:

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

### Aptitude:

Number System, LCM & HCF, Ratio and Proportion, Averages

### Reasoning:

Number Series, Letter Series, Number Analogy, Letter Analogy, Odd Man Out, Logical Sequence of Words.

### Verbal:

Introduction to soft skills, how to improve communication? Parts of Speech, Mind your language towards better English, Vocabulary Expansion

### Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

**Reference Books:**

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Premkishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

**Web Links:**

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.bankersadda.com](http://www.bankersadda.com)

## Employability Skills- II

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E & Agri.E.)

**Course Code:2501UC13**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>3</b> | <b>0</b> |

### Course Outcome:

**At the end of the course, student will be able to :**

- CO1:** Apply percentage, profit & loss, and partnership concepts to solve real-world quantitative problems.
- CO2:** Analyze age-related problems to develop logical problem-solving strategies.
- CO3:** Evaluate logical reasoning questions including ranking, directions, and alphabet tests for accurate decision-making.
- CO4:** Solve pattern-based problems in coding and decoding to enhance analytical skills.
- CO5:** Demonstrate effective written communication using correct grammar and structured presentation techniques

### Mapping Course outcomes with Program Outcomes:

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

### Aptitude:

Problems on Ages, Partnership, Percentages, Profit and Loss

### Reasoning:

Coding and Decoding, Ranking Test, Alphabet Test, Direction Test

### Verbal:

Written communication skill practice, Grammatical use, Concept of 4 step method for presentation, Present Tense

### Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

**Reference Books:**

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Premkishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

**Web Links:**

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.bankersadda.com](http://www.bankersadda.com)

### Employability Skills- III

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E & Agri.E.)

**Course Code:2501UC14**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 0 |

#### Course Outcome:

**At the end of the course, student will be able to :**

- CO1:** Solve financial and quantitative aptitude problems using concepts of simple and compound interest.
- CO2:** Apply logical time-work frameworks to solve real-time problems related to work efficiency and pipe systems.
- CO3:** Analyze and interpret problems related to blood relations, clocks, calendars, and coded inequalities.
- CO4:** Evaluate spatial and logical reasoning through cubes, dice, and symbolic interpretation problems.
- CO5:** Demonstrate effective communication using correct grammar, and participate actively in discussions and comprehension activities.

#### Mapping with Program Outcomes :

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

#### Aptitude:

Simple Interest, Compound Interest, Time and Work, Pipes and Cisterns

#### Reasoning:

Blood Relations, Calendar, Clocks, Cubes and Dice, Coded Inequalities

#### Verbal:

Grammar in use, Group discussion, Reading Comprehension, Past Tense, Future Tense

#### Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

**Reference Books:**

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal , Non-Verbal & Analytical – Jaikishan and Premkishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

**Web Links:**

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.bankersadda.com](http://www.bankersadda.com)

## Employability Skills- IV

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min.E & Agri.E.)

**Course Code:2501UC15**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>3</b> | <b>0</b> |

### Course Outcome:

**At the end of the course, student will be able to:**

- CO1** Apply concepts of time, speed, distance, trains, boats and streams to solve motion-related aptitude problems.
- CO2** Solve mensuration problems involving surface area and volume in real-world contexts.
- CO3** Analyze logical reasoning questions involving Venn diagrams and syllogisms to make valid conclusions.
- CO4** Interpret seating arrangements and solve non-verbal reasoning questions involving patterns and spatial reasoning.
- CO5** Demonstrate effective communication through structured self-introduction, emails, letters, reports, and grammar usage.

### Mapping with Program Outcome:

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

### Aptitude:

Time, Speed and Distance, Problems on Trains, Boats and Streams, Mensuration - I, Mensuration - II

### Reasoning:

Venn Diagrams, Syllogisms, Non - Verbal Reasoning, Seating Arrangement

### Verbal:

Grammatical use, Self-introduction, Letters, E-Mail & Report writing, Error correction, Effective Communication

### Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.



**Reference Books:**

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal, Non-Verbal & Analytical – Jaikishan and Premkishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

**Web Links:**

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.bankersadda.com](http://www.bankersadda.com)

### Employability Skills- V

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

**Course Code:2501UC16**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1 |

#### Course Outcome:

**At the end of the course, student will be able to :**

- CO1:** Apply principles of permutations, combinations, probability, and logarithms to solve quantitative aptitude problems.
- CO2:** Interpret and analyze data from charts, graphs, and statistical tables for decision-making and accuracy.
- CO3:** Evaluate logical reasoning statements involving arguments, assumptions, conclusions, and data sufficiency.
- CO4:** Solve puzzle and eligibility test problems using analytical and critical thinking skills.
- CO5:** Demonstrate effective interpersonal, communication, and time management skills for successful personal and professional interactions.

#### Mapping with Program Outcomes:

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

#### Aptitude:

Permutations and Combinations, Probability, Data Interpretation, Logarithms, Statistics

#### Reasoning:

Puzzle Tests, Eligibility Test, Data Sufficiency, Statements – Arguments, Statements – Assumptions, Statements - Course of Action, Statements - Conclusions

#### Verbal:

Interview skills, Grammar in use, Interpersonal Skills, Negotiation Skills, Social Skills, Problem-Solving Skills, Time Management Skills

#### Text Books:

1. Quantitative Aptitude –Dr. R. S. Aggarwal, S CHAND, ISBN · 9789355012326.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal, ISBN-13. 978-9352832163.

3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND, ISBN-13. 978-8121922111.

**Reference Books:**

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications, ISBN-13 9789389957426.
2. How To Crack Test of Reasoning Verbal, Non-Verbal & Analytical – Jaikishan and Premkishan, Arihant Publications, NEW EDITION 2024, ASIN : B0CRQ9BVBC.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications, ISBN-13: 978-8186651032.

**Web Links:**

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.bankersadda.com](http://www.bankersadda.com)

## Advanced Data Structures & Algorithm Analysis

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501AC06</b> | <b>2</b> | <b>0</b> | <b>1</b> | <b>0</b> |

### Course Outcomes:

At the end of the Course, Student will be able to:

**CO1:** Analyze the algorithms efficiency and hashing techniques for searching.

**CO2:** Illustrate the concepts of search trees and operations of Priority Queues.

**CO3:** Analyze the algorithms of Divide & Conquer and Greedy paradigms.

**CO4:** Analyze the algorithms of Dynamic Programming paradigm.

**CO5:** Design the algorithms of Backtracking and Brach & Bound paradigms.

### Mapping of Course Outcomes with Program Outcomes:

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

### UNIT – I

**Introduction to Algorithm Analysis,** Space and Time Complexity analysis, Asymptotic Notations.

**Hashing:** Introduction to Static Hashing, Hash Tables, Hash Functions, Different Hash Functions, Collision Resolution Techniques, Dynamic Hashing.

#### Practice:

1. Write a program to implement collision resolution techniques of Hash data structure.

### UNIT – II

**AVL Trees** – Creation, Insertion, Deletion operations and Applications.

**B-Trees** – Creation, Insertion, Deletion operations and Applications

**Priority Queues (Heaps):** Introduction, Binary Heaps-Model and Simple Implementation, Basic Heap Operations, Other Heap Operations, Applications of Priority Queue.

#### Practice:

1. Write a program to implement AVL tree operations
2. Write a program to implement Max heap and min heap operations

## UNIT – III

**Divide and Conquer:** The General Method, Binary Search, Merge Sort, Quick Sort.

**Greedy Method:** The General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths.

**Practice:**

1. Write a program to sort the given list of elements using Merge sort technique using divide and conquer approach.
2. Write a program to implement Single Source Shortest Paths using greedy approach.

## UNIT – IV

**Dynamic Programming:** The General Method, Single Source Shortest Paths– General Weights (Bellman Ford Algorithm), All-pairs shortest paths, Optimal Binary Search Trees, 0/1 Knapsack, Travelling Salesperson problem

**Practice:**

1. Write a program to implement 0/1 Knapsack problem using Dynamic Programming approach.
2. Write a program to implement all pairs shortest path problem using Dynamic Programming approach.

## UNIT – V

**Backtracking:** The General Method, N-Queens Problem, Sum of Subsets problem, Graph Coloring, Hamiltonian cycles.

**Branch and Bound:** The General Method, 0/1 Knapsack Problem, Travelling Salesperson problem.

**Practice:**

1. Write a program to implement N-Queens problem using backtracking algorithm.
2. Write a program to implement Travelling Salesperson problem using branch and bound approach.

**Text Books:**

1. Fundamentals of Data Structures in C++, Horowitz, Ellis; Sahni, Sartaj; Mehta, Dinesh, 2<sup>nd</sup> Edition Universities Press.
2. Computer Algorithms in C++, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, 2<sup>nd</sup> Edition University Press.

**Reference Books:**

1. Data Structures and program design in C, Robert Kruse, 2nd Edition Pearson Education Asia.
2. An introduction to Data Structures with applications, Trembley & Sorenson, McGraw Hill
3. The Art of Computer Programming, Vol.1: Fundamental Algorithms, Donald E Knuth, Addison - Wesley.
4. Data Structures using C & C++: Langsam, Augenstein & Tanenbaum, Pearson

**Web Links:**

1. <https://archive.nptel.ac.in/courses/106/102/106102064/>
2. <https://archive.nptel.ac.in/courses/106/106/106106131/>
3. <http://peterindia.net/Algorithms.html>

### Mandatory Courses (MC)

| Course Code | Course Name                            | Level | L         | T | P | C        | CIE | SEE | Total | Pre-requisite |
|-------------|----------------------------------------|-------|-----------|---|---|----------|-----|-----|-------|---------------|
| 2501AC01    | Environmental Science                  | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC02    | Constitution of India                  | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC03    | Research Methodology                   | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC04    | Intellectual Property Rights & Patents | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
| 2501AC05    | Indian Knowledge Systems               | FC    | 2         |   |   | 0        | 100 | -   | 100   | -             |
|             | <b>Total</b>                           |       | <b>10</b> |   |   | <b>0</b> |     |     |       |               |

## **Mandatory Courses (MC)**



## Environmental Science

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT &Min.E)

**Course Code: 2501AC01**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>0</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Outline the natural resources and their importance for the sustenance of the life
- CO2:** Explain about the biodiversity of India, threats and its conservation methods
- CO3:** Illustrate various attributes of the pollution, impacts and measures to control the pollution along with waste management practices
- CO4:** Describe social issues of both rural and urban environment to combat the challenges and the legislations of India in environmental protection
- CO5:** Explain the population growth and its implications

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 1    | -    | -    | -    | 1    | -    | 2    | -    | -    | -     | -     |
| CO2   | 1    | -    | -    | -    |      | -    | 3    | -    | -    | -     | -     |
| CO3   | -    | -    | -    | -    | 2    | -    | 3    | -    | -    | -     | 1     |
| CO4   | -    | -    | -    | -    | 1    | -    | 3    | 1    | -    | -     | 1     |
| CO5   | -    | -    | -    | -    | -    | -    | 3    | -    | -    | -     | -     |

### UNIT – I

#### Multidisciplinary Nature of Environmental Studies:

Definition, Scope and Importance, Need for Public Awareness.

**Natural Resources:** Renewable and non-renewable resources – Natural resources and associated problems.

### UNIT – II

#### Ecosystem, Biodiversity and Its Conservation:

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers, and decomposers. Food chains, food webs and ecological pyramids.

Biodiversity And Its Conservation: Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Values of biodiversity. Hot-spots of biodiversity – Threats to biodiversity. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

### UNIT – III

#### Environmental Pollution and Solid Waste Management:

Environmental Pollution: Definition, Cause, effects, and control measures of:

- a. Air Pollution.
- b. Water Pollution
- c. Soil Pollution
- d. Marine Pollution
- e. Noise Pollution

**Solid Waste Management:**

Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution

#### **UNIT – IV**

##### **Social Issues and The Environment:**

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to Energy & Water. Resettlement and rehabilitation of people, Environmental ethics, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, and holocaust. Environment Protection Act – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act-Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

#### **UNIT – V**

##### **Human Population and The Environment:**

Population growth, variation among nations.

Environment and human health, Human Rights, Value Education. Role of Information Technology in Environment and human health.

##### **Text Books:**

1. Textbook of Environmental Studies for Undergraduate Courses, Erach Bharucha for University Grants Commission, Universities Press. ISBN: 9788173718625.
2. Environmental Studies, Palaniswamy – Pearson education. ISBN: 978-9332528277.

##### **Reference Books:**

1. Textbook of Environmental Science, Deeksha Dave and E.Sai Baba Reddy, Cengage Publications. ISBN: 978-8131517604.
2. Textbook of Environmental Sciences and Technology by M.Anji Reddy, B.S Publication. ISBN: 9385433385.
3. Comprehensive Environmental studies by J.P.Sharma, Laxmi publications. ISBN: 978-8170087380.

##### **Web Links:**

1. <https://archive.nptel.ac.in/courses/127/105/127105018/>
2. [https://onlinecourses.swayam2.ac.in/cec24\\_ge05/preview](https://onlinecourses.swayam2.ac.in/cec24_ge05/preview)

## Constitution of India

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT &Min.E)

**Course Code: 2501AC02**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>0</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain historical background of the constitution making and its importance for building a democratic India
- CO2:** Compare the functioning of three wings of the government i.e., executive, legislative and judiciary
- CO3:** Interpret the value of the fundamental rights and duties for becoming good citizen of India
- CO4:** Compare the decentralization of power between central, state and local self-government
- CO5:** Extend the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | -    | -    | -    | -    | 3    | -    | -    | 1    | 2    | -     | -     |
| <b>CO2</b> | -    | -    | -    | -    | 2    | -    | -    | 1    | 3    | -     | -     |
| <b>CO3</b> | -    | -    | -    | -    | 3    | -    | -    | 2    | 3    | -     | -     |
| <b>CO4</b> | -    | -    | -    | -    | 3    | -    | -    | 2    | 1    | -     | -     |
| <b>CO5</b> | -    | -    | -    | -    | 2    | -    | -    | 1    | 3    | -     | -     |

### UNIT – I

#### **Introduction to Indian Constitution:**

Constitution’ meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

### UNIT – II

#### **Union Government and its Administration Structure of the Indian Union:**

Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions.

### UNIT – III

#### **State Government and its Administration Governor:**

Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions

## **UNIT – IV**

### **Local Administration:**

District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PanchayatiRaj: Functions PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy.

## **UNIT – V**

### **Election Commission:**

Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women.

### **Text Books:**

1. Introduction to the Constitution of India, Durga Das Basu, Prentice – Hall of India Pvt. Ltd. New Delhi. ISBN: 978-9388548861.
2. Indian Constitution, Subash Kashyap, National Book Trust. ISBN: 9788123707341.

### **Reference Books:**

1. Dynamics of Indian Government & Politics, J.A. Siwach. ISBN: 9788120709768.
2. Indian Government and Politics, D.C. Gupta. ISBN: 9780706987782.
3. Constitutional Law of India , H.M.Sreevai, 4<sup>th</sup> edition in 3 volumes (Universal Law Publication). ISBN: 9788194776529.

### **Web Links:**

1. [nptel.ac.in/courses/109104045/](https://nptel.ac.in/courses/109104045/)
2. [nptel.ac.in/courses/101104065/](https://nptel.ac.in/courses/101104065/)

## Research Methodology

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT &Min.E)

**Course Code: 2501AC03**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>0</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain the characteristics and process of research.
- CO2:** Select the research problem by applying problem identification techniques.
- CO3:** Formulate and execute research design process.
- CO4:** Report the results of research process adhering to professional ethics.
- CO5:** Analyze the results of research using statistical measures of central tendency

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | 1     |
| <b>CO2</b> | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | 1     |
| <b>CO3</b> | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | 1     |
| <b>CO4</b> | 1    | -    | -    | 2    | -    | -    | -    | 3    | -    | 2     | 1     |
| <b>CO5</b> | 1    | -    | -    | 2    | 2    | -    | -    | -    | -    | 2     | 1     |

### UNIT – I

#### Meaning of Research:

Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature review.

### UNIT – II

#### Identification of Research Problem :

Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

### UNIT – III

#### Research Design :

Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design.

### UNIT – IV

#### Interpretation and Report Writing:

Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report.

## **UNIT – V**

### **Statistical Techniques and Tools :**

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete series and continuous series) – Correlation – Regression.

### **Text Books:**

1. Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint. ISBN: 9788122415223.
2. A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press. ISBN: 9780367135720.

### **Reference Books:**

1. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd. ISBN: 978-8126530755.
2. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi. ISBN: 9788120349469.
3. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi. ISBN: 978-8180545283.

### **Web Links:**

1. <https://nptel.ac.in/courses/127106227>
2. <https://archive.nptel.ac.in/courses/121/106/121106007/>

## Intellectual Property Rights & Patents

(Common to CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT & Min.E)

|                              |          |          |          |          |
|------------------------------|----------|----------|----------|----------|
|                              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 2501AC04</b> | <b>2</b> | <b>0</b> | <b>0</b> | <b>0</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Compare various types of Intellectual Property rights.
- CO2:** Discuss Intellectual Property and infer rights on such Intellectual Property owners
- CO3:** Explain the process of patenting
- CO4:** Apply for Trade marks and Copyrights.
- CO5:** Explain the methods to protect Trade secrets

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 1    | -    | -    | -    | 1    | -    | -    | 3    | -    | -     | 2     |
| <b>CO2</b> | 1    | -    | -    | -    | 1    | -    | -    | 3    | -    | -     | 2     |
| <b>CO3</b> | 1    | -    | -    | -    | 1    | -    | -    | 3    | -    | -     | 2     |
| <b>CO4</b> | 1    | -    | -    | -    | 1    | -    | -    | 3    | -    | -     | 2     |
| <b>CO5</b> | 1    | -    | -    | -    | 1    | -    | -    | 3    | -    | -     | 2     |

### UNIT – I

Introduction to Intellectual Property Rights (IPR): Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO –Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR – Layout Designs and Integrated Circuits – Use and Misuse of Intellectual Property Rights.

### UNIT – II

Copyrights and Neighboring Rights: Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Case Law - Semiconductor Chip Protection Act.

### UNIT – III

Patents: Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent - Exclusive Rights – Limitations - Ownership and Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Double Patenting — Patent Cooperation Treaty – New developments in Patents – Software Protection and Computer related Innovations.

## **UNIT – IV**

Trademarks and Trade secrets: Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Deceptive Similarities - Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies – Passing off Action - Introduction to Trade Secrets – General Principles - Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreements.

## **UNIT – V**

Cyber Law and Cyber Crime : Introduction to Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions - E-commerce - Data Security – Authentication and Confidentiality - Privacy - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention and Punishment – Liability of Network Providers. Relevant Cases Shall be dealt where ever necessary.

### **Text Books:**

1. Fundamentals of IPR for Engineers- Kompal Bansal & Parishit Bansal, B. S. Publications (Press). ISBN: 9788178002774.
2. Intellectual Property -Deborah E.Bouchoux, Third Edition, Cengage Learning, New Delhi. ISBN: 0 340 67786 4.

### **Reference Books:**

1. Intellectual property rights- Prabuddha Ganuli, Tata Mcgraw hill. ISBN: 978-0070077171.
2. Intellectual property rights M.Ashok kumar and Mohd.Iqbal Ali., Serials Publications. ISBN: 9788183871648.
3. Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi. ISBN: 979-8886848229.
4. Intellectual Property- Richard Stim, Cengage Learning, New Delhi. ISBN: 978-0766826656.

### **Web Links:**

1. <http://www.wipo.int/portal/en/index.html>
2. <https://indiankanoon.org/>
3. <http://www.ipindia.nic.in/patents.htm>
4. <http://www.ipindia.nic.in/trade-marks.htm>
5. <http://copyright.gov.i>



**Indian Knowledge Systems (IKS)**  
(CE, EEE, ME, ECE, CSE, IT, AIML, CSE(DS), PT, Min. E)

**Course Code: 2501AC05**

**L      T      P      C**  
**2      0      0      0**

**Course Outcomes:**

**At the end of the course, students will be able to:**

- CO1:** Describe the foundations and scope of Indian Knowledge Systems.
- CO2:** Recognize major Indian contributions to knowledge, science, and culture.
- CO3:** Appreciate ethical values and sustainability rooted in Indian traditions.
- CO4:** Relate traditional knowledge to contemporary societal and technological needs.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | -    | -    | -    | -    | -    | 3    | 1    | 1    | -    | -     | -     |
| CO2   | -    | -    | -    | -    | -    | 3    | 1    | 1    | -    | -     | -     |
| CO3   | -    | -    | -    | -    | -    | 3    | 1    | 1    | -    | -     | -     |
| CO4   | -    | -    | -    | -    | -    | 3    | 1    | 1    | -    | -     | -     |
| CO5   | -    | -    | -    | -    | -    | 3    | 1    | 1    | -    | -     | -     |

**UNIT – I**

**Foundations of Indian Knowledge Systems**

Meaning, scope, and importance of IKS. Sources of IKS: Vedas, Upanishads, Itihasas, Puranas, Shastras. Traditional Knowledge, Indigenous Knowledge, and Western Knowledge – comparison. Gurukula system and knowledge transmission traditions

**UNIT – II**

**Indian Civilization and Philosophical Traditions**

Overview of ancient Indian civilization (Indus Valley, Maurya, Gupta). Indian philosophical schools and ethical values. Epics: Ramayana and Mahabharata – cultural and moral significance. Religious traditions: Hinduism, Buddhism, Jainism, Sikhism

**UNIT – III**

**Arts, Architecture and Cultural Expressions**

Temple architecture: Nagara, Dravidian, Vesara. Mughal architecture and monuments. Indian classical dance forms and music traditions. Handicrafts, sculpture, painting, and iconography

**UNIT – IV**

**Traditional Knowledge in Health, Environment and Sustainability**

Ayurveda and Yoga – holistic health systems. Traditional agriculture and food practices. Water conservation methods and environmental ethics. Biodiversity conservation and sustainable living

## UNIT – V

### Traditional Knowledge and Contemporary Relevance

Protection of Traditional Knowledge. Traditional Knowledge (TK) and Intellectual Property Rights (overview). Role of government and national initiatives. Relevance of IKS to engineering, innovation, and entrepreneurship

#### Text Books:

1. **Indian Knowledge Systems**, Kapil Kapoor & Avadhesh Kumar Singh, D.K. Printworld (India) Pvt. Ltd., New Delhi. ISBN: 9788124608177.
2. **Indian Philosophy – Volume I & II**, S. Radhakrishnan, Oxford University Press, New Delhi. ISBN: 9780195698418.
3. **Science and Technology in Ancient India**, O.P. Jaggi, Atma Ram & Sons, Delhi. ISBN: 9788185694085.
4. **Indian Heritage and Culture**, Madhukar K. Bhagat, McGraw Hill Education (India). ISBN: 9789332901476.
5. **Traditional Knowledge System in India**, Yogendra K. Malik, Pearson Education India. ISBN: 9788131762219.

#### Reference Books:

1. **Ancient Indian Science and Technology**, Debiprasad Chattopadhyaya, History of Science, Philosophy and Culture in Indian Civilization Series. ISBN: 9788187586098.
2. **Indian Culture and Heritage**, Nitin Singhanian, McGraw Hill Education. ISBN: 9789353161132.
3. **Knowledge Traditions of India**, Bhu Dev Sharma, Indian Council of Philosophical Research (ICPR). ISBN: 9788185636306.

#### Web Links:

1. <https://iks.aicte-india.org/>
2. <https://www.education.gov.in/iks>

## **Minor Stream Courses (MSC)**

## **Minor Streams**

- Minor Stream in VLSI
- Minor Stream in Embedded Systems
- Minor Stream in Signal Processing and Communication Technology
- Minor Stream in Space Technology
- Minor Stream in Technology for Digital Resilience Industry Integrated Program- L & T
- Minor Stream in Smart Infrastructure (Electronics) Industry Integrated Program- L & T
- Minor Stream in Embedded AI/ML
- Minor Stream in Semiconductor Design Framework for Industrial ICs

### Minor Stream: VLSI

| Course Code  | Minor Stream Course                     | level | L         | T        | P        | C         | CIE | SEE | Total | Pre-requisite |
|--------------|-----------------------------------------|-------|-----------|----------|----------|-----------|-----|-----|-------|---------------|
| 2501EC86     | Digital System Design through Verilog   | IC    | 2         |          | 1        | 3         | 50  | 50  | 100   | DELD          |
| 2501EC26     | Digital Design through system Verilog   | AC    | 2         |          | 1        | 3         | 50  | 50  | 100   | DDTV          |
| 2501EC23     | CMOS Digital IC Design                  | IC    | 2         | 1        |          | 3         | 50  | 50  | 100   | DELD          |
| 2501EC27     | FPGAs & ASIC Design                     | AC    | 3         |          |          | 3         | 50  | 50  | 100   | DDTV          |
| 2501EC22     | Design For Testability                  | IC    | 3         |          |          | 3         | 50  | 50  | 100   | DDTV          |
| 2501EC30     | Testing & Verification of VLSI Circuits | IC    | 3         |          |          | 3         | 50  | 50  | 100   | VLSI          |
| 2501EC24     | Analog VLSI Design                      | IC    | 2         | 1        |          | 3         | 50  | 50  | 100   | VLSI          |
| 2501EC28     | Low Power VLSI Design                   | AC    | 2         | 1        |          | 3         | 50  | 50  | 100   | VLSI          |
| 2501EC29     | SoC Design                              | AC    | 3         |          |          | 3         | 50  | 50  | 100   | MPMC          |
| 2501EC25     | CMOS Mixed signal IC Design             | AC    | 2         |          | 1        | 3         | 50  | 50  | 100   | CDIC, AVLSI   |
| 2501EC31     | VLSI Physical Design                    | AC    | 2         |          |          | 2         | 50  | 50  | 100   | LPVLSI        |
| <b>Total</b> |                                         |       | <b>26</b> | <b>3</b> | <b>3</b> | <b>32</b> |     |     |       |               |

## Digital System Design through Verilog

**Course Code: 2501EC86**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1:** Develop RTL designs using Verilog HDL.
- CO2:** Apply timing-aware and low-power RTL coding practices.
- CO3:** Perform functional verification using testbenches.
- CO4:** Implement and analyze RTL designs on FPGA platforms.
- CO5:** Understand industry-standard digital system design flow.

The course emphasizes RTL design, verification, and FPGA-oriented implementation using Verilog HDL.

**Mapping of Course Outcomes with Program Outcomes:**

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

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 3    |
| <b>CO3</b> |      | 3    |
| <b>CO4</b> |      | 3    |
| <b>CO5</b> |      | 2    |

### UNIT – I

RTL Design Methodology: Review of digital design flow (Specifications, RTL, Verify, Synthesize, and Implement), RTL abstraction vs gate-level design, Coding styles: Combinational vs sequential RTL, Synchronous design concepts, Verilog-2001 features, Parameterized and reusable modules, Hierarchical & modular design practices.

**Practice:**

1. **Design parameterized and reusable modules using Verilog-2001 constructs.**
2. **Verify RTL functionality using basic testbench programs and waveform analysis.**

## **UNIT – II**

Verilog Language Constructs: Data types: reg, wire, integer, genvar, generate blocks & scalable design, Tasks vs functions, Blocking vs non-blocking, Compiler directives & macros, Coding for synthesis vs simulation.

### **Practice:**

1. **Implement scalable RTL designs using generate blocks and genvar.**
2. **Compare blocking vs non-blocking assignments using sequential logic examples.**

## **UNIT – III**

Combinational Systems: Multi-bit adders (Ripple, Carry Look-Ahead) RTL level, ALU design, Priority encoders, barrel shifters.

Sequential Systems: Registers, counters, shift registers, Clocking strategies, reset strategies (Synchronous vs Asynchronous), FSM design (Mealy & Moore) using RTL templates.

### **Practice:**

1. Implement an ALU with arithmetic and logical operations.
2. Implement registers using RTL templates.

## **UNIT – IV**

**Verification & Debug Techniques:** Importance of verification, Testbench architecture, Self-checking testbenches, Tasks/functions in testbenches, File-based stimulus, Debugging using waveform analysis.

### **Practice:**

1. Write testbenches using tasks, functions, and file-based stimulus.
2. Debug RTL designs using waveform analysis and assertion-style checks.

## **UNIT – V**

**Timing, Power & FPGA Implementation:** RTL, Synthesis, Place & Route flow, Timing concepts: Setup & hold time, Clock skew & jitter, Low-power RTL techniques: Clock gating, Power-efficient coding, FPGA flow overview: Constraints basics, RTL mapping to hardware, Large Language Models (LLMs) for Verilog RTL generation.

### **Practice:**

1. Perform RTL synthesis and analyze timing, area, and power reports.
2. Apply timing-aware coding techniques to fix setup/hold violations.
3. Implement RTL designs on FPGA and understand constraint-based mapping.

### **Text Books:**

4. Verilog HDL: A Guide to Digital Design and Synthesis, Samir Palnitkar, 2nd Edition, Pearson Education India, ISBN: 978-8177583724.
5. Advanced Digital Design with Verilog HDL, Michael D. Ciletti, 2nd Edition, Pearson Education, ISBN: 978-0136019282.

6. FPGA Prototyping by Verilog Examples: Xilinx Spartan-3 Version, Pong P. Chu, 1st Edition, Wiley India, ISBN: 978-8126521517.
7. Synthesis and Scripting Techniques for Designing Multi-Clock Systems, Clifford E. Cummings, 1st Edition, Springer, ISBN: 978-0387294476.

### Reference Books:

1. Digital Systems Design Using Verilog, Charles H. Roth Jr. and Lizy Kurian John, 2nd Edition, Cengage Learning, ISBN: 978-8131518465.
2. A Verilog HDL Primer, Bhasker J, 3rd Edition, Star Galaxy Publishing, ISBN: 978-0970954428.
3. Digital Design and Computer Architecture, David Harris and Sarah Harris, 2nd Edition, Morgan Kaufmann (Elsevier), ISBN: 978-0123944245.
4. Algorithms for VLSI Physical Design Automation, Naveen A. Sherwani, 3rd Edition, Springer, ISBN: 978-0792383932.
5. Huyen, Chip, Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications, 1st Edition, O'Reilly Media, 2022, ISBN: 978-1098107963.
6. Chip Huyen, Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications, 1st Edition, O'Reilly Media, 2022, ISBN: 978-1098107963.

### Web Resources:

#### Tutorials & Learning:

1. **Verilog HDL Tutorial – ASIC World** <https://asic-world.com/verilog/>
2. **EEWeb Verilog HDL Tutorial** <https://www.eeweb.com/verilog-hdl-tutorial/>
3. **EDA Playground** <https://www.edaplayground.com/>  
Simulation & Verification:
4. **ChipVerify – Verilog Quick Reference & Examples**  
[https://www.chipverify.com/verilog/verilog\\_quick\\_ref](https://www.chipverify.com/verilog/verilog_quick_ref)  
Synthesis & FPGA Tools:
4. **Xilinx Vivado Design Suite Documentation**  
[https://www.xilinx.com/support/documentation/sw\\_manuals.html](https://www.xilinx.com/support/documentation/sw_manuals.html)
5. **Intel (Altera) Quartus Prime Resources**  
<https://www.intel.com/content/www/us/en/programmable/support/support-resources/design-software.html>



## Digital Design Through System Verilog

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501EC26</b> | <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the basics of system verilog HDL.
- CO2:** Develop various combinational circuit using system verilog HDL
- CO3:** Illustrate various asynchronous sequential circuits.
- CO4:** Make use of System Verilog concepts for sequential circuits design.
- CO5:** Interpret on various system model synthesis.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | 1    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 1    | 3    | 1    | 2    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | 1    | 3    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 1    | 2    | -    | 2    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 1    | 1    | 2    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 3    |
| <b>CO2</b> | -    | 3    |
| <b>CO3</b> | -    | 3    |
| <b>CO4</b> | -    | 3    |
| <b>CO5</b> | -    | 3    |

### UNIT- I

**Introduction to System Verilog HDL:** Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools.

**Language Constructs and Conventions:** Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Operator

#### Practice:

1. Study and implementation of basic SystemVerilog constructs.
2. Design and simulation of arithmetic and logical operations. Develop a test bench to verify all operations and analyze the simulation results.

## UNIT-II

**Combinational Logic building blocks:** Introduction, multiplexers, Decoders, parameterizable decoder, seven segment decoder, priority encoder, adders, parity checker, three state buffers, design using System Verilog, test benches for combinational blocks.

**Practice:**

1. Design and verification of Multiplexer. Develop a test bench to verify the functionality of the circuits through simulation.
2. Design and verification of Seven Segment Decoder. Develop a test bench to verify the correctness of outputs for all possible input combinations.

## UNIT-III

**Sequential Logic Design using system verilog:** Latches and flip flops, Ring Counter, Johnson Counter, Design of Modulus-N Synchronous Counters, Shift Registers, Universal Shift Registers, Modeling of sequential circuits using System verilog.

**Asynchronous Sequential design:** Introduction, Asynchronous sequential circuits, design of asynchronous circuits, asynchronous state machines, setup and hold times, metastability using system verilog HDL.

**Practice:**

1. Design and implementation of Shift Registers.
2. Design and implementation of Counters.

## UNIT-IV

**Synchronous Sequential design:** Basic synchronous sequential systems, model of synchronous sequential systems, algorithmic state machines, synthesis from ASM charts, state machine in system verilog, test benches for state machines and complex sequential systems.

**Practice:**

1. Design and implementation of Moore State Machine.
2. Design and implementation of Mealy State Machine.

## UNIT-V

**System verilog synthesis:** Introduction, RTL synthesis-combinational logic, RTL synthesis rules, constraints-attributes, area and structural constraints, synthesis for FPGA, behavioural synthesis, timing simulations

**Practice:**

1. RTL Synthesis of Combinational and Sequential Circuits.
2. FPGA Implementation and Timing Simulation.

**Text Books:**

1. System Verilog for Design, Sturt Sutherland, Simon Davidmann, Peter flake, 2<sup>nd</sup> Edition, ISBN: 9780387364957.
2. System Verilog Functional Verification, Sasaniman, Smith, 1<sup>st</sup> Edition, ISBN : 9780981656212.

**Reference Books:**

1. Fundamentals of Logic Design with Verilog Design by Stephen.Brown and ZvonkoVranesic, TMH, 2<sup>nd</sup> Edition, ISBN: 978-0077211646.
2. Advanced Digital Logic Design using Verilog, State Machine & Synthesis for FPGA – Sunggu Lee, Cengage Learning, ISBN: 9780534551612.

**Web Links:**

1. <http://nptel.ac.in/courses/117105080/> by Prof.D. Roy Chaudhry
2. <http://nptel.ac.in/courses/117106086/1> by Prof.S.Srinivasan

## CMOS Digital IC Design

**Course Code:2501EC23**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the design parameters of MOS logic.
- CO2:** Build combinational circuits using CMOS logic.
- CO3:** Build sequential circuits using CMOS logic.
- CO4:** Infer the dynamic characteristics of CMOS logic.
- CO5:** Analyze the semiconductor memories for logic design.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO4   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO5   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | 2    |
| CO2    | -    | 2    |
| CO3    | -    | 2    |
| CO4    | -    | 2    |
| CO5    | -    | 2    |

## UNIT – I

### MOS Design:

Pseudo NMOS Logic: Inverter, Inverter threshold voltage, Output high voltage, Output Low voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.

## UNIT – II

### Combinational MOS Logic Circuits:

MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design – Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

### **UNIT – III**

#### **Sequential MOS Logic Circuits:**

The behavior of bi-stable elements, SR Latch, Clocked latch and flip-flop circuits, CMOS D latch, and edge-triggered flip-flop.

### **UNIT – IV**

#### **Dynamic Logic Circuits:**

Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High-performance Dynamic CMOS circuits.

### **UNIT – V**

#### **Semiconductor Memories:**

Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory- NOR flash and NAND flash.

#### **Text Books:**

1. CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, TMH, 3<sup>rd</sup> Edition, ISBN: 9780072925074.
2. Digital Integrated Circuits, Jan M Rabaey, Pearson Education, 2<sup>nd</sup> Edition, ISBN: 9780130909961.

#### **Reference Books:**

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective, Ming - BO Lin, CRC Press, ISBN: 9781439868591.
2. Digital Integrated Circuits –A Design Perspective, JanM.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, PHI, 2<sup>nd</sup> Edition, ISBN: 9789332573925.
3. Digital Integrated Circuit Design, Ken Martin, Oxford University Press, ISBN: 9780195125849.

#### **Web Links:**

1. <https://subodhtripathi.files.wordpress.com/2012/01/0072460539cmos1.pdf>
2. [https://onlinecourses.nptel.ac.in/noc21\\_ee09](https://onlinecourses.nptel.ac.in/noc21_ee09)

## FPGAs & ASIC Design

**Course Code:2501EC27**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

**CO1:** Compare the performance of different FPGAs and their programming Technologies.

**CO2:** Identify different SRAM and Anti-Fuse programmable FPGA architectures.

**CO3:** Develop digital circuits with ACT architectures.

**CO4:** Illustrate the different types of ASICs with I/O modules and their interconnects.

**CO5:** Explain the construction, simulation and testing of ASICs.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 1    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

## UNIT – I

### Field Programmable Gate Arrays:

Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, Applications of FPGAs.

## UNIT – II

### Programming FPGAs:

SRAM Programmable FPGAs, Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 and XC4000 Architectures. ACT FPGA Architectures: Anti-Fuse Programmed FPGAs, Introduction, Programming Technology, Device Architecture, The Actel AC1, AC2 and ACT3 Architectures.

**Applications:**

Design Applications, General Design Issues, Counter Examples, A Fast Video Controller, A Position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices.

**UNIT – III**

**Introduction to ASICs:** Types of ASICs, Design Flow, Case Study, Economics of ASICs, ASIC Cell Libraries, Transistors as resistors, Transistor Parasitic Capacitance, Logical Effort, Library Cell Design, Library Architecture, Gate-Array Design, Standard Cell Design, Data Path Cell Design.

**UNIT – IV****Programmable ASICs and Programmable ASIC Logic Cells:**

The Anti fuse, Static RAM, EPROM and EEPROM Technology, Practical Issues, Specifications, PREDP Benchmarks, FPGA Economics, Actel ACT, Xilinx LCA, Altera Flex, Altera Max, DC Output, AC Output, DC input, AC input, Clock input, Power input, Xilinx I/O block, Other I/O Cells. Low Level Design Entry and Logic Synthesis: Schematic Entry, Low level Design Languages, PLA Tools, EDIF, A logic synthesis example, A Comparator/MUX, Inside a Logic Synthesizer, Synthesis of Viterbi Decoder, Verilog and Logic synthesis, VHDL and Logic Synthesis, Finite State Machine Synthesis, Memory Synthesis, The Engine Controller, Performance Driven Synthesis, Optimization of the viterbi decoder.

**UNIT – V****Simulation, Test and ASIC Construction:**

Types of Simulation, The Comparator/MUX Example, Logic Systems, How Logic Simulation Works, Cell Models, Delay Models, Static Timing Analysis, Formal Verification, Switch Level Simulation, Transistor Level Simulation, The importance of test, Boundary Scan Test, Faults, Faults Simulation, Automatic Test Pattern Generator, Scan Test, Built in Self Test, A simple test Example, Physical Design, CAD Tools, System Partitioning, Estimating ASIC Size, Power Dissipation, FPGA Partitioning, Partitioning Methods.

**Text Books:**

1. Field Programmable Gate Array Technology, Stephen M. Trimberger, Springer International Edition, ISBN: 978-1461361831.
2. Application Specific Integrated Circuits, Michael John Sebastian Smith, Pearson Education, ISBN : 978-8177584080.

**Reference Books:**

1. Digital Design Using Field Programmable Gate Arrays, Pak K. Chan/Samiha Mourad, Pearson Low Price Edition, ISBN: 9788131724408.
2. Advanced ASIC Chip Synthesis using Synopsis Design compiler, Himanshu Bhatnagar, Kluwer Academic, 2<sup>nd</sup> Edition, ISBN: 9780792385370.

**Web Links:**

1. <https://nptel.ac.in/courses/117108040>
2. <http://www.eng.ucy.ac.cy/theocharides/Courses/ECE664/L5.pdf>



## Design for Testability

**Course Code:2501EC22**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Interpret the fault modeling and logic simulation.
- CO2:** Develop test pattern for combinational logic circuits.
- CO3:** Develop test pattern for sequential logic circuits.
- CO4:** Outline the testable sequential circuits.
- CO5:** Outline the testable memory circuits.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO4   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO5   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | 2    |
| CO2    | -    | 2    |
| CO3    | -    | 2    |
| CO4    | -    | 2    |
| CO5    | -    | 2    |

### UNIT – I

#### Introduction to Testing:

Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends affecting Testing, Types of Testing, Fault Modeling: Defects, Errors and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault.

### UNIT – II

#### Logic and Fault Simulation:

Simulation for Design Verification and Test Evaluation, Modeling Circuits for Simulation, Algorithms for True value Simulation, Algorithms for Fault Simulation

### UNIT – III

SCOAP Controllability and Observability, High Level Testability Measures, Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.

## **UNIT – IV**

### **Built-In Self-Test:**

The Economic Case for BIST, Random Logic BIST: Definitions, BIST Process, Pattern Generation, Response Compaction, Built-In Logic Block Observers, Test-Per- Clock, Test-Per-Scan BIST Systems, Circular Self-Test Path System, Memory BIST, Delay Fault BIST.

## **UNIT – V**

### **Boundary Scan Standard:**

Motivation, System Configuration with Boundary Scan: TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BSDL Description Components, Pin Descriptions.

### **Text Books:**

1. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits -M.L. Bushnell, V. D. Agrawal, Kluwer Academic Publishers, ISBN: 9780792379911.
2. Digital Systems and Testable Design, M. Abramovici, M.A.Breuer and A.D Friedman, Jaico Publishing House, ISBN: 0-9660176-3-3.

### **Reference Books:**

1. Digital Circuits Testing and Testability - P.K. Lala, Academic Press, ISBN: 9780124343306.
2. Digital Systems and Testable Design - M. Abramovici, M.A.Breuer and A.D.Friedman, Jaico Publishing House, ISBN: 0-9660176-3-3.

### **Web Links:**

1. <https://www.slideshare.net/labishettybhanu/trends-and-challenges-in-vlsi>
2. <http://www.engr.uconn.edu/~tehrani/teaching/test>
3. <http://nptel.ac.in/courses/106103116/34>
4. <http://eesemi.com/bist.html>

## Testing & Verification of VLSI Circuits

**Course Code:2501EC30**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Infer the challenges in VLSI Testing at different abstraction levels.
- CO2:** Explain the fault models for generation of test vectors.
- CO3:** Analyze the observability and controllability parameters of circuit.
- CO4:** Make use of simulation techniques for designing and testing of VLSI circuits.
- CO5:** Identify characteristics of verification methods.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 1    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 1    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 1    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I

#### Basics of Testing:

Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing-based testing. Classification of sequential ATPG methods. Fault collapsing and simulation.

### UNIT – II

**Universal test sets:** Pseudo-exhaustive and iterative logic array testing. Clocking schemes for delay fault testing. Testability classifications for path delay faults. Test generation and fault simulation for path and gate delay faults.

### **UNIT – III**

#### **Delay fault testing:**

Introduction, Combinational test generation, Combinational fault simulation, Combinational delay fault diagnosis, Sequential test generation, Sequential fault simulation, Pitfalls in delay fault testing and some remedies, Unconventional delay fault testing techniques. CMOS testing: Testing of static and dynamic circuits. Fault diagnosis: Fault models for diagnosis, Cause- effect diagnosis, Effect-cause diagnosis.

### **UNIT – IV**

#### **High-level test synthesis:**

Introduction, RTL test generation, RTL fault simulation, RTL design for testability, RTL built-in self-test, Behavioral modification for testability, Behavioral synthesis for testability.

### **UNIT – V**

#### **Verification Techniques:**

Introduction to Hardware Verification and methodologies Binary Decision Diagrams (BDDs) and algorithms over BDDs Combinational equivalence checking Temporal Logics modelling sequential systems and model checking Symbolic model checking.

#### **Text Books:**

1. Testing of Digital Systems, N. Jha & S.D. Gupta, Cambridge, ISBN: 0 521 77356 3.
2. VLSI Test Principles and Architectures Design for Testability, W.W.Wen, Morgan Kaufmann Publishers, ISBN: 978-0123705976.

#### **Reference Books:**

1. Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits, Michael L. Bushnell & Vishwani D. Agrawal, Kluwer Academic Publishers, ISBN: 9780792379911.
2. Digital circuit Testing and Testability, P. K. Lala, Academic Press, ISBN: 9780124343306.

#### **Web Links:**

1. <https://archive.nptel.ac.in/courses/106/103/106103116>
2. <https://www.maven-silicon.com/blog/difference-between-vlsi-verification-and-vlsi-testing/>

## Analog VLSI Design

**Course Code:2501EC24**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Illustrate the MOS I/V, C-V Characteristics & Single Stage amplifie.
- CO2:** Analyze the characteristics of CMOS differential Amplifier & Current Mirrors.
- CO3:** Develop the knowledge of Bandgap Reference.
- CO4:** Analyze the two stage CMOS operational amplifiers.
- CO5:** Develop basic Analog layout & CMOS Processing based knowledge acquired in the course.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 1    | 3    | -    | 2    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 1    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 1    |
| <b>CO2</b> | -    | 3    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 3    |
| <b>CO5</b> | -    | 3    |

### UNIT – I

**Introduction to Analog Design-** Basic MOS Device Physics, MOSFET Structure, MOS I/V Characteristics, MOS Transconductance, Second-Order Effects, MOS Device Capacitances. Single-Stage Amplifiers- Common-Source Stage with Resistive Load, CS Stage with Diode-Connected Load, CS Stage with Current-Source Load.

### UNIT – II

**Differential Amplifier-** Basic Differential Pair, Qualitative Analysis, Common-Mode Response. Differential Pair with MOS Load. Current Mirrors and Biasing Techniques- Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors-Large Signal Analysis, Small Signal Analysis, Biasing Techniques – CS biasing, CG Biasing.

### **UNIT – III**

#### **Band Gap References:**

General Considerations, Supply-Independent Biasing, Temperature-Independent References, PTAT Current Generation, Constant-Gm Biasing, Low-Voltage Band Gap References.

### **UNIT – IV**

#### **MOS Operational Amplifier:**

General Considerations, One-Stage Op Amps, Two-Stage Op Amps, Gain Boosting, Output Swing Calculation, Common Mode Feedback– Basic Concepts, CM sensing Techniques, CM feedback Techniques, Input Range Limitations, Slew Rate, Power Supply Rejection.

### **UNIT – V**

#### **CMOS Processing Technology:**

General Considerations, Photolithography, Oxidation, Ion Implantation, Deposition and Etching. Analog Layout Techniques- Antenna Effect, Multifinger Transistors, Well Proximity Effect, Latch Up Prevention.

#### **Text Books:**

1. Design of Analog CMOS Integrated Circuits by Behzad Razavi 2<sup>nd</sup> Edition, ISBN:9780071188395, 0071188398 .
2. R.Jacob Baker, H.W.Li, and D.E. Boyce CMOS Circuit Design, Layout and Simulation, Prentice-Hall of India, ISBN:9781118038239, 1118038231 .

#### **Reference Books:**

1. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edn, ISBN:9788126517787, 8126517786
2. Analysis and Design of Analog Integrated Circuits, 1<sup>st</sup> Edition by Meyer Gray, Hurst, Lewis. 5<sup>th</sup> Edition, ISBN:9788126521487, 8126521481 .

#### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc23\\_ee142](https://onlinecourses.nptel.ac.in/noc23_ee142)
2. <https://nptel.ac.in/courses/117101105>

## Low Power VLSI Design

**Course Code:2501EC28**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Outline the fundamentals of low-power logic design.
- CO2:** Interpret low-power design approaches.
- CO3:** Interpret the constraints for low power design through CAD Tools.
- CO4:** Contrast adder architectures for the efficient subsystem design.
- CO5:** Outline the low-power multiplier architectures.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I

#### Introduction:

Introduction to Low Power VLSI design, Importance of low power design, Challenges in low power VLSI design, Application of Low Power VLSI circuits, Power analysis of CMOS circuits, Themes of Low Power VLSI design, Supply voltage scaling, Reduction of load capacitances.

### UNIT – II

#### Low Voltage Process Technology and Device Modelling:

CMOS device structure and process fabrication, Innovation on process technology for low power consumption, Multi-threshold process technology, Latch up problem in CMOS technology, Discussion on SPICE Models of MOS transistor, MOS Capacitances, CMOS Low voltage analytical model, Threshold voltage definitions, Different Short Channel Effects.

### **UNIT – III**

#### **Techniques for low power design at Logic Design Level:**

CMOS logic design style, CMOS Inverter design, Transfer characteristics of CMOS inverter, Delay calculation of CMOS Logic gates, Analysis of various logic design styles for their power consumption (CPL, Domino Logic, NORA CMOS, TSPC Logic, DCVSL, etc.).

### **UNIT – IV**

#### **Low power design techniques at Architectre and System Level:**

Importance of parallelism, Introduction to Pipelining, Low power design utilizing redundancy and Data Encoding, Importance of Regularity and Locality, Reduction of complexity to improve power consumption, Low power design techniques at system level.

### **UNIT – V**

#### **Low Power Random Access Memory Circuits:**

Introduction to Static RAM Design, Low power Bit-line Conditioning Circuits, Low Power Techniques, Sense Amplifiers, Dynamic RAM Design, Bit line capacitance reduction methodologies, Self-Refresh Techniques, Low Voltage DRAM Operations, and Leakage Power Analysis.

#### **Text Books:**

1. Low-power CMOS digital design, A.P.Chandrakasan and R.W.Broderson, Low Power CMOS Design, IEEE Press, ISBN:ISBN: 978-1-4615-2325-3.
2. Low-Power Digital VLSI Design: Circuits and Systems, A. Bellaouar and M. I. Elmasry, Springer, ISBN:ISBN : 9780792395874.

#### **Reference Books:**

1. Low-Power VLSI Circuits and Systems, Ajit Pal, Springer, ISBN:ISBN: 9788132219361.
2. Low Power Design Methodologies, Jan M. Rabaey, Massoud Pedram, Springer Science+Business Media,LLC, ISBN: ISBN: 978-1-46 13-5975-3.

#### **Web Links:**

1. <https://www.synopsys.com/glossary/what-is-low-power-design.html>
2. <https://resources.system-analysis.cadence.com/blog/msa2021-implementing-low-power-design-through-voltage-scaling-in-vlsi>
3. <https://link.springer.com/book/10.1007/978-1-4615-2355-0>



## SoC Design

**Course Code:2501EC29**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course student will be able to:**

- CO1:** Explain all the building blocks of SoC.
- CO2:** Classify the concept of processors and instruction handling.
- CO3:** Analyze vector, VLIW and superscalar processors.
- CO4:** Develop a Memory as part of SoC.
- CO5:** Illustrate the concepts of interconnect optimization and configuration in SoC.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

## UNIT – I

### Introduction to the System Approach:

System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

## UNIT – II

### Processors:

Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers:minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

### **UNIT – III**

#### **Memory Design for SOC:**

Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor – memory interaction.

### **UNIT – IV**

#### **Interconnect Customization:**

Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor.

### **UNIT – V**

#### **Interconnect Configuration:**

Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism.

#### **Text Books:**

1. Computer System Design System-on-Chip, Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd, ISBN: 978-0470643365.
2. ARM System on Chip Architecture, Steve Furber, Addison Wesley Professional, 2<sup>nd</sup> Edition, ISBN : 9780201675191 .

#### **Reference Books:**

1. Design of System on a Chip: Devices and Components, Ricardo Reis, Springer 1<sup>st</sup> Edition, ISBN: 978-1441954541.
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), Jason Andrews, Newnes, BK and CDROM, ISBN: 978-0750677301.
3. System on Chip Verification–Methodologies and Techniques, Prakash Rashinkar, Peter Paterson and Leena Singh L, Kluwer Academic Publishers, ISBN: 978-0792372790.

#### **Web Links:**

1. <https://www.peterindia.net/System-On-ChipLinks.html>
2. <https://www.ieee-socc.org/>
3. <http://nptel.ac.in/courses/108102045/10> (Prof. Santanu Chaudhary, IIT Delhi)

## CMOS Mixed Signal IC Design

**Course Code:2501EC25**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Infer the characteristics of CMOS based Switched capacitor and PLL.
- CO2:** Analyze the performance of sampling circuits.
- CO3:** Demonstrate the non idealities of data converters.
- CO4:** Apply appropriate techniques and tools in development of data converters.
- CO5:** Model the frequency and Q tunable time domain filters.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 1    | 2    | 3    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 1    | 2    | 3    | -    | 2    | -    | -    | 1    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I

#### PLL & Switched Capacitors:

Characterization of a comparator, Basic CMOS comparator design, Analog multiplier, PLL – simple PLL, charge-pump PLL, applications of PLL, Switched Capacitor circuits – basic principles, switched capacitor sensitive integrator and insensitive integrator, switched capacitor filter, switched capacitor amplifier.

#### Practice:

1. Design of PLL
2. Design of switched capacitor circuits.

### UNIT – II

#### Sampling Circuits:

Basic sampling circuits for Analog signal sampling, performance metrics of sampling circuits, different types of sampling switches. Sample-and-Hold Architectures: Open-loop

& closed-loop architectures, open-loop architecture with miller capacitance, multiplexed-input architectures, recycling architecture.

**Practice:**

1. Design Sample hold circuit.
2. Estimation of open loop Miller capacitance.

### **UNIT – III**

**Digital-to-Analog Conversion:**

Input/output characteristics of an ideal D/A converter, performance metrics of D/A converter, Resistor string 3-bit DAC, Binary scale DACs, Cyclic DAC. D/A Converter architectures: Resistor-Ladder architectures, current-steering, Pipeline DAC.

**Practice:**

1. Design of basic DAC.
2. Design of Resistor string 3-bit DAC.

### **UNIT – IV**

**Analog-To-Digital Conversion:**

Input/output characteristics and quantization error of an A/D converter, performance metrics of A/D converter. A/D converter architectures: Flash architectures, interpolate and folding architectures, pipelined architectures, Ramp type ADC, Integrating (Dual slope) ADC, Successive approximation architectures, Sigma Delta ADC, Design of Decimation filter.

**Practice:**

1. Design of basic ADC.
2. Design of Successive approximation ADC.

### **UNIT – V**

**Analog CMOS Filters :**

Low Pass filters, active-RC fully differential integrator, Two transistor MOSFET- C integrator, gm-C Integrator, Active RC integrators.

**Practice:**

1. Design of first order filters.
2. Design of Gm-C Integrator.

**Text Books:**

1. Design of Analog CMOS Integrated Circuits, B.Razavi, 2<sup>nd</sup> Edition, McGrawHill, ISBN: 9780072524932.
2. CMOS Mixed-Signal Circuit Design, Jacob Bakeret, IEEE Press, ISBN: 9780471227540.

**Reference Books:**

1. Analog MOS Integrated Circuit for signal processing, R Gregorian, G.C. Temes, John Wiley & Sons, ISBN: 978-0-471-09797-6.
2. Understanding Delta-Sigma Data Converters, Schreier & Themes, Wiley –IEEE Press, ISBN: 9781119258292.

**Web Links:**

1. <https://ioe.iitm.ac.in/project/rf-analog-and-mixed-signal-integrated-circuits>
2. [https://link.springer.com/chapter/10.1007/978-0-387-35597-9\\_29](https://link.springer.com/chapter/10.1007/978-0-387-35597-9_29)
3. <https://www.ims.fraunhofer.de/en/Core-Competence/Smart-Sensor-Systems/Integrated-Sensor-Systems/Mixed-Signal-IC-Design.html>

## VLSI Physical Design

**Course Code:2501EC31**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the VLSI physical design cycle at various levels of abstraction
- CO2:** Choose different algorithms for system partitioning.
- CO3:** Develop floor planning for different VLSI Circuits.
- CO4:** Make use of placement & routing algorithms for placement and routing purpose.
- CO5:** Explain the concepts of timing closure involved in placement & routing..

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 1    | 3    | 1    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 1    | 1    | 3    | 1    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT- I

#### Introduction to physical design automation

VLSI design flow, Physical design cycle, design styles, Layout layers and design rules, Physical design optimizations

### UNIT- II

#### Net list and system partitioning

Introduction, terminology, optimization goals, partitioning algorithms, a frame work for multi level partitioning

### UNIT-III

#### Floor planning

Introduction to floor planning, optimization goals, terminology, floor plan representations, floor planning algorithms, pin assignment, power and ground routing.

#### **UNIT-IV**

**Placement & Routing:** Global placement, Representation of routing regions, The global routing flow, single net routing, full net list routing, Detailed routing- horizontal and vertical constraints graph, channel routing algorithms, switch box routing.

#### **UNIT-V**

**Timing Closure:** Introduction, timing analysis and performance constraints, timing driven placement, timing driven routing

#### **Text Books:**

1. VLSI Physical Design: From Graph Partitioning to Timing Closure-Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu ,Springer, ISBN: 978-94-007-9020-9.
2. VLSI Physical Design Automation Theory and Practice by Sadiq M. Sait, Habib Youssef, world scientific, ISBN : 9789810238834.

#### **Reference Books:**

1. Modern VLSI DesignSystem-on-Chip Design by Wayne Wolf, Pearson education, 3<sup>rd</sup>Edition, ISBN: 978-8178086538.
2. Analog Integrated Circuit Design AutomationPlacement, Routing and Parasitic Extraction Techniques by Ricardo Martins, Nuno Lourenço, Nuno Horta, springer international publishing, ISBN: 978-3319816685.

#### **Web Links:**

1. <https://nptel.ac.in/courses/106105161> - by Prof. Indranil Sen Gupta, IIT Khargpur.
2. <https://nptel.ac.in/courses/117101004> - by Prof.D.K.Sharma, Prof. Sachin Patkar,Prof. Virendra singh, Prof.A.N.Chandorkar, IIT Bombay.
3. <https://nptel.ac.in/courses/117103125> - by Dr.Santosh Biswas, IIT Guwahati.

### Minor Stream: Embedded Systems

| Course Code | Course Name                           | Level | L         | T | P        | C         | CIE | SEE | Total | Pre-requisite |
|-------------|---------------------------------------|-------|-----------|---|----------|-----------|-----|-----|-------|---------------|
|             | Sensors & Actuators                   | FC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | Embedded C                            | IC    | 2         |   | 1        | 3         | 50  | 50  | 100   | -             |
| 2501EC36    | Hardware interfacing & Networking     | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC38    | Microcontrollers for Embedded Systems | IC    | 3         |   |          | 3         | 50  | 50  | 100   | MPMC          |
| 2501EC32    | Embedded Real Time Systems            | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC42    | Wireless LANs & PANs                  | IC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | System Programming                    | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC34    | Embedded System Design                | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | Real Time operating System using QNX  | AC    | 0         | 0 | 2        | 2         | 50  | 50  | 100   | ERTS          |
|             | Machine Learning for Embedded Systems | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
| 2501EC35    | Hardware & Software Co-Design         | AC    | 3         |   |          | 3         | 50  | 50  | 100   | -             |
|             | <b>Total</b>                          |       | <b>29</b> |   | <b>3</b> | <b>32</b> |     |     |       |               |



## Sensors & Actuators

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain fundamentals of sensors and measurement systems.
- CO2:** Analyze resistive, capacitive, and inductive sensors.
- CO3:** Describe optical and modern sensors.
- CO4:** Explain signal conditioning and sensor interfacing.
- CO5:** Describe actuators and their applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    |      |      |      |      |      |      |      |       |       |
| <b>CO2</b> | 3    | 2    | 1    |      |      |      |      |      |      |       |       |
| <b>CO3</b> | 3    | 2    |      |      |      |      |      |      |      |       |       |
| <b>CO4</b> | 2    | 2    | 1    |      |      |      |      |      |      |       |       |
| <b>CO5</b> | 2    | 1    | 1    |      |      |      |      |      |      |       |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | 1    |
| <b>CO2</b> | 2    | 1    |
| <b>CO3</b> | 2    | 1    |
| <b>CO4</b> | 2    | 2    |
| <b>CO5</b> | 2    | 2    |

The course is covered at a conceptual level with emphasis on working principles, block diagrams, and applications. Detailed mathematical derivations and implementation-level complexities are excluded.

### UNIT – I

#### Fundamentals of Sensors and Measurement:

Introduction to sensors, transducers, and actuators; Differences between sensors, transducers, and actuators; Measurement system components; Classification of sensors (active/passive, analog/digital); Static characteristics (accuracy, precision, sensitivity, and linearity); Dynamic characteristics (response time and bandwidth); Error analysis and calibration.

## UNIT – II

### **Resistive, Capacitive and Inductive Sensors:**

Resistive sensors: potentiometer, strain gauge; Temperature sensors: RTD, thermistor; Capacitive sensors: principle, construction, and applications; Inductive sensors: LVDT (working principle and characteristics); Comparison of sensor types (resistive, capacitive, inductive); Advantages, limitations, and selection criteria.

## UNIT-III

### **Optical and Application-Based Sensors:**

Optical sensors: photodiode, LDR; Infrared sensors: principle and applications; Ultrasonic sensors: time-of-flight concept; Magnetic sensors: Hall effect sensor; Motion sensors: accelerometer and Gyroscope (working principle and applications); Introduction to smart sensors (features and advantages) and MEMS sensors (basic concept, structure, and applications).

## UNIT- IV

### **Signal Conditioning and Sensor Interfacing:**

Need for signal conditioning; Sensor signal characteristics (low-level signals, noise, impedance); Instrumentation amplifier for sensor applications; Signal conditioning for resistive and capacitive sensors; Isolation and impedance matching; Noise reduction techniques (shielding, grounding, and filtering); Data acquisition system (block diagram and working); Multiplexing in data acquisition; and basic concept of sensor interfacing with microcontrollers.

## UNIT-V

### **Actuators and Applications:**

Introduction to actuators and their working principles; Classification of actuators; Electrical actuators: DC motor, stepper motor, and servo motor (working principles and basic characteristics); Basic concepts of hydraulic and pneumatic actuators; Relay and switching devices; Actuator control (open-loop and closed-loop concept); Integration of sensors and actuators; Applications in automation systems, robotics, and IoT.

### **Text Books:**

1. Handbook of Modern Sensors: Physics, Designs, and Applications, Jacob Fraden, Spring 4th Edition, ISBN: 978-1441964656.
2. Sensors and Transducers, D. Patranabis, PHI Learning Pvt. Ltd., 2nd Edition, ISBN: 978 8120326941.

**Reference Books:**

1. Principles of Measurement Systems, John P. Bentley, Pearson Education, 4th Edition, ISBN: 978-0130430281.
2. Electronic Instrumentation, H.S. Kalsi, McGraw-Hill Education, 3rd Edition, ISBN: 978-0070702066.
3. Measurement Systems: Application and Design, Ernest O. Doebelin and Dhanesh N. Manik, McGraw-Hill, 5th Edition, ISBN: 978-0072426328.

**Web Links:**

1. <https://nptel.ac.in/courses/108105064>
2. <https://nptel.ac.in/courses/108106165>
3. <https://www.youtube.com/watch?v=nE1C4ghfvac&list=PLgMDNELGJ1CbufZjqWa8uoSlQWKqVwPN7>

## EMBEDDED C

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain embedded system concepts and 8051 architecture
- CO2:** Apply Embedded C programming for interfacing peripherals
- CO3:** Analyze real-time systems using timers, interrupts, and delays.
- CO4:** Develop multi-state embedded systems using timed and input-based state machines.
- CO5:** Develop complete embedded system applications by integrating peripherals

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      |      |      |      |      |      |      |       |       |
| <b>CO2</b> | 3    | 3    | 2    |      | 3    |      |      |      |      |       |       |
| <b>CO3</b> | 3    | 3    | 2    | 3    | 2    |      |      |      |      |       |       |
| <b>CO4</b> | 3    | 3    | 3    | 2    | 3    |      |      |      |      |       |       |
| <b>CO5</b> | 3    | 3    | 3    | 3    | 3    |      |      |      |      |       |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

## UNIT – I

### Introduction:

Introduction to embedded systems, Processor suitable for embedded system, Selection of programming language, Operating system, Development of embedded software. Introduction to microcontroller family, External interface of the Standard 8051, Reset requirements, Clock frequency and performance, Memory issues, I/O pins, Timers, Interrupts Serial interface Power consumption.

## UNIT – II

### Introduction to Reading switches:

Basic techniques for reading from port pins, Example: Reading ,writing bytes and Bits, The need for pull-up resistors, dealing with switch bounce with an example.

### Adding Structure to the Code:

Introduction to adding structure to your code, Object-oriented programming with C, The

Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the 'Hello Embedded World', Example: Restructuring the goat-counting, Further examples.

**Practice:**

1. Write an Embedded C Program to interface the switch with a microcontroller in Proteus to control an LED using I/O Ports.
2. Write an Embedded C Program to interface a 16×2 LCD with a microcontroller and display messages.

### UNIT – III

**Meeting real-time constraints:** Introduction, creating 'hardware delays' using Timer 0 and Timer 1, Example: Generating a precise 50ms delay, creating a portable hardware delay, Need for Timeout Mechanism, Creating loop Timeouts with Examples, Creating hardware Timeouts with Examples .

**Practice:**

1. Write an Embedded C Program to Interface stepper motor be controlled (CW/CCW rotation and speed control) using a microcontroller and Proteus simulation.
2. Write an Embedded C Program for timer interrupts and external interrupts in a microcontroller demonstrate them through Proteus

### UNIT – IV

Introduction to multi-state systems and function sequences, Implementing a Multi-State (Timed) system, Example: Traffic light sequencing, Example: Animatronic dinosaur, Implementing a Multi-State (Input/Timed) system, Example: Controller for a washing machine.

**Practice:**

1. Write an Embedded C Program to design a traffic light sequencing system using Embedded C.

### UNIT – V

**Case study:**

Intruder alarm system, Software architecture of Intruder alarm system, Key software components used in Intruder alarm system, Intruder alarm system program using Embedded C.

**Practice:**

1. Develop an Application to interface a 4×4 keypad with a microcontroller and display the key pressed using LCD or serial terminal in Proteus?
2. Design and simulate a complete embedded system application in Proteus using Embedded C (e.g., password door lock, digital clock, sensor system, etc.)

**Text Books:**

1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008.

2. An Embedded Software Primer, David. E. Simon, Pearson Education, 2001.
3. Embedded Software Development with C, Kai Qian, David Den Haring, Li Cao (auth.), Springer US, 2009.

**Reference Books:**

1. Embedded Microcomputer Systems, Jonathan W. Valvano, Brooks / Cole, Thompson Learning.
2. Fundamentals of Embedded Software where C and Assembly meet, Daniel W. Lewis, PHI, 2002.
3. Embedded System Design, Frank Vahid and Tony Gwargie, John Wiley & sons, 2002.

**Web Links:**

1. <https://nptel.ac.in/courses/106/105/106105193/> Prof. Indranil Sen Gupta, IIT, Kharagpur (NPTEL course)
2. [https://onlinecourses.nptel.ac.in/noc20\\_ee98/preview](https://onlinecourses.nptel.ac.in/noc20_ee98/preview) Prof. Dhananjay V. Gadre, Prof. Badri Subudhi | Netaji Subhas University of Technology, IIT Jammu
3. <http://www.ecpe.nu.ac.th/ponpisut/22323006-Embedded-c-Tutorial-8051.pdf>

## Hardware Interfacing & Networking

**Course Code: 2501EC36**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the fundamentals of serial communication and UART-based protocols used in embedded systems.
- CO2:** Describe synchronous communication protocols such as SPI and I2C for peripheral interfacing in embedded applications.
- CO3:** Explain the architecture and communication mechanisms of industrial protocols including CAN, MODBUS, PROFIBUS, and LIN bus.
- CO4:** Describe Ethernet networking fundamentals, network hardware components, and Internet protocol concepts used in embedded networking.
- CO5:** Explain embedded Ethernet communication using TCP/IP, UDP, FTP, web-based communication, and network security concepts.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      |      |      |      |      |      |      | 1     |       |
| <b>CO2</b> | 3    | 2    |      |      |      |      |      |      |      | 1     |       |
| <b>CO3</b> | 2    | 3    |      |      |      |      |      |      |      | 1     |       |
| <b>CO4</b> | 2    | 2    |      |      |      |      |      |      |      | 1     |       |
| <b>CO5</b> | 2    | 2    | 2    |      |      |      |      |      |      | 1     |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

### UNIT – I

**Fundamental Serial Communication Protocols:** Introduction to embedded communication, serial communication basics, RS-232 standard, RS-485 standard, MAX232, electrical characteristics and interfacing, UART protocol, asynchronous transmission, framing and baud rate.

### UNIT – II

#### Synchronous Peripheral Communication Protocols:

Synchronous serial communication, SPI protocol, architecture and data transfer modes, timing characteristics, I2C protocol, addressing schemes, arbitration, clock synchronization and data transfer.

## UNIT – III

### **Industrial communication Protocols:**

USB bus-Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types, introduction to CAN, CAN architecture, signaling and bit timing, data frame format, arbitration mechanism, CAN bus operation. MODBUS protocol, message structure and communication, Profibus protocol, architecture and communication model, LIN bus protocol.

## UNIT – IV

**Ethernet Basics:** Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers –Using the internet in local and internet communications – Inside the Internet protocol.

## UNIT – V

**Embedded Ethernet:** Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

### **Text Books:**

1. Embedded Systems Design: A Unified Hardware/Software Introduction - Frank Vahid, Tony Givargis, John & Wiley Publications, ISBN: 9788126508372.
2. Embedded networking with CAN and CAN open by Olaf Pfeiffer, Andrew Ayre and Christian Keydel, Copper hill Technologies Corporation, ISBN: 978-0976511625.
3. Embedded Ethernet and Internet Complete - Jan Axelson, Penram publications, ISBN: 978-1931448000.

### **Reference Books:**

1. Modbus-IDA, MODBUS application protocol specification, Modbus-IDA,. Siemens, Profibus network manual, Siemens manual.
2. Profibus in practice: System Architecture and Design byXiu Ji, CRC press, ISBN: 978-1507633045.
3. Lin Application note AN1278 by SGS-Thompson, SGS - Thompson Ltd.

### **Web Links:**

1. <https://archive.nptel.ac.in/courses/108/102/108102045/>.
2. <https://archive.nptel.ac.in/courses/108/105/108105057/>.



## Microcontrollers for Embedded Systems

**Course Code: 2501EC38**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the basic architecture and features of PIC microcontrollers.
- CO2:** Explain architecture and programming model of ARM 7TDMI.
- CO3:** Interpret the programmer's model of ARM cortex M3-processor.
- CO4:** Compare the various exceptions present in the processor.
- CO5:** Summarize the low power modes of MSP 430 micro controller.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| CO2   | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| CO3   | 2    | 3    | 1    | 1    |      |      |      |      |      |       | 1     |
| CO4   | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| CO5   | 2    | 3    |      |      |      |      |      |      |      |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    |      | 2    |
| CO2    |      | 2    |
| CO3    |      | 2    |
| CO4    |      | 2    |
| CO5    |      | 2    |

## UNIT – I

### Arduino Microcontroller (ATmega328P):

Introduction to Arduino Uno, Features and architecture overview, Pin configuration Programming Fundamentals, Digital and analog operations, Serial communication and debugging, Arduino Libraries & Code Reusability, logic-based LED pattern generation.

## UNIT – II

### PIC Microcontrollers:

PIC16F877 Architecture, Instructions Set, addressing modes, PIC16F877 **Peripherals:** Timers, CCP modules, ADC modules.

## **UNIT-III**

### **MSP430 16 - BIT MICROCONTROLLER :**

The MSP430 Architecture, CPU Registers, Instruction Set, addressing modes, the MSP430 family viz. MSP430x2x, MSP430x4x, MSP430x5x. Low power aspects of MSP430 : low power modes, active Vs standby current consumption, FRAM Vs Flash for low power and reliability.

## **UNIT- IV**

### **ARM7 Microcontroller:**

ARM7 microcontroller architecture, memory organization, description of functional units of microcontroller: ports, interrupts, on chip ADCs, DACs, serial peripheral interface, timers, programmable counter array.

## **UNIT-V**

### **ARM Cortex-M3 processor:**

Applications, Programming model– Registers, Operation modes, Instruction Set, Memory Maps, Exceptions and Interrupts, Reset Sequence, Memory Access Attributes, Permissions, Bit-Band Operations, Unaligned and Exclusive Transfers. Pipeline, Bus Interfaces.

### **Text Books:**

1. Micro Controller theory and Application ,Ajay .V. Deshmukh, TATA McGraw –Hill, 1<sup>st</sup> Edition, ISBN: 9780070585959.
2. ARM System Developer's Guide: Design in and Optimizing, Sloss Andrew N, Symes Dominic, Wright Chris, Morgan Kaufman Publication, ISBN: 978-1-55860-874-0.

### **Reference Books:**

1. ARM System-on-Chip Architecture, Steve furber, Addison-Wesley Educational Publishc Inc, 2<sup>nd</sup> Edition, ISBN: 9780201675191
2. PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18Muhamn Ali Mazidi, Rolin D. Mc Kinlay, Danny Causey, Pearson Prentice Hall, ISBN: 9780136009023.
3. MSP 430 Micro controller basics, John H. Davies, Elsevier, ISBN: 978-0-7506-8276-3.

### **Web Links:**

1. <http://nptel.ac.in/courses/117/106/117106086> .
2. [https://onlinecourses.nptel.ac.in/noc20\\_ee42](https://onlinecourses.nptel.ac.in/noc20_ee42)
3. <https://nptel.ac.in/courses/117106111>

## Embedded Real Time Systems

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the services and tasks in RTOS.
- CO2:** Infer interrupts and timer services for embedded applications.
- CO3:** Outline memory management in embedded systems.
- CO4:** Illustrate program modeling for case studies.
- CO5:** Identify Fundamental Issues in Hardware software co- design

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| <b>CO2</b> | 3    | 1    |      |      |      |      |      |      |      |       | 1     |
| <b>CO3</b> | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| <b>CO4</b> | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| <b>CO5</b> |      | 3    |      |      |      |      |      |      |      |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

## UNIT – I

**Operating System Concepts:** History of Operating Systems, Functions performed by an OS, Kernel, Tasks, Processes, Threads, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, Tasks States, Task Operations and Task Structure.

## UNIT – II

### Synchronization and Inter Process Communication:

Defining Semaphore, Typical Semaphore Operation, Typical Semaphore Uses, Defining Message Queue, Message Queue States, Typical Message Queue Operation, Typical Message Queue Use, Pipes, Event Registers, Signals, Condition variables.

## **UNIT – III**

### **Exceptions, Interrupts and Timers:**

Exceptions, Interrupts, Applications of Exceptions and Interrupts, Processing General Exceptions, Nature of Spurious Interrupts, Introduction to Timers, Programmable Interval Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

## **UNIT – IV**

### **Memory Management:**

Dynamic Memory Allocation in Embedded Systems, Fixed-Size Memory management in Embedded Systems, Blocking VS. Non-Blocking Memory Functions, Hardware Memory Management Units.

## **UNIT – V**

### **Case study and Example RTOS:**

Linux POSIX system, MicroC/OS-II, Vx Works, QNX RTOS, Kernel Design Issues-process states, data structures, inter-task communication mechanism, Scheduling.

### **Text Books:**

1. Embedded/Real-Time Systems Dr. K.V.K.K. Prasad, Dream Tech Publications, Blackpad book, ISBN: 978-8177224610.
2. Real Time Concepts for Embedded Systems – Qing Li, Caroline Yao, Taylor & Francis Group, CRC Press, ISBN: 9781482280821
3. Embedded Systems, An Integrated Approach, Lyla B.Das, Pearson Education, ISBN: 9789332511675

### **Reference Books:**

1. Embedded Systems-Architecture, Programming and Design ,Rajkamal,Tata McGraw Hill Publications, Second Edition,ISBN: 978-0070667648.
2. Real-Time Systems: Scheduling, Analysis and Verific Cheng WileyInter science, ISBN: 9780471460848
3. Real-Time Systems: Design Principles for Distributed Embedded Applica Hermann Kopetz, Kluwer, ISBN: 9781441982377

### **Web Links:**

1. <http://www.nptelvideos.in/2012/11/embedded-systems.html>
2. [http://www.dauniv.ac.in/Embedded\\_Sys.php](http://www.dauniv.ac.in/Embedded_Sys.php)
3. <https://sites.google.com/site/embeddedsystemddr/ppt>

## Wireless LANs & PANs

**Course Code: 2501EC42**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course student will be able to:**

- CO1:** Explain the fundamentals of computer networks, reference models, IoT concepts, communication models, and layered architecture.
- CO2:** Describe WLAN technologies based on IEEE 802.11 standards.
- CO3:** Illustrate the architecture, operation, and applications of short-range wireless communication technologies.
- CO4:** Illustrate the architecture, operation, and applications of long Range and w-power wireless communication Communication Technologies.
- CO5:** Discuss IoT communication protocols such as WirelessHART, Z-Wave, 6LoWPAN, CoAP, and MQTT for smart and industrial applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| CO2   | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| CO3   | 3    | 3    |      |      |      |      |      |      |      |       | 1     |
| CO4   | 3    | 3    |      |      |      |      |      |      |      |       | 1     |
| CO5   | 3    | 2    |      |      |      |      |      |      |      |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    |      | 2    |
| CO2    |      | 2    |
| CO3    |      | 2    |
| CO4    |      | 2    |
| CO5    |      | 2    |

### UNIT – I

**Computer Networks Basics:** Basics of Computer Networks, Types of Networks: PAN, LAN, MAN, WAN, OSI Reference Model, TCP/IP Reference Model,

**IoT Fundamentals:** Introduction, Evolution of IOT, IOT and M2M, IoT communication models, Functionality of Layers in IoT.

### UNIT – II

**Random Access Protocols:** Multiple access Techniques, random access protocols, Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA.

**WLAN :** Wireless LAN Introduction, WLAN Topologies: Infrastructure and Ad-hoc, Features of IEEE 802.11 Standards (a/b/g/n/ac/ax), Wi-Fi Architecture and Operation, Wired LAN vs Wireless LAN Comparison.

### **UNIT – III**

#### **Short Range Wireless Technologies (WPAN):**

Bluetooth protocol, architecture and operation, Bluetooth Low Energy (BLE), IEEE 802.15.4 standard, low-rate WPAN communication principles, ZigBee protocol, architecture and network topologies, RFID communication principles, NFC Technology.

### **UNIT – IV**

#### **Long Range and Low-Power Wireless Communication Technologies:**

LPWAN communication, LoRa and LoRaWAN architecture, end devices, gateways and network server, Sigfox Overview, NB-IoT Basics, LTE-M Technology, Introduction to 5G IoT Communication (mMTC, URLLC, eMBB).

### **UNIT – V**

#### **IoT Communication Protocols:**

Architecture and Applications of IoT Communication protocols - Wireless HART, Z-Wave, 6LoWPAN, CoAP, MQTT.

#### **Text Books:**

1. Ad Hoc and Sensor Networks - Carlos de Moraes Cordeiro and Dharma Prakash Agrawal, World Scientific, ISBN: 978-9814338882.
2. Wireless Communications and Networking - Vijay K.Garg, Morgan Kaufmann Publishers, ISBN: 978-0123735805.
3. Internet of Things by Raj Kamal, McGraw-Hill Education. Copyright.

#### **Reference Books:**

1. Principles of Wireless Networks - Kaveh Pahlaram, Prashant Krishnamurthy, PHI, ISBN:978-0130930033.
2. Guide to Wireless Communication- Marks Ciampor, Jeorge Olenewa, Cengage Learning, ISBN: 9781111307318.
3. Internet of Things (A Hands-on- Approach) by Vijay Madisetti and ArshdeepBahga, 1 stEdition, VPT, 2014.

#### **Web Links:**

1. <https://archive.nptel.ac.in/courses/106/105/106105183/>
2. <https://archive.nptel.ac.in/courses/108/108/108108179/>
3. [https://onlinecourses.nptel.ac.in/noc21\\_cs17/preview?msclkid=16aacd77c08211ec97fb643b5beb9cd2](https://onlinecourses.nptel.ac.in/noc21_cs17/preview?msclkid=16aacd77c08211ec97fb643b5beb9cd2) Introduction to internet of things - Course (nptel.ac.in)
4. [Design for internet of thingsBy Prof. Prabhakar T V | IISc Bangalore Design for internet of things - Course \(nptel.ac.in\)](#)



## System Programming

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Code:**

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO1:** Apply the fundamental concepts of C programming and data structures to solve basic computational problems.
- CO2:** Apply knowledge of Linux basics in SHELL programming.
- CO3:** Analyze the components of embedded Linux systems to understand their roles and interactions.
- CO4:** Apply kernel module programming techniques to develop and test basic device driver programs.
- CO5:** Design and implement embedded and Linux-based development environments using state-of-the-art hardware and software tools.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 1    |      |      |      |      |      |      |       |       |
| <b>CO2</b> | 2    | 2    | 1    |      |      |      |      |      |      |       |       |
| <b>CO3</b> | 3    | 3    | 2    |      |      |      |      |      |      |       |       |
| <b>CO4</b> | 3    | 3    | 2    |      |      |      |      |      |      |       |       |
| <b>CO5</b> | 3    | 2    | 3    |      |      |      |      |      |      |       |       |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

### UNIT – I

#### **Programming Concepts with C and Data Structures:**

Basic concepts of C, Embedded C Vs C, Embedded programming aspects with respect to firmware, Bitwise manipulation, Functions, Recursive Functions, Arrays, pointers, Function Pointers, File Handling, Preprocessor Directives, structures, Union, and Inputs/Outputs, static and dynamic memory allocation, Linked list, Single linked list, Double linked list and Queues.

### UNIT – II

#### **Linux Essentials with Shell Scripting Techniques**

Command prompt, X windows basics, navigating file system, finding files, working with folders, reading files text editing in Linux, Compression and archiving tools, Basic shell commands, File Management, I/O Handling, File Locking. Processes, giving more than one command at a time, prioritizing and killing processes, Scheduling Commands, pipes and

redirection, regular expression, pattern matching, Scripting using for while, if and other commands.

### **UNIT – III**

#### **Embedded Linux Development Essentials:**

Introduction to Embedded Linux - Linux Kernel Basics for Embedded Systems - Build Systems and Cross-Compilation - Root Filesystem Essentials - Device Drivers and Hardware Interfacing - Debugging Techniques.

### **UNIT – IV**

#### **Kernel Module Programming:**

Compiling kernel, Configuring Kernel and compilation, Kernel code, browsers, Static linking, dynamic linking of modules, User space, kernel space concepts, writing simple modules – Writing, Make-files for modules.

### **UNIT – V**

#### **Device Driver concepts:**

Driver concepts, Block & character driver distinction, Low level drivers, OS drivers etc, Writing character drivers – GPIO driver, Device major, minor number.

#### **Text Books:**

1. Neil Mathew, Richard stones, Beginning Linux Programming, 2012, 4th Edition, Wrox – Wiley Publishing, USA.
2. Eric Foster Johnson, John C. Welch, Micah Anderson, Beginning shell scripting, 2012, 1st Edition, Wrox – Wiley Publishing, USA.

#### **Reference Books:**

1. Derek Molloy, Exploring Beagle Bone: Tools and Techniques for Building with Embedded Linux, 2015, 1st Edition, Wiley Publications, USA
2. Frank Vasquez, Profile Icon Chris Simmonds, Mastering Embedded Linux Programming, 2021, 3rd Edition, Packt Publishing, UK.

#### **Web Links:**

1. <https://www.coursera.org/specializations/c-programming-linux#courses>
2. <https://www.coursera.org/learn/linux-system-programming-introduction-to-buildroot>



## Embedded System Design

**Course Code: 2501EC34**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the building blocks of an Embedded system.
- CO2:** Interpret the hardware modules required to design an Embedded system.
- CO3:** Infer the firmware design approaches for an Embedded system.
- CO4:** Discuss the functionalities of Real time Operating Systems.
- CO5:** Develop Embedded systems based on their applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    |      |      |      |      |      | 1    | 1    |       | 1     |
| CO2   | 3    | 2    | 1    | 1    |      |      |      | 1    | 1    |       | 1     |
| CO3   | 2    | 3    |      |      |      |      |      | 1    | 1    |       | 1     |
| CO4   | 2    | 3    |      |      |      |      |      | 1    | 1    |       | 1     |
| CO5   | 2    | 2    | 3    | 1    |      |      |      | 1    | 1    |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    |      | 2    |
| CO2    |      | 2    |
| CO3    |      | 2    |
| CO4    |      | 2    |
| CO5    |      | 2    |

## UNIT – I

### Introduction:

Embedded System-Definition, History of embedded system, Characteristics of an embedded system, classification of embedded systems, Embedded System Architecture Quality attributes of embedded systems, Challenges in Embedded System Design, Examples of an embedded system.

## UNIT – II

### Designing Embedded Computing Platform:

Introduction to Processors & Controllers, Sensors, Actuators, Analog and digital electronic components, I/O types and examples, Memory Classification, Timer and counting devices, Watchdog Timers, RTC, Wireless Protocols.

## UNIT – III

**Embedded Firmware:**

Embedded Firmware design approaches & development languages, Pre-processors, Interpreters, Compilers and Linkers, Debugging tools , C versus Embedded C, ALP Programming.

**UNIT – IV****Real-Time Operating Systems:**

Classification of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization. Application Programming on RTOS.

**UNIT – V****Embedded System Development:**

The IDE, Types of files generated on cross- compilation, Deassembler/ Decompile, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.

**Text Books:**

1. Embedded Systems, Shibu.K. V, Tata McGraw Hill Education Private Limited, ISBN: 978-9339219680.
2. Computers as Components – Principles of Embedded Computing System Design, Marilyn Wolf, Morgan Kaufmann Publisher (An imprint from Elsevier), 3<sup>rd</sup> Edition, ISBN: 0128053879.

**Reference Books:**

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, ISBN: 9781222995374.
2. The Designer's Guide to the Cortex-M Processor Family - A Tutorial Approach, Trevor Martin, Elsevier Science, <sup>st</sup> Edition, ISBN: 9780080982991.

**Web Links:**

1. [http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1\\_ESIntroduction.pdf](http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf)
2. <http://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf>
3. <http://www.vtt.fi/inf/pdf/publications/2004/P526.pdf>

## Real Time operating system using QNX

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Describe the QNX OS architecture and its microkernel-based design.
- CO2:** Develop and debug QNX-based applications using appropriate tools.
- CO3:** Apply process/thread management and synchronization techniques in QNX.
- CO4:** Implement inter-process communication methods for real-time systems.
- CO5:** Configure and build QNX boot/OS images for specific hardware platforms.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      |      | 2    |      |      |      |      |       | 1     |
| <b>CO2</b> | 3    | 1    |      |      | 2    |      |      |      |      |       | 1     |
| <b>CO3</b> | 3    | 2    |      |      | 2    |      |      |      |      |       | 1     |
| <b>CO4</b> | 3    | 2    |      |      | 2    |      |      |      |      |       | 1     |
| <b>CO5</b> |      | 3    |      |      | 2    |      |      |      |      |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

## UNIT – I

### Introduction to QNX OS Architecture:

Overview of QNX OS architecture: microkernel, process manager, and standards. Protected address spaces, process/thread model, and scheduling. Introduction to inter-process communication (IPC) and synchronization. Resource managers and shared objects.

#### Practice:

1. Introduction to QNX Software and installation
  - QNX SOFTWARE Centre
  - Momentics IDE
  - QNX800
  - VMware Workstation
2. Execution of a program-print “hello world” using IDE environment and VMware
3. Installing QNX image into Raspberry Pi board- Execution of a program-print “hello world”

## UNIT – II

### **Processes, Threads, and Synchronization:**

Process management: creation, termination, and memory protection. Thread management: creation, termination, and synchronization. Synchronization techniques: mutexes, semaphores, and condition variables.

#### **Practice:**

1. Multiple Child creation using fork, exec and spawn, detecting termination of a child
2. Multiple thread creation-Thread Synchronization-Thread join and Mutex.
3. Condition variable

## UNIT – III

### **Inter-Process Communication (IPC):**

Overview of IPC methods in QNX: message passing, pulses, and shared memory. Comparing IPC methods: advantages and disadvantages.

#### **Practice:**

1. IPC-Client Server-Message passing.
2. IPC-Pulse and Name-attach and Name-open
3. IPC-IOV & Pulses events

## UNIT – IV

### **Hardware Programming and Timing:**

Hardware access methods: IO-mapped and memory-mapped IO. Interrupt handling and DMA-safe memory allocation. Timing architecture: periodic timing, one-shot timing, and timeouts.

#### **Practice:**

1. Simple interrupt handling
2. Implement two processes that communicate via shared memory using shm\_open and mmap. One process writes data, and the other reads and displays it.

## UNIT – V

### **Building and Configuring QNX Boot/OS Images:**

Overview of QNX boot/OS image structure. Components of a boot image: startup code, kernel, drivers, and scripts. Building and loading boot images onto target hardware. Introduction to resource managers and their implementation.

#### **Practice:**

1. BSP Booting
2. Create a new virtual machine image with a larger boot disk.

**Web Links:**

1. [https://blackberry .qnx.com/en/products/qnx-everywhere](https://blackberry.qnx.com/en/products/qnx-everywhere)
2. <https://gitlab.com/qnx>
3. <https://www.reddit.com/r/QNX/>
4. <https://stackoverflow.com/questions/tagged/qnx>
5. <https://www.youtube.com/qnxcam>

## Machine Learning for Embedded System

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Understand ML fundamentals and TinyML concepts.
- CO2:** Apply neural network training and optimization techniques.
- CO3:** Apply ML algorithms for embedded applications.
- CO4:** Discuss deep learning architectures for embedded systems.
- CO5:** Apply deployment frameworks for real-world embedded AI applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      |      |      |      |      |      |      | 1     |       |
| <b>CO2</b> | 3    | 3    | 2    |      |      |      |      |      |      | 1     |       |
| <b>CO3</b> | 2    | 3    | 2    |      |      |      |      |      |      | 1     |       |
| <b>CO4</b> | 2    | 2    | 3    |      |      |      |      |      |      | 1     |       |
| <b>CO5</b> | 2    | 2    | 3    |      |      |      |      |      |      | 1     |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

## UNIT – I

### Foundations of Machine Learning in Embedded System:

Various paradigms of learning problems, Forms of Learning: Supervised, and Unsupervised algorithms, Reinforcement Learning, Machine Learning Terminologies and Model Evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-Score, training, testing, validation, cross-validation, overfitting, underfitting, early stopping, regularization, bias and variance, Introduction to TinyML and Edge AI.

## UNIT – II

### Neural Networks and Model Training:

Differences between Biological and Artificial Neural Networks - General Architecture, Multi-layer neural network, Linear Separability, Perceptron, Adaline, Standard Back propagation, Training Algorithms for Pattern Association - Hebb rule and Delta rule, Gradient descent, Boltzmann Machine Learning, Model training vs inference on embedded systems, Lightweight Neural Network deployment strategies -quantization, and pruning.

### **UNIT – III**

#### **Advanced Machine Learning Techniques:**

Feature Engineering, Dimensionality Reduction, Classifiers: K-Nearest Neighbour (KNN), Support Vector Machine (SVM), Decision Trees, Naïve Bayes, Binary Classification, Multi-class Classification, Clustering, Ensemble learning, Low-power classification methods for Embedded controllers.

### **UNIT – IV**

#### **Deep Learning Architectures:**

Convolutional Neural Networks: Convolution layers, Pooling layers, Fully connected layers, Advanced CNN models: Alexnet, VGGnet, ResNet, Handling overfitting in CNN: drop out, transfer learning, data augmentation, Recurrent Neural Networks, Structure of RNN Cell, LSTM and GRU, Autoencoders: Convolutional Autoencoders, Denoising Autoencoders, Variational Autoencoders, Lightweight DL architectures for embedded systems: Squeeze Net, MobileNetV3, and Tiny-YOLO.

### **UNIT – V**

#### **Generative Models, Deployment and Real-World Applications:**

Generative Adversarial Networks (GANs): The Discriminator, Generator, Introduction to BERT Transformer, Real-world applications in NLP, Computer Vision, Healthcare, and Finance, Deployment frameworks: TensorFlow Lite, PyTorch Mobile.

#### **Text Books:**

1. ShaiShalev-Shwartz and Shai Ben-David, Understanding Machine Learning, 2017,1st Edition, Cambridge University Press., ISBN: 978-1107057135.
2. Ian Good fellow, Yoshua Bengio and Aaron Courville, Deep Learning, 2016, MIT Press, ISBN: 9780262035613.

#### **Reference Books:**

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012,1st Edition, PHI learning.ISBN: 9780132610667.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning, 2009,2nd Edition, Springer Series. ISBN: 9780387848846.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, 2016, Springer, ISBN: 978-0-387-31073-2.

#### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/e-learning/preview/noc26\\_ee53](https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee53)
2. [https://onlinecourses.nptel.ac.in/e-learning/preview/noc26\\_cs74](https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs74)

## Hardware & Software Co-Design

**Course Code:2501EC35**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Analyze embedded system's hardware and software design issues.
- CO2:** Develop the applications on 8051, ADSP2106 and TMS320C60 processors.
- CO3:** Explain modern embedded architectures and compilation technologies.
- CO4:** Interpret the Design, co design by using design verification tools.
- CO5:** Develop a system from system level specification languages.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 3    |      |      |      |      |      |      |      |       |       |
| CO2   | 2    | 2    | 2    |      |      |      |      |      |      |       |       |
| CO3   | 3    |      |      |      |      |      |      |      |      |       |       |
| CO4   | 3    | 1    |      |      |      |      |      |      |      |       |       |
| CO5   | 2    | 2    | 1    |      |      |      |      |      |      |       |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    |      | 2    |
| CO2    |      | 2    |
| CO3    |      | 2    |
| CO4    |      | 2    |
| CO5    |      | 2    |

### UNIT – I

**Co- Design Issues:** Co- Design Models, Architectures, Languages, A Generic Co-design Methodology.

**Co-Synthesis Algorithms:** Hardware software synthesis algorithms, hardware, software partitioning distributed system co synthesis.

### UNIT – II

**Prototyping and Emulation:** Prototyping and emulation techniques, prototyping and emulation environments.

**Target Architectures:** Architecture Specialization techniques, System Communication infrastructure, Architecture for control dominated systems (8051-Architectures), Architecture for Data dominated systems (ADSP21060).



### UNIT – III

**Compilation Techniques and Tools for Embedded Processor Architectures:** Modern embedded architectures(MMDSP Processor), embedded software development needs, compilation technologies.

### UNIT – IV

**Design Specification and Verification:** Design,co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools, interface verification.

### UNIT – V

**Languages for System – Level Specification and Design-I:** System – level specification, design representation for system level synthesis, system level specification languages. Languages for System-Level Specification and Design-II: Heterogeneous specifications and multi-language co-simulation.

#### Text Books:

1. Hardware / Software Co- Design Principles and Practice, Jorgen Staunstrup, Wayne Wolf, Springer, ISBN: 978-1441950185.
2. Hardware / Software Co- Design, Giovanni DeMicheli, Mariagiovanna Sami, Kluwer Academic Publishers, ISBN: 978-0792338833.

#### Reference Books:

1. A Practical Introduction to Hardware/Software Co-design, Patrick R.Schaumont, Springer Publications, ISBN: 978-1441959997.

#### Web Links:

1. <https://embedded.eecs.berkeley.edu/Research/hsc/abstract.html>
2. <http://ieeexplore.ieee.org/document/6172642/>
3. <http://www.tik.ee.ethz.ch/education/lectures/hswcd/>
4. <http://ieeexplore.ieee.org/document/715400/>

### Minor Stream: Signal Processing and Communication Technology

| Course Code  | Course Name                               | Level | L         | T | P        | C         | CIE | SEE | Total | Pre-requisite |
|--------------|-------------------------------------------|-------|-----------|---|----------|-----------|-----|-----|-------|---------------|
| 2501EC45     | Fundamentals of Speech Processing         | IC    | 2         |   | 1        | 3         | 50  | 50  | 100   | S&S           |
| 2501EC46     | Information Theory & Coding Techniques    | IC    | 2         |   | 1        | 3         | 50  | 50  | 100   | -             |
| 2501EC44     | Digital Signal Processors & Architectures | IC    | 2         | 1 |          | 3         | 50  | 50  | 100   | DSP           |
| 2501EC43     | Digital Image Processing                  | IC    | 2         |   | 1        | 3         | 50  | 50  | 100   | S&S           |
| 2501EC49     | Radar Engineering                         | IC    | 3         |   |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC51     | Soft Computing Techniques                 | AC    | 2         | 1 |          | 3         | 50  | 50  | 100   | -             |
| 2501EC47     | Optical Communications                    | AC    | 3         |   |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC50     | Satellite Communications                  | AC    | 3         |   |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC48     | Pattern Recognition                       | AC    | 2         |   |          | 2         | 50  | 50  | 100   | DIP           |
| 2501EC52     | Wireless Communications                   | AC    | 2         | 1 |          | 3         | 50  | 50  | 100   | ADCM          |
| 2501EC53     | Wireless Sensor Networks                  | AC    | 3         |   |          | 3         | 50  | 50  | 100   | IOT           |
| <b>Total</b> |                                           |       | <b>29</b> |   | <b>3</b> | <b>32</b> |     |     |       |               |

## Fundamentals of Speech Processing

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501EC45</b> | <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Interpret the basic concepts of speech production and perception.
- CO2:** Classify the concepts of analysis and processing of speech signals .
- CO3:** Analyze the enhancement of speech signals in the presence of different background noises.
- CO4:** Interpret the concepts pattern recognition system and different statistical modeling approaches.
- CO5:** Analyze the applications of speech processing including speaker recognition and speech recognition.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 1    | 3    | -    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 2    | 3    | -    | -    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | -    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 2    | 3    | 2    | -    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 3    | -    | 1    | -    | -    | 1    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Introduction to Speech Processing:

Speech Fundamentals, Speech production and perception, information sources in speech signal, linguistic aspect of speech, acoustic and articulatory phonetics, nature of speech, models for speech analysis and perception, short-term processing of speech, time, frequency and time-frequency analysis, development of short-term Fourier transform (STFT), transform and filter-bank views of STFT.

**Practice:**

1. Manual speech signal-to-symbol transformation for speech signal.
2. Time-varying nature of the speech signal in the time domain as well as frequency domain.

**UNIT – II****Speech Analysis:**

Basis and development cepstrum analysis of speech, real and complex cepstrum, pitch detection, formant estimation, Mel-frequency cepstral coefficient (MFCC), delta and delta-delta MFCC, Linear Prediction (LP) analysis, LP analysis of speech, solution of LP equation using Levinson-Durbin's method, normalized error, LP spectrum, LP cepstrum, LP residual.

**Practice:**

1. Analyze speech signals by computing the cepstrum for various voiced and unvoiced sounds.
2. Analyze the characteristics of speech using linear prediction (LP) analysis.

**UNIT – III****Speech enhancement:**

objective, issues, enhancement of noisy speech, reverberant speech and multi-speaker speech using time, frequency and time-frequency approaches.

**Practice:**

1. Spectrographic Analysis of voiced, unvoiced and plosive Speech.
2. Short-time spectrum analysis of speech signals, the effect of size of the analysis window (less than one pitch period, one pitch period, two to four pitch periods).

**UNIT – IV****Basic concepts of pattern recognition:**

Feature extraction, modeling, testing, Objective, issues, block diagram description of automatic speech recognition (ASR) system, development of ASR system using vector quantization (VQ), dynamic time warping (DTW), Hidden Markov Model (HMM) and Neural networks (NN).

**Practice:**

1. Analyze speech signals by computing the cepstrum for various voiced and unvoiced sounds.
2. Analyze effects of sampling (aliasing) and quantization on speech signals by playing them at different sampling rates and bits per sample.

**UNIT – V****Speech Recognition:**

Objective, issues, block diagram description of speaker recognition system, classification of speaker recognition systems, development of speaker recognition system using VQ, Gaussian mixture model (GMM), Adapted-GMM and I-vector.

**Practice:**

1. Speaker voice activity detection in speech.
2. Reconstruct the spectrum of various components (source, system) using the spectrum.

**Text Books:**

1. Digital Processing of Speech Signals, L.R. Rabiner and R.W. Schafer, Pearson Education, Delhi, India, ISBN: 978813170513.
2. Fundamentals of speech recognition, L. R. Rabiner, B. H. Juang and B. Yegnanarayana, Pearson Education, ISBN: 8177585606.

**Reference Books:**

1. Discrete-Time Processing of Speech Signals, J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, Wiley-IEEE Press, NY, USA, ISBN: 0780353862.
2. Discrete time processing of speech signals, T. F. Quatieri, Pearson Education, ISBN: 013242942X.
3. Speech and Audio Processing, Dr.Shaila D.Apte -, First Edition, WILEY, ISBN: 978-8126534081.
4. Statistical Methods of Speech Recognition, Frederick Jelinek, MIT Press, 2022, ISBN: 9780262546607.

**Web Links:**

1. <https://archive.nptel.ac.in/courses/117/105/117105145/#/> Prof. S.K. Das Mandal
2. <https://www.cse.iitb.ac.in/~pjyothi/cs753/index.html/> Prof. Preethi Jyothi
3. <https://ssp-iiith.vlabs.ac.in/Introduction.html/> Speech Signal Processing Lab
4. <https://vlab.amrita.edu/index.php?sub=59&brch=164/> Speech Signal Processing Lab

## Information Theory & Coding Techniques

**Course Code:2501EC46**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the basics of Information theory.
- CO2:** Implement the various types of source coding algorithms and analyze their performance.
- CO3:** Design a channel coding scheme for a communication system.
- CO4:** Discuss the different types of entropy and coding theorem for Gaussian channels.
- CO5:** Evaluate the performance of coding techniques and error corrections.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 1    | -    | -    | -    | 1    | 2    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 3    | 1    | -    | -    | -    | 1    | 2    | 1    | -     | 1     |
| <b>CO3</b> | 3    | 3    | 2    | -    | -    | -    | 1    | 2    | 1    | -     | 1     |
| <b>CO4</b> | 2    | 3    | 2    | -    | -    | -    | 1    | 2    | 1    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 2    | -    | -    | -    | 1    | 2    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Information Theory:

Entropy, Joint Entropy and Conditional Entropy, Relative Entropy and Mutual Information, Chain Rules, Data-Processing Inequality, Fano's Inequality.

### Practice:

1. Write a program using matlab for the determination of various entropies and mutual information of a given channel. Test various types of channel such as
  - a) Noise free channel    b) Error free channel    c) Binary symmetric channel
  - d) Noisy channel

## **UNIT – II**

### **Source Coding:**

Shannon –Fano Coding, Optimality of Huffman Coding, Capacity of a Gaussian channel, bandwidth –S/N trade off, Capacity of discrete channels, Related Problems.

### **Practice:**

1. Minimize coding redundancy using Source Encoder and Decoder using hardware kit.
2. Analyze the channel coding techniques in time and frequency domain using hardware kit.
3. Write a program for generation and evaluation of variable length source coding using matlab.
  - a) Shannon –Fano coding and decoding.
4. Write a program for generation and evaluation of variable length source coding using matlab.
  - a) Huffman coding and decoding.

## **UNIT – III**

### **Linear Block Codes:**

Introduction, Matrix description of Linear Block Codes, Error detection and error correction capabilities of Linear block codes, Hamming codes, Binary Cyclic Codes, Algebraic structure, Encoding, Syndrome calculation, BCH Codes.

### **Practice:**

1. Perform error detection and correction using Linear Block Code-Encoder and Decoder using hardware kit.
2. Write a program for encoding and decoding of BCH codes using matlab.

## **UNIT – IV**

### **Cyclic Codes:**

Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding, Cyclic Hamming Codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes, shortened cyclic codes.

### **Practice:**

1. Perform error detection and correction using Binary Cyclic Code – Encoder and Decoder using hardware kit.

## **UNIT – V**

**Convolutional Codes:**

Encoding of Convolutional Codes- Structural and Distance Properties, state, tree, trellis diagrams, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ system. Low Density Parity Check (LDPC) codes.

**Practice:**

1. Perform error detection and correction using Convolution Code – Encoder and Decoder using hardware kit.
2. Implementation of ARQ technique using matlab.

**Text Books:**

1. Information theory and coding - K. N. Hari Bhat , D. Ganesh Rao ,Cengage India Private Limited, First Edition,ISBN: 978-9386650924.
2. Information theory and coding by Anoop Singh poonia,Rupal Bansal,Ashirwad publisher,Fifth Edition,ISBN: 8190571109.

**Reference Books:**

1. Digital and Analog Communication Systemsby K.Sam Shanmugam,Wiley India Pvt Ltd, 1<sup>st</sup>Edition,ISBN: 8126509147.
2. Information Theory and Coding ( Wiley India: 2015) by Dr. Muralidhar Kulkarni Dr. Shivaprakash K S,Wiley, 2<sup>nd</sup> Edition,ISBN: 9788126553051.

**Web Links:**

1. <https://archive.nptel.ac.in/courses/108/102/108102117/>
2. <https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee39/>



## Digital Signal Processors & Architectures

**Course Code:2501EC44**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the concepts of number formats and various DSP related errors.
- CO2:** Illustrate the architectural features of Programmable digital signal processors.
- CO3:** Infer the TMS320C54XX processor architecture details, addressing modes and on-Chip peripherals.
- CO4:** Implement the basic DSP algorithms using digital signal processors.
- CO5:** Interpret the interfacing of devices with digital signal processors.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO2   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO3   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO4   | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO5   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

## UNIT – I

### Computational Accuracy in DSP implementations:

Review of Digital signal processing, Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors

## UNIT – II

### Architectures for Programmable DSP Devices:

Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing

## **UNIT – III**

### **Programmable Digital Signal Processors:**

Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX Instructions and Programming, On Chip Peripherals, Interrupts of TMS320C54XX Processors, Pipeline Operation of TMS320C54XX Processors. Architectural features of TMS320C67XX Processors.

## **UNIT – IV**

### **Implementations of basic DSP algorithms:**

The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX, Computation of the signal spectrum.

## **UNIT – V**

### **Interfacing Memory and I/O Peripherals to Programmable DSP Devices:**

Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts, Direct memory access (DMA).

### **Text Books:**

1. Digital Signal Processing, Avtar Singh and S. Srinivasan, Thomson Press, ISBN: 9788131500347.
2. Digital Signal Processing: Principles, Algorithms & Applications – J.G. Proakis & D.G. Manolakis, PHI, 4<sup>th</sup> Edition, ISBN: 9788131710005..

### **Reference Books:**

1. A Practical Approach to Digital Signal Processing, K Padmanabhan, R.Vijayarajeswaran, and Ananthi S, New Age International, 2<sup>nd</sup> Edition, ISBN: 978-8122432428.
2. Embedded Signal Processing with the Micro Signal Architecture, Woon-Seng Gan, and Sen M. Kuo, Wiley-IEEE Press, 1<sup>st</sup> Edition, ISBN. 978-0471738411.
3. DSP Processor Fundamentals, Architectures & Features, Lapsley et al, S. Chand & Co, 1<sup>st</sup> Edition, ISBN: 978-8126523542.

**Web Links:**

1. <https://nptel.ac.in/courses/108/101/108101174> NPTEL course on “Digital Signal Processing and its Applications”.
2. <https://nptel.ac.in/courses/108106149> NPTEL course on “Mapping Signal Processing Algorithms to Architectures”.
3. <https://www.analog.com/en/design-center/landing-pages/001/beginners-guide-to-dsp.html>
4. <https://www.dspguide.com/ch28/3.html>

## Digital Image Processing

**Course Code:2501EC43**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Interpret the concepts of digital image processing and image transforms.
- CO2:** Apply spatial and frequency domain techniques for image enhancement and Restoration.
- CO3:** Apply discontinuity and similarity based techniques for image segmentation.
- CO4:** Perform compression techniques for images.
- CO5:** Utilize color models for image processing applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 1    | 1    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 2    | 2    | 1    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 3    | 2    | 2    | 1    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 2    | 1    | 1    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 3    | 2    | 2    | 1    | 1    | -    | -    | 1    | 1    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

**Introduction:** Introduction to Image Processing, Fundamental steps in digital image processing, Components of an image processing system, Image sensing and acquisition, Image sampling and quantization, Some basic relationships between pixels, An introduction to the mathematical tools used in digital image processing.

**Image Transforms:** Need for image transforms, Discrete Fourier transform (DFT) of one variable, Extension to functions of two variables, some properties of the 2-D Discrete Fourier transform, Importance of Phase, DCT, DST, Walsh-Hadamard transform, KLT, Haar transform, Radon Transform

### Practice:

1. Compute arithmetic and logical operations on images

2. Compute DFT, DCT and DST of an image also calculate phase

## UNIT – II

**Image Enhancement:** Back ground, basic intensity transformation methods, histogram processing, fundamentals of spatial filtering, smoothing and sharpening spatial filters, Combining spatial enhancement methods. The basics of filtering in the frequency domain, image smoothing and sharpening using frequency domain filters, selective filtering.

**Practice:**

1. Obtain the enhancement of a low contrast image using histogram equalization
2. Perform unsharp masking and high boost filtering to sharpen the image.

## UNIT – III

**Image Restoration and Reconstruction:** A model of the image degradation/ Restoration process, Noise models, restoration in the presence of noise only- Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Linear, Position –Invariant Degradations, Estimating the degradation function, Inverse filtering, Minimum mean square error (Wiener) filtering, constrained least squares filtering, geometric mean filter.

**Practice:**

1. Compute the denoised image using mean filters for the removal of noise and compare the results in terms of PSNR.
2. Compute the denoised image using order-statistics filters for the removal noise and compare the results in terms of PSNR.
3. Perform deblurring using inverse filter and Wiener filter.

## UNIT – IV

**Image Segmentation:** Fundamentals, point, line, edge detection, thresholding, region – based segmentation, Hough Transform.

**Image Compression:** Fundamentals, Basic compression methods: Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-Length coding, Symbol-Based coding, Bit-Plane coding, Block Transform coding, Predictive coding.

**Practice:**

1. Compute the edge of an image using Sobel and Prewitt operator.
2. Compress image using Huffman coding and Arithmetic coding techniques

## UNIT – V

**Color Image Processing:** Color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening. Image segmentation based on color, noise in color images.

**Morphological Image Processing:** Dilation, Erosion, Opening, Closing.**Practice:**

1. Compute smoothing on color images with and without noise
2. Compute sharpening on color images

**Text Books:**

1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Prentice Hall, 4<sup>th</sup> Edition, 2018, ISBN: 978-9353062989
2. Digital Image Processing, Jayaraman, S. Esakkiraja and T. Veerakumar, Tata McGrawHill Education, 2<sup>nd</sup> Edition, ISBN: 9780070144798

**Reference Books:**

1. Fundamentals of Digital Image Processing, Anil K. Jain, Prentice Hall of India, 9<sup>th</sup> Edition, ISBN: 978-9332551916.
2. Digital Image Processing, S. Sridhar, Oxford higher Education Publication, 2<sup>nd</sup> Edition, ISBN: 978-0199459353.
3. Digital Image Processing using MATLAB, R. C. Gonzalez and R. E. Woods, Prentice Hall, 3<sup>rd</sup> Edition, ISBN: 978-0131687288.

**Web Links:**

1. [http://nptel.ac.in/courses/117105079/\(Digital Image Processing, IIT Kharagpur Prof. P.K. Biswas\)](http://nptel.ac.in/courses/117105079/(Digital%20Image%20Processing,%20IIT%20Kharagpur%20Prof.%20P.K.%20Biswas))
2. [https://www.coursera.org/learn/digital#ratings\(Fundamentals of digital image and video processing, Aggelos K. Katsaggelos, University of North westren\)](https://www.coursera.org/learn/digital#ratings(Fundamentals%20of%20digital%20image%20and%20video%20processing,%20Aggelos%20K.%20Katsaggelos,%20University%20of%20North%20westren))
3. <https://sisu.ut.ee/imageprocessing/avaleht>

## RADAR Engineering

**Course Code:2501EC49**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Model the RADAR range equation.
- CO2:** Outline the working principle of CW and FM-CW RADARs.
- CO3:** Illustrate the principle of MTI RADAR and its characteristics.
- CO4:** Infer the RADAR tracking techniques.
- CO5:** Analyze matched filter receiver characteristics and subsystems of RADAR receiver.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Basics of Radar:

Introduction, nature of radar, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Illustrative Problems. Radar Equation: Modified Radar Range Equation, SNR, probability of detection, probability of False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.

## **UNIT – II**

### **CW and Frequency Modulated Radar:**

Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. Illustrative Problems. FM-CW Radar, FM-CW altimeter, Multiple Frequency CW Radar.

## **UNIT – III**

### **MTI and Pulse Doppler Radar:**

Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Range Gated Doppler Filters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar.

## **UNIT – IV**

### **Tracking Radar:**

Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two- coordinates), Phase Comparison Mono pulse, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers.

## **UNIT – V**

### **Detection of Radar Signals in Noise:**

Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation detection and Cross-correlation Receiver, Efficiency of Non-Matched Filters, Matched Filter with Non-white Noise, Noise Figure and Noise Temperature.

**Radar Receivers:** Displays – types. Duplexers – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Series versus parallel feeds, Applications, Advantages and Limitations, Radomes.

### **Text Books:**

1. Introduction to Radar Systems, Merrill I. Skolnik, TMH Special Indian Edition, 2<sup>nd</sup> Edition, ISBN: 9780070634411.
2. Radar: Principles, Technology, Applications, Byron Edde, Pearson Education, ISBN: 9788131713839.



**Reference Books:**

1. Radar Principles – Peebles, Jr., P.Z., Wiley, New York, ISBN: 9780471252054.
2. Radar Handbook, Merrill I. Skolnik, McGraw Hill, Third, 3rd Edition, ISBN: 9780471252054.
3. Introduction to Radar System, KK Sharma, S.K. Kataria & Sons, 1<sup>st</sup> Edition, 2023, ISBN: 9789350142615.

**Web Links:**

1. <https://www.jlab.org/ir/MITSeries>
2. <https://ocw.mit.edu/resources/res-ll-001>
3. [https://onlinecourses.nptel.ac.in/noc24\\_ee104](https://onlinecourses.nptel.ac.in/noc24_ee104)

## Soft Computing Techniques

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:2501EC51</b> | <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Discuss the basic concepts of soft computing techniques.
- CO2:** Explain Fuzzy systems, components and their applications.
- CO3:** Demonstrate Fuzzy modeling and control schemes for nonlinear systems.
- CO4:** Infer Genetic Algorithm for solving the optimization problems.
- CO5:** Develop proficiency in the Back Propagation algorithm for training Multilayer Perceptron networks.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 3    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Introduction:

Concept of computing systems, Soft computing versus Hard computing, Characteristics of Soft computing, Introduction to Fuzzy Computing, Neural Computing, Some applications of Soft computing techniques.

## UNIT – II

### Fuzzy Sets and Fuzzy Logic:

Introduction, Fuzzy Sets Versus Crisp Sets, Operations on Fuzzy Sets, Extension Principle, Fuzzy Relations and Relation Equations, Fuzzy Numbers, Linguistic Variables, Fuzzy Logic, Linguistic Hedges, Applications.

## **UNIT – III**

### **Inference in Fuzzy Logic:**

Fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzifications, Inferencing, and De-fuzzifications, Fuzzy modeling and control schemes for nonlinear systems, Fuzzy Pattern Recognition, Fuzzy Image Processing, Fuzzy Database.

## **UNIT – IV**

### **Genetic Algorithm:**

Basic concept of Genetic algorithm and detail algorithmic steps, Search space, working principle. Encoding: binary, Octal, Hexadecimal, permutation, Value and Tree. Decoding, fitness function, Selection: Roulette wheel, Boltzmann, Tournament, Rank and Steady-state. Crossover: single-point, two-point, multi-point, uniform, matrix and crossover rate, Mutation: mutation, mutation rate, Ant-colony Optimization, Particle Swarm Optimization, Solving problems using GA.

## **UNIT – V**

### **Artificial Neural Networks:**

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, Single Neuron/Perceptron networks: training methodology, Typical application to linearly separable problems. Feed-forward Multilayer Perceptron, Multilayer Perceptron: Back propagation algorithm, virtues and limitation of BP algorithm, Modifications to back-propagation, Hopfield network.

### **Text Books:**

1. Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, 2nd Edition, S. Rajasekharan, G. A. Vijayalakshmi Pal, Prentice Hall India, ISBN: 978-8120353343
2. Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering, Nikola K. Kasabov, MIT Press, ISBN: 0-262-11212-4

### **Reference Books:**

1. Neural Networks and Learning Machine, Simon Haykins, Prentice Hall India, 3<sup>rd</sup> Edition, ISBN: 978-0-13-147139-9
2. Fuzzy Logic with Engineering Application, Timothy J. Ross, Wiley, 3<sup>rd</sup> Edition, ISBN: 0-470-86075-8

**Web Links:**

1. <https://archive.nptel.ac.in/courses/106/105/106105173/> (Prof. Debasis Samanta, IIT Kharagpur)
2. [https://onlinecourses.nptel.ac.in/noc21\\_ge07/preview](https://onlinecourses.nptel.ac.in/noc21_ge07/preview) (Prof. Dilip Kumar Pratihari, IIT Kharagpur)
3. <https://www.udemy.com/course/geneticalgorithm>
4. <https://www.udemy.com/course/fuzzylogic/>

## Optical Communications

**Course Code:2501EC47**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Realize the significance of optical fiber communications.
- CO2:** Recognize the construction and characteristics of optical fiber cable.
- CO3:** Illustrate the knowledge of optical signal sources and power launching.
- CO4:** Examine and understand the operation of various optical detectors.
- CO5:** Summarize the performance metrics of optical systems and WDM system.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Overview of Optical Fiber Communication:

The general optical fiber communication system, Optical fiber wave guides, Ray theory transmission, Total Internal Reflection, acceptance angle, Cylindrical fibers- Modes Fiber materials, fiber fabrication techniques, fiber optic cables, classification of Optical Fibers: single mode fibers, graded index fibers.

## **UNIT – II**

### **Signal Distortion In Optical Fibers:**

Attenuation, absorption, scattering and bending losses, core and cladding losses, information capacity determination, group delay, Types of dispersion - material dispersion, wave-guide dispersion, polarization mode dispersion, intermodal dispersion, pulse broadening.

## **UNIT – III**

### **Optical Sources:**

Intrinsic and extrinsic materials-direct and indirect band gaps-LED-LED structures surface emitting LED-edge emitting LED-quantum efficiency and LED power-light source materials modulation of LED.

## **UNIT – IV**

### **Optical Detectors:**

Physical principles of PIN and APD, detector response time, temperature effect on avalanche gain, comparison of photo detectors.

## **UNIT – V**

### **Optical System Design:**

Considerations, component choice, multiplexing, point-to- point links, system considerations, link power budget with examples. WDM –passive DWDM components-elements of optical networks-SONET/SDH.

### **Text Books:**

1. Optical Fiber Communications, Gerd Keiser, Tata Mc Graw-Hill International edition, 5<sup>th</sup>Edition,ISBN: 978-1259006876.
2. Optical Fiber Communications , John M. Senior, PHI, 3<sup>rd</sup> Edition, ISBN: 978-9332535787

### **Reference Books:**

1. Fiber Optic Communication,J. C. Palais, Pearson Prentice Hall,ISBN: 978-8131717912.
2. Optoelectronics and Photonics: Principles and Practices, S.O. Kasap, Pearson Prentice Hall, 2<sup>nd</sup>Edition,ISBN: 978-0132151498.

**Web Links:**

1. <http://nptel.ac.in/courses/117104127/2>
2. <https://www.linktionary.com/f/fiber-optic.html>

## Satellite Communications

**Course Code:2501EC50**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the trends of satellite communications.
- CO2:** Illustrate the orbital effects on satellite communication and associated sub systems.
- CO3:** Compare the multiple access techniques.
- CO4:** Analyze the parameters to enhance the satellite link performance and the satellite based link designs.
- CO5:** Outline the satellite-based navigation systems.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Introduction:

Origin of satellite communications, historical back-ground, basic concepts of satellite communications, frequency allocations for satellite services, future trends of satellite communications. Orbital mechanics and launchers: orbital mechanics, look angle determination, orbital perturbations, orbital determination, launches and launch vehicles, orbital effects in communication systems performance.



## **UNIT – II**

### **Satellite Subsystems:**

Introduction-attitude and orbit control system, telemetry, tracking, commanding and monitoring, power systems, communication subsystems, satellite antennas subsystems, propulsion subsystems equipment reliability and space qualification.

## **UNIT – III**

### **Multiple Accesses Techniques:**

Frequency Division Multiple Access (FDMA), intermodulation, calculation of C/N. Time Division Multiple Access (TDMA), frame structure, slotted aloha spread spectrum methodology.

## **UNIT – IV**

### **Satellite Link Design:**

Basic link analysis, uplink and downlink design equation, free space loss-atmospheric effects, ionospheric scintillation, rain induced attenuation and interference, system noise temperature, link design with and without frequency reuse.

## **UNIT – V**

### **Satellite Applications:**

Mobile satellite services: GSM, LEO, MEO, Satellite Navigational System-GPS, Satellite applications, VSAT , DTH television principles – Direct broadcast radios ,INSAT ,IRS satellites ,PSLVs ,GSLVs.

### **Text Books:**

1. Satellite Communications ,Timothy Pratt & Jeremy Allnutt, WSE, John Wiley & Sons Publications,3<sup>rd</sup>Edition, October2019, ISBN:978-1119482178.
2. Satellite Communications Engineering-,Wilbur L. Pritchard, Robert A Nelson, and Henri G. Suyderhoud, Pearson Publications, 2<sup>nd</sup>Edition,ISBN: 978-0137914685.

### **Reference Books:**

1. Satellite Communication, D.C Agarwal & Rishabh Anand, Khanna Publications, 1<sup>st</sup>Edition, 2021,ISBN: 978-8194752844.
2. Satellite Communications: Design Principles- M. Richharia, B S publications, 2<sup>nd</sup>Edition,ISBN: 978-0070523746.

**Web Links:**

1. <https://archive.nptel.ac.in/courses/117/105/117105131>
2. <https://www.coursera.org/learn/satellite-communications>

## Pattern Recognition

**Course Code:2501EC48**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Summarize the various techniques involved in pattern recognition.
- CO2:** Categorize the various pattern recognition techniques into supervised and unsupervised.
- CO3:** Illustrate the artificial neural network-based pattern recognition.
- CO4:** Discuss the applications of pattern recognition in various applications.
- CO5:** Evaluate the performance of speech recognition systems and optimize them for real-world applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 3    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 3    | 3    | 3    | -    | -    | -    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Introduction:

Fundamental concepts and blocks of a typical pattern recognition system. Decision functions- role and types, pattern and weight space, properties and implementation of decision functions.

## **UNIT – II**

### **Feature Identification and Feature Selection:**

Feature identification, selection and extraction. Distance measures, clustering transformation and feature ordering, clustering in feature selection, feature selection through maximization and approximations.

## **UNIT – III**

### **Pattern Classification:**

Pattern classification by distance functions. Clusters and cluster seeking algorithms. Pattern classification by likelihood functions. Baye's classifier and performance measures.

## **UNIT – IV**

### **Artificial Neural Network:**

Artificial neural network model, Neural network-based pattern associators, Feed forward networks and training by back-propagation- ART networks.

## **UNIT – V**

### **Applications of Statistical and Neural Network:**

Applications of statistical and neural network – based pattern classifiers in speech recognition, image recognition and target recognition.

### **Text Books:**

1. Pattern Recognition Principles by J.I. Tou & R.C. Gonzalez, Addison-Wesley, ISBN: 9780201075878.
2. Pattern Recognition - Statistical, Structural and Neural Approaches by R. Schalkoff, John Wiley, ISBN: 978-8126513703.

### **Reference Books:**

1. Pattern Recognition - A Statistical Approach by P.A. Devijer & J. Kittler, Prentice-Hall, ISBN: 978-0136542360.
2. Pattern recognition and machine learning by Christopher. M. Bishop, Springer, ISBN: 978-1493938438.

### **Web Links:**

1. <https://www.geeksforgeeks.org/pattern-recognition-introduction>
2. <https://archive.nptel.ac.in/courses/117/105/117105101/>

## Wireless Communications

**Course Code:2501EC52**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Illustrate the basic concepts of cellular networks.
- CO2:** Interpret concepts of mobile radio propagation.
- CO3:** Distinguish the concepts of modulation techniques and diversity.
- CO4:** Analyse the concepts of multiple access techniques.
- CO5:** Infer the wireless networking methods.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

## UNIT – I

### Cellular System Design:

Introduction-frequency reuse, channel assignment strategies, Handoff strategies: prioritizing handoffs, practical handoff considerations, Interference and system capacity: Co-channel interference and system capacity, channel planning for wireless systems, adjacent channel interference, power control for reducing interference, trunking and grade of service.

## UNIT – II

### Mobile Radio Propagation:

Large scale path loss: Introduction to radio wave propagation, free space propagation model, small scale multipath propagation, fading effects due to multipath time delay spread, fading effects due to Doppler spread.

## **UNIT – III**

### **Modulation Techniques and Diversity:**

Digital Modulation: Factors that influence the choice of digital modulation, Spread Spectrum Modulation Techniques: Pseudo- Noise (PN) Sequences, Direct Sequence Spread Spectrum (DS-SS) - Diversity techniques: Practical space diversity considerations, polarization diversity, frequency diversity, time diversity.

## **UNIT – IV**

### **Multiple Access Techniques:**

Introduction to multiple access-Spread Spectrum Multiple Access, Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiple Access (OFDMA), Space Division Multiple Access (SDMA), Packet Reservation Multiple Access (PRMA), Capacity of Cellular Systems.

## **UNIT – V**

### **Wireless Networking:**

Network transmission hierarchy, traffic routing in wireless networks: Circuit switching, packet switching, cellular packet, switched architecture, network databases: distributed database for mobility management, Universal Mobile Telecommunication Systems (UMTS).

### **Text Books:**

1. Wireless Communications, Rappaport, Pearson Education, 2<sup>nd</sup> Edition, ISBN: 9788131731864
2. Wireless Communication, Andrea Goldsmith, Cambridge University Press, ISBN: 9780521837163

### **Reference Books:**

1. Wireless Communications, Andreas.F. Molisch, John Wiley, India, 3<sup>rd</sup> Edition, November 2022, ISBN: 9781119117209
2. Wireless Communication, Upena Dalal, Oxford University Press, 1<sup>st</sup> Edition, ISBN: 9780198060666

### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_ee66/preview](https://onlinecourses.nptel.ac.in/noc21_ee66/preview), by Prof. R. David Koilpillai, IIT, Madras.
2. <https://archive.nptel.ac.in/courses/117/104/117104117/> by Prof. Aditya K Jagannatham, IIT, Kanpur.

## Wireless Sensor Networks

**Course Code:2501EC53**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Identify the components of Wireless Sensor Networks.
- CO2:** Develop node architecture for specific applications.
- CO3:** Realize the challenges in establishment of infrastructure.
- CO4:** Program sensor network platforms using specialized operating system.
- CO5:** Summarize the challenges in Sensor Network protocols.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO2   | 3    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO3   | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO4   | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO5   | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PO | PSO1 | PSO2 |
|-------|------|------|
| CO1   | 2    | -    |
| CO2   | 2    | -    |
| CO3   | 2    | -    |
| CO4   | 2    | -    |
| CO5   | 2    | -    |

## UNIT – I

### Introduction:

Constraints and Challenges, Opportunities and Challenges in Wireless Sensor Networks, Advantages of Sensor Networks (Energy Advantage and Detection Advantage), Sensor Network Applications, Smart Transportation, Collaborative Processing

## UNIT – II

### Sensor Network Architecture and Applications:

Introduction, Functional Architecture for Sensor Networks, Sample Implementation Architectures, Classification of WSNs, Characteristics, Technical Challenges, and Design Directions, Technical Approaches, Coverage in Wireless Sensor Networks, Location in Wireless Sensor Networks, Data Gathering and Processing.

## UNIT – III

### **Infrastructure Establishment:**

Topology Control, Clustering, Time Synchronization, Localization and Localization Services.

## UNIT – IV

### **Sensor Network Platforms and Tools:**

Individual Components of SN Nodes, Sensor Network Node, WSNs as Embedded Systems, Sensor Node Hardware, Sensor Network Programming Challenges.

## UNIT – V

### **Taxonomy of Routing Techniques:**

Routing Protocols, Applications/Application Layer Protocols, Localization Protocols, Time Synchronization Protocols, Transport Layer Protocols, Network Layer Protocols, Data Link Layer Protocols.

### **Text Books:**

1. Wireless Sensor Networks, F. Zhao, C Guibas, Morgan Kaufmann, Elsevier, ISBN: 978-1558609143.
2. Hand book of Sensor Networks, Mohammad Ilyas, Imad Mahgoub, , CRC Press, ISBN: 9780429205576.

### **Reference Books:**

1. Wireless Sensor Networks- Technology, Protocols, and Applications, Kazem Sohraby, Daniel Minoli, & Taieb Znati, John Wiley, ISBN: 978-0-470-11275-5.
2. Wireless Sensor Networks- An Information Processing Approach, Feng Zhao & Leonidas J. Guibas, Elsevier, ISBN: 9781558609143.

### **Web Links:**

1. <https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-cs07/>, Prof.S Misra, IIT- Madras
2. [https://onlinecourses.nptel.ac.in/noc22\\_ee72/preview](https://onlinecourses.nptel.ac.in/noc22_ee72/preview), Prof. Aditya K Jagannatham, IIT-Madras.



### Minor Stream: Space Technology

| Course Code  | Course Name                                                 | Level | L         | T        | P | C         | CIE | SEE | Total | Pre-requisite |
|--------------|-------------------------------------------------------------|-------|-----------|----------|---|-----------|-----|-----|-------|---------------|
| 2501EC54     | Introduction to Space Laws                                  | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC55     | Aircraft Communication Systems                              | IC    | 2         | 1        |   | 3         | 50  | 50  | 100   | -             |
| 2501EC57     | Aircraft Navigation Systems                                 | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC62     | Missile & Space Vehicle Guidance & Control                  | IC    | 2         |          |   | 2         | 50  | 50  | 100   | -             |
| 2501EC60     | Flight Control Systems                                      | IC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC58     | Avionics Embedded Systems                                   | IC    | 2         | 1        |   | 3         | 50  | 50  | 100   | -             |
| 2501EC59     | Avionics Network Technology                                 | AC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC64     | Unmanned Aircraft Systems                                   | AC    | 3         |          |   | 3         | 50  | 50  | 100   | -             |
| 2501EC56     | Aerospace Electromagnetic Compatibility                     | AC    | 2         | 1        |   | 3         | 50  | 50  | 100   | -             |
| 2501EC61     | Global Navigation Satellite Systems & Applications          | AC    | 3         |          |   | 3         | 50  | 50  | 100   | SC            |
| 2501EC63     | Remote Sensing & Digital Image Processing of Satellite Data | AC    | 3         |          |   | 3         | 50  | 50  | 100   | DIP           |
| <b>Total</b> |                                                             |       | <b>29</b> | <b>3</b> |   | <b>32</b> |     |     |       |               |

## Introduction to Space Laws

**Course Code:2501EC54**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Infer the foundational principles and treaties of international space law, including the Outer Space Treaty, the Moon Agreement, and the Rescue Agreement.
- CO2:** Ability to summarize key provisions of major space treaties.
- CO3:** Critical analysis of national space policies and their alignment with international laws.
- CO4:** Discuss the legal implications of space resource utilization.
- CO5:** Discuss the legal obligations for environmental protection in space.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT-I

**Basic concepts of international law and space law:** Introduction to international law, The Outer Space Treaty and the fundamental principles of space law, Other space treaties and General Assembly resolutions, National regulations, commercialization and privatization.

### UNIT-II

**Remote sensing/GIS, satellite meteorology and global climate + international law:** International law relating to remote sensing, National legislation for remote sensing, Regional and global agreements on remote sensing, Sources of remote sensing data.

### UNIT-III

**International laws on Satellite communications:** Overview of international law on satellite communications, Technical standards and national licensing, International trade in satellite communication services and global mobile personal communication services, Satellite broadcasting.

### UNIT-IV

**International law on Global navigation satellite systems (GNSS):** International institutional context for GNSS operations, GNSS providers and GNSS augmentation, GNSS users, Legal framework for GNSS services, GNSS services.

### UNIT-V

**Space Law relating to commercial space activities:** Legal issues in emerging trends of space activities - Human space flight, tourism, resource utilization, small satellite constellations, IPR.

#### Text Books:

1. Space Law - A treatise, Francis Lyall and Paul B. Larsen, Ashgate publishing Limited, England, ISBN: 978-1472447821.
2. Recent trends in international space law and policy, V.S Mani, S.Bhatt, V.Balakista Reddy, Asia Law house, ISBN: 978-9385556791.

#### Reference Books:

1. Handbook of space law, Frans von der Dunk, Fabio Tronchetti, Edward Elgar Publishing Limited, UK, ISBN: 978-1784713638.  
Recent Developments in Space Law - Opportunities & Challenges, R. Venkata Rao V.
2. Gopalkrishnan, Kumar Abhijeet, Springer, ISBN: 978-9811049255.

## Aircraft Communication Systems

**L      T      P      C**

**Course Code:2501EC55**

**2      1      0      3**

### Course Outcomes:

**At the end of the course, student will be able to:**

**CO1:** Explain the terminology of aircraft communication.

**CO2:** Learn the wave propagation types to be used for effective communication.

**CO3:** Aware of encryption standards in communication systems

**CO4:** Examine and understand the aircraft data links, communication band allotted for different satellites.

**CO5:** Get brief insight of future airborne communication systems – software defined radio.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO2   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO3   | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO4   | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO5   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT-I

**Introduction:** The Isotropic Power Source and Free Space Path Loss, Radio Geometry - Radio Horizon Calculations, Earth Bulge Factor – k Factor, Great-circle Distances.

### UNIT-II

**Wave Propagation:** Radio wave propagation – LOS, Complex Propagation: Refraction, Absorption, Non-LOS Propagation, Communication Frequency Bands and Allotment, Legacy and Modern Communications.

### UNIT-III

**Encryption standards in Communication Systems:** Introduction to Cryptography, crypto systems and types. Traditional ciphers - Caesar Cipher, Transposition Cipher, Substitution Cipher.

## UNIT-IV

**Aircraft and UAV Data Links:** Aircraft Data Link: VHF data link – ACARS, VDL 2, VDL 3, and VDL 4. UHF data link - Link-11, Link-16. SELCAL, ALE and HF Data link. UAV Data link functions and attributes, Video & Telemetry Links.

## UNIT-V

**Future Airborne Communication Systems:** Software Defined Radio (SDR)- Need, characteristics and benefits, design principles, RF front end implementation – purpose, receiver topologies and importance of components.

### Text Books:

1. Radio Communication Systems and Networks– Dale Stacey, Wiley, ISBN :978-0470018590.
2. Software Radio: A Modern Approach to Radio Engineering, Jeffrey H. Reed, PEA publication, ISBN: 9780130811585.

### Reference Books:

1. Future Aeronautical Communications, Simon Plass., InTech, ISBN: 978-9533076256.
2. Cryptography and Network Security Principles and Practice, William Stallings, Pearson 6<sup>th</sup> Edition, ISBN: 978-93325018773.

### Web Links:

1. <https://nptel.ac.in/courses/101101079>
2. [Fiber-Optic Cable \(Linktionary term\)](#)

## Aircraft Navigation Systems

**Course Code:2501EC57**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Describe the various types of radio navigation systems.
- CO2:** Explain the architecture and components of inertial navigation systems.
- CO3:** Design and implement inertial navigation systems.
- CO4:** Demonstrate knowledge of practical applications of satellite and hybrid navigation systems.
- CO5:** Discuss the integration and interoperability of landing aids.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO2   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO3   | 3    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO4   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| CO5   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

## UNIT – I

### Radio Navigation Systems

Different Types of navigation, Automatic Direction Finder, VHF Omni-directional Range, Distance Measuring Equipment, Tactical Air Navigation, VORTAC, Doppler Navigation –Beam Configurations.

## UNIT – II

### Inertial Navigation Sensors

Accelerometer - operating principle, classification- open loop pendulous, closed loop pendulous, vibrating beam and interferometric fibre optic accelerometer.

Gyroscope – Coriolis vibrating gyro, optical gyro – RLG, IFOG – Principle of operation, construction and working.

### **UNIT – III**

#### **Inertial Navigation System**

Inertial navigation, Geometry of earth, gravitation and gravity, Reference frame ECI, LPI, ECEF and ENU. Navigation in rotating earth frame, Inertial system, Strap-down navigation.

### **UNIT – IV**

#### **Satellite and Hybrid Navigation System**

GPS, position and velocity determination- Error sources, GDOP, position computation process. Velocity measurement, Precise Point Positioning (PPP), Integrated inertial navigation – processing of measurements, Complimentary nature of sensors, GNSS and INS fusion using Kalman filter.

### **UNIT – V**

#### **Landing aids, Secondary Surveillance Radar (SSR)**

Low visibility operation, Mechanics of landing. Instrument Landing System(ILS), Satellite Landing Systems, Carrier-Landing Systems. Introduction, SSR modes, Interrogation, Mode-S.

#### **Text Books:**

1. Avionics Navigation Systems, Myron Kayton, Walter R. Fried, Wiley-Inter science 2<sup>nd</sup> Edition, ISBN: 978-0471547952.
2. Fundamentals of Navigation and inertial sensors, Amitava Bose, K.N.Bhat, Thomas Kurian, PHI learning Private limited, ISBN: 978-81-203-4859-2.
3. Radar Principles, Technology, Applications, Byron Edde, LPE, Pearson, ISBN: 978-0137523467

#### **Reference Books:**

1. Aircraft Communications & Navigation Systems: Principles Operation and Maintenance, Mike Tooley, \ David Wyatt, Butterworth-Heinemann an imprint of Elsevier, ISBN: 9780750681377.
2. Global Positioning Systems, Inertial Navigation and Integration, Mohinder S. Grewal, Lawrence R. Weill, Angus P. Andrews, Wiley-Inter science, 2<sup>nd</sup> Edition, ISBN: 978-0470041901.

#### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc23\\_ce94/](https://onlinecourses.nptel.ac.in/noc23_ce94/)
2. [https://onlinecourses.nptel.ac.in/noc21\\_ae12/](https://onlinecourses.nptel.ac.in/noc21_ae12/)

## Missile & Space Vehicle Guidance & Control

**Course Code: 2501EC62**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>2</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

**CO1:** Discuss the basic of Missile Airframes and autopilots.

**CO2:** Explain the Missile guidance laws and control.

**CO3:** Describe the launch of strategic missiles.

**CO4:** Summarize the orbital mechanics of system.

**CO5:** Demonstrate the satellite guidance in free space.

### Mapping of course outcomes with program outcomes:

| CO/PO       | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| <b>CO 1</b> | 2   | 1   | -   | -   | -   | -   | -   | -   | -   | -    | 1    |
| <b>CO 2</b> | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | 1    |
| <b>CO 3</b> | 2   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | 1    |
| <b>CO 4</b> | 2   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | 1    |
| <b>CO 5</b> | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | 1    |

### Mapping of course outcomes with program Specific Outcomes:

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 3     | -     |
| <b>CO 2</b> | 2     | -     |
| <b>CO 3</b> | 2     | -     |
| <b>CO 4</b> | 2     | -     |
| <b>CO 5</b> | 2     | -     |

### UNIT – I

#### Missile Airframes, Autopilots and Control

Missile aerodynamics: - Force Equations, Moment Equations, Phases of missile flight, Missile control configurations. Missile Mathematical Model, Autopilots - Definitions, Types of Autopilots, Example Applications, Open-loop autopilots, inertial instruments, and feedback.

### UNIT – II

#### Missile Guidance Laws

Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation.

### UNIT – III

#### Strategic Missiles

Introduction, The Two-Body Problem, Lamberts Theorem, First-Order Motion of a Ballistic Missile Correlated Velocity and Velocity-to-Be-Gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Re-Entry, Ballistic Missile Intercept.



## **UNIT – IV**

### **Orbital Mechanics**

Orbital Transfers: Impulse Transfer between Circular Orbits, Hofmann Transfer, Other Coplanar and Non-coplanar Transfers-Orbital Plane Changes.

## **UNIT – V**

### **Satellite Guidance**

Space Flight, Space Vehicle Trajectories, Launch Vehicle Guidance Implicit and Explicit Guidance-Open loop and Closed loop Guidance, FE guidance- F. guidance-VG guidance-Q guidance-Delta guidance.

#### **Text Books:**

1. Fundamentals of Astrodynamics, Roger.R. Bate, Dover Publications, ISBN: 978-0486600611.
2. Navigation and Guidance in Space, Edwards V.B.Stearns, Prentice Hall, ISBN: B0007E24DA.

#### **Reference Books:**

1. Space Flight Dynamics, William Wiesel, Tata McGraw Hill, Third Edition, ISBN: 978-1452879598.
2. Missile Guidance and Control systems, GM Siouris, Springer, ISBN: 978-0-387-00726.

#### **Web Links:**

1. <https://archive.nptel.ac.in/courses/101/108/101108054/>,Debasish Gose,IISC Bangalore.
2. <https://apps.dtic.mil/sti/tr/pdf/AD0813281.pdf>

## Flight Control Systems

**Course Code:2501EC60**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

**CO1:** Discuss the static stability of an aircraft.

**CO2:** Interpret the Equations of Motions under different conditions.

**CO3:** Aware of Aircraft Response to Control or Atmospheric Inputs.

**CO4:** Infer classical control theory in aircraft design.

**CO5:** Interpret the essence of Auto pilot and aircraft design.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT -I

**Static Stability and Control:** Introduction, Longitudinal Control, Stick Forces, Definition of Directional Stability, Directional Control, Roll Stability, Roll Control.

### UNIT-II

**Aircraft Equations of Motion-1:** Introduction, Derivation of rigid Body Equations of Motion, Orientation and Position of the Airplane, Gravitational and Thrust Forces, Small Disturbance theory, Aerodynamic Force and Moment Representation.

### UNIT -III

**Aircraft Equations of Motion-2:** Pure Pitching Motion, Stick Fixed Longitudinal Motion, Longitudinal Approximations, Influence of Stability Derivatives, Pure Rolling Motion, Pure Yawing Motion, Lateral Direction Equations of Motion.

### UNIT -IV

**Aircraft Response to Control or Atmospheric Inputs:** Longitudinal Flying Qualities, Lateral Flying Qualities, Inertial Coupling, Equations of Motion in a Non Uniform Atmosphere, Pure Vertical or Plunging Motion.

## **UNIT -V**

**Control Theory applied to Aircraft design:** Applications of Classical Control Theory to Aircraft Autopilot Design: Aircraft Transfer Functions Displacement Autopilot, Stability Augmentation, and Instrument Landing.

### **Text Books:**

1. Flight Dynamics, Simulation, and Control for Rigid and Flexible Aircraft, Ranjan Vepa, CRC Press Taylor & Francis Group, ISBN: 9781466573352.
2. Flight Stability and Automatic Control, Robert C Nelson, Tata McGraw-Hill, 2<sup>nd</sup> Edition, ISBN : 978-0070661103.

### **Reference Books:**

1. Automatic control of Aircraft and missiles, Blakelock, J.H, John Wiley Sons, New York, ISBN: 978-0471506515.
2. Aircraft control & simulation, Stevens B.L & Lewis F.L, John Wiley Sons, New York, ISBN: 978-0471371458.

### **Web Links:**

1. <https://nptel.ac.in/courses/101104330>

## Avionics Embedded Systems

|                             | L        | T        | P        | C        |
|-----------------------------|----------|----------|----------|----------|
| <b>Course Code:2501EC58</b> | <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

At the end of the course, student will be able to:

**CO1:** Summarize the building blocks of an embedded system.

**CO2:** Apply standard guidelines for development of Aircraft Systems.

**CO3:** Illustrate the services and tasks in RTOS.

**CO4:** Compare continuous dynamics and discrete dynamic mechanics.

**CO5:** Distinguish state machines based on computational models.

### Mapping of Course Outcomes with Program Outcomes:

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

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

## UNIT - I

### Introduction to Embedded Systems

Categories, Overview of architecture, Characteristics, Recent trends, Architecture of Embedded systems: Hardware Architecture: CPU, Memory, Clock, Watch dog timer, I/O, Debug port, Communication interface, Power Supply.

## UNIT – II

### Embedded System Development

Development Process, Requirements, Design, Implementation, Integration and Testing, Packaging, Configuration Management. ARP-4754 Standard for systems engineering guidelines.

## UNIT – III

### RTOS

Real time concepts, Kernel Structure, Tasks and Scheduler, Time Management, Event Control blocks, Semaphore management, Mutex, Event Management, Message mail box management, Message Queue management, memory management.

## UNIT – IV

### Modelling Dynamic Behaviors-1

Continuous Dynamics: Newtonian Mechanics, Actor Models, Properties of Systems, Feedback Control.

**Discrete Dynamics:** Discrete Systems, The Notion of State, Finite-State Machines, Extended State Machines, Non-determinism, Behaviors and Traces.

## UNIT – V

### Modelling Dynamic Behaviors-2

Composition of State Machines: Concurrent Composition, Hierarchical State Machines. Concurrent

Models of Computation: Structure of Models, Synchronous-Reactive Models, Dataflow Models of Computation.

### Text Books:

1. Introduction to Embedded Systems: A cyber physical systems approach by Edward Ashford Lee and Sanjit Arun kumar Seshia, MIT Press, Second Edition, ISBN: 978-0262533812.
2. Embedded /Real-Time Systems: Concepts, Design & Programming by K.V.K.K.Prasad Dreamtech Press, ISBN: 978-8177224610 .

### Reference Books:

1. Embedded System Design: A Unified Hardware/Software Approach by Frank Vahid, Tony Givargis, Wiley India Edition, 3<sup>rd</sup> Edition, ISBN: 978-8126508372.
2. Computers as Components-Principles of Embedded Computer System Design by Wayne Wolf, Morgan Kaufman Publisher, ISBN: 9780128053874.
3. Embedded Systems Architecture, Programming and Design by Rajkamal Tata McGraw Hill, 2<sup>nd</sup> Edition, ISBN: 978-0070667648.

### Web Links:

1. <http://www.nptelvideos.in/2012/11/embedded-systems.html>

## Avionics Network Technology

**Course Code:2501EC59**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Demonstrate the design and operation of optical access networks
- CO2:** Study protocols and standards unique to aviation communications
- CO3:** Compare sensor network with hoc network
- CO4:** Explore different network topologies suitable for wireless sensor networks
- CO5:** Explore the integration of smart antenna systems with various communication systems.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 3    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT- I

**Optical Networks:** Fiber channel – WDM LAN – Fiber channel-R Fover fiber Highly integrated photonics (HIP) – Routing in optics- Amplification in optics.

### UNIT – II

**ATN (Aeronautical Telecommunication Network):** ATN Concepts – ATN functionality – ATN Components – End Systems – ATN physical and administrative structures – ATN planning and implementation process – ATN Router.

### UNIT – III

**Wireless Sensor Network Attributes:** Introduction-Challenges for wireless sensor networks-Comparison of sensor network with hoc network-single node architecture-Hardware components-energy consumption of sensor nodes.

## **UNIT – IV**

**Wireless Sensor Network Architecture:** Network architecture-sensor network scenarios-types of sources and sinks-single hop versus multi hop networks-multiple sinks and sources-Design, principles:- Development of wireless sensor networks.

## **UNIT – V**

**Wideband Wireless Communication and Networks for Military Avionics:** Communication data link (CDL)-IP based routing in FBW-Smart antenna networking.

### **Text Books:**

1. Avionics Data Buses by Carry Spitzer, Fifth Edition, ISBN: 978-1138076983.
2. Smart Antennas for Wireless Communication by Frank Gross, Wiley Publications, Second Edition, ISBN: 978-0071447898.

### **References Books:**

1. Wireless Sensor Networks by C.S.Raghavendra Krishna, M.Sivalingam and Taripznati, Springer publication.
2. Wireless Sensor Networks: Architecture and Protocol by H.Callaway, Edgar, CRS press, ISBN : 978-0849318238.

### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc20\\_ae03](https://onlinecourses.nptel.ac.in/noc20_ae03)
2. [https://onlinecourses-archive.nptel.ac.in/noc18\\_cs09](https://onlinecourses-archive.nptel.ac.in/noc18_cs09)

## Unmanned Aircraft Systems

**Course Code:2501EC64**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the basic concepts of UAV.
- CO2:** Discuss the basics of airframe.
- CO3:** Describe the Avionics hardware.
- CO4:** Summarize the design considerations for communications payload and control.
- CO5:** Summarize the UAV certification standards.

### Mapping of course outcomes with program outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of course outcomes with program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT– I

#### Introduction to UAV:

History and Overview, Classes and Missions of UAV's, System composition, few applications of Unmanned Aircraft Systems.

### UNIT – II

#### Design of UAV Systems

Introduction to design and selection of system, Aerodynamics and airframe configurations, Characteristics of Aircraft Types, Design of stealth, Data links.

### UNIT – III

#### Communication and Navigation of UAV

Communication media: Radio communication, Mid-Air collision (MAC) Avoidance, Data Rate and Bandwidth Usage, Antenna Types, NAVSTAR Global Positioning System, TACAN, LORAN-C, Radio Tracking, Inertial Navigation and Control Stations.



## **UNIT – IV**

### **Development of UAV Systems**

System development and certification, System ground testing -UAV component testing, sub-system testing, control station testing and System in flight testing.

## **UNIT – V**

### **UAV Payloads**

Surveillance payloads-overview, image sensors, Weapon payloads, Design issues related to Carriage and delivery of weapons, other issues related to combat operations, other payloads.

### **Text Books:**

1. Introduction to UAV Systems by Paul Gerin Fahlstorm, Wiley Publication, Fourth Edition, ISBN: 9781118396780.
2. Unmanned Aircraft Systems-UVAS Design, Development and Deployment by Reg Austin, Wiley Publication, Third Edition, ISBN: 978-0470058190.

### **Reference Books:**

1. Remote sensing and activation using UAV by Haiyang Chao and Yang Quan Chen, IEEE Press, ISBN: 978-1118122761.
2. Unmanned Aircraft Design A review of fundamentals by Mohammad H. Sadraey, Morgan & Claypool Publishers series, ISBN: 978-1681731681.

### **Web Links:**

1. <https://archive.nptel.ac.in/courses/101/104/101104073/>, Prof..SaderlaSubrahamanyam, IIT Kanpur.
2. [https://www.icao.int/meetings/uas/documents/circular%20328\\_en.pdf](https://www.icao.int/meetings/uas/documents/circular%20328_en.pdf)

## Aerospace Electromagnetic Compatibility

**Course Code:2501EC56**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>1</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the concepts of EMI and EMC in transmission.
- CO2:** Analyse the EMI effect on aircraft.
- CO3:** Describes the various procedures for radiated measurement systems.
- CO4:** Analyse the effect of EMI on flight control systems.
- CO5:** Analyse the effect of EMI on unmanned flight control systems.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT – I

#### Introduction to Sources of EMI and EMC

Electromagnetic environment, Concepts, Practical experiences & concerns, Natural and Nuclear sources of EMI, Electromagnetic emissions, Cross talk in transmission lines, Transients in power supply lines, Electromagnetic Interference Principles and types of grounding, Shielding and bonding.

### UNIT – II

#### Effects of EMI on Aircraft and Analysis

HEMP Threat to Aircraft, HEMP Coupling to Aircraft, Lightning interactions with Aircraft, Avionic Equipment functional verification in presence of lightning induced electrical transients.

### UNIT – III

#### Avionics Subsystems Radiated and Conducted Measurement

Motivations for Testing, Test Plans for Avionics Sub-Systems. Open area test sites and measurements. Anechoic chamber, TEM cell, GTEM Cell, Conducted EMI from equipment, Immunity to conducted EMI, Detectors and measurements.

## **UNIT – IV**

### **EMI Effects in Flight Control Systems and their Mitigations.**

Analysis of the Contemporary Aerial EME, Elements of FBW System and Their Susceptibility to EMI, EMI Susceptibilities of FMS, EMC Test Methodologies of FCS.

## **UNIT – V**

### **EMI Effects on Unmanned Flight Control Systems**

EMI Susceptibilities of UAV Flight Control System, How EMI Couples to FCS, Modeling and Simulation, Some Special Considerations for EMI Mitigation.

#### **Text Books:**

1. Engineering Electromagnetic Compatibility by Dr.V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd, New Delhi, ISBN: 978-0780347434.
2. Handbook of Aerospace Electromagnetic Compatibility, Reinaldo J. Perez, IEEE Publication, Published by John Wiley & Sons, ISBN: 978-1118910511.

#### **Reference Books:**

1. Introduction to Electromagnetic Compatibility, Clayton R Paul, John Wiley, ISBN: 978-0471755005.
2. Principles and Techniques of EMC, Christos Christopoulos, CRC press, 2<sup>nd</sup> Edition, ISBN: 978-0849370359.
3. Handbook of Aerospace Electromagnetic Compatibility Editor(s): Dr. Reinaldo J. Perez, ISBN: 9781118910511.

#### **Web Links:**

1. <https://www.amazon.in/Handbook-Aerospace-Electromagnetic-Compatibility-Reinaldo/dp/1118910516>
2. <https://www.amazon.in/Handbook-Aerospace-Electromagnetic-Compatibility-Reinaldo-ebook/dp/B07L8DZP4F>
3. [https://books.google.co.in/books/about/Handbook\\_of\\_Aerospace\\_Electromagnetic\\_Co.html?id=ac95DwAAQBAJ&redir\\_esc=y](https://books.google.co.in/books/about/Handbook_of_Aerospace_Electromagnetic_Co.html?id=ac95DwAAQBAJ&redir_esc=y)

## Global Navigation Satellite Systems & Applications

**Course Code: 2501EC61**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Illustrate the usage of GNSS in position determination
- CO2:** Classify various navigation satellite systems
- CO3:** Interpret the GNSS errors and correction methods
- CO4:** Utilize the GNSS for developing applications
- CO5:** Summarize the current trends and opportunities of GNSS

### Mapping of Course Outcomes with Program Outcomes:

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

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT– I

Introduction to Global Navigation Satellite System (GNSS), How position is determined by the GNSS, NAVSTAR - Global Positioning System

### UNIT – II

Global Navigation Satellite System (GLONASS), BeiDou Navigation Satellite System (BDS), Indian Regional Navigation Satellite System (IRNSS), GALILEO, Quasi-Zenith Satellite System (QZSS).

### UNIT – III

Differential Global Navigation Satellite System (DGNSS), REAL-TIME KINEMATIC (RTK), Satellite Based Augmentation System (SBAS), GNSS Errors, GNSS Correction Methods.

### UNIT – IV

Why altitude estimated by GNSS receivers is not very accurate, Global Navigation Satellite Systems (GNSS) Applications.

## **UNIT – V**

### **GNSS: Current Trends and Future, Opportunities in India**

#### **Text Books:**

1. Environmental Monitoring using GNSS: Global Navigation Satellite Systems, Awange J. L, Springer, London, ISBN: 978-3540882558.
2. Global Navigation Satellite Systems: Insights into GPS, Glonass, Galileo, Compass, and Others, BS Publications, New Delhi, ISBN: 978-8178002200.

#### **Reference Books:**

1. GNSS – Global Navigation Satellite Systems, Hofmann-Wellenhof, B. Lichtenegger, Wasle, Springer, Verlag Wien, ISBN : 978-3211730126.
2. Global Positioning Systems, Inertial Navigation, and Integration, Grewal, M. S. Weill, L. R. Andrews, John Wiley & Sons, New York.
3. GNSS Systems and Engineering: The Chinese Beidou Navigation and Position Location Satellite, Tan, S., John Wiley & Sons, Singapore, ISBN: 978-1118897034.

#### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc23\\_ce94By](https://onlinecourses.nptel.ac.in/noc23_ce94By) Prof. Arun K. Saraf, IIT Roorkee
2. <https://www.spiceworks.com/tech/iot/articles/what-is-gnss/>

## Remote Sensing & Digital Image Processing of Satellite Data

**Course Code:2501EC63**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

**CO1:** Outline the electromagnetic concepts in remote sensing technology

**CO2:** Contrast satellites based on the remote sensing

**CO3:** Make use of image interpretation for remote sensing

**CO4:** Illustrate about image acquisition and enhancement techniques

**CO5:** Utilize the multispectral transforms for image processing

### Mapping of Course Outcomes with Program Outcomes:

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

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT - I

Development of remote sensing technology and advantages, Different platforms of remote sensing, EM spectrum, solar reflection and thermal emission remote sensing, Interaction of EM radiation with atmosphere including atmospheric scattering, absorption and emission.

### UNIT – II

Interaction mechanisms of EM radiation with ground, spectral response curves, Principles of image interpretation, Multi Spectral scanners and imaging devices, Salient characteristics of LANDSAT, IRS, Cartosat, ResourceSat etc. sensors, Image characteristics and different resolutions in Remote Sensing.

### UNIT – III

Image interpretation of different geological landforms, rock types and structures, Remote Sensing integration with GIS and GPS, Georeferencing Technique, Basic image enhancement techniques, Spatial filtering techniques, Image classification techniques, InSAR Technique and its applications, Hyper

spectral Remote Sensing, Integrated applications of RS and GIS in groundwater studies, Limitations of Remote Sensing Technique.

#### **UNIT – IV**

Different techniques of Image acquisition, Image characteristics and different resolutions in Remote Sensing, EM spectrum, solar reflection and thermal emission remote sensing, Colour representations and transforms, Image Histograms and statistics, Geometric transformations /Georeferencing Technique, Image enhancement techniques.

#### **UNIT – V**

Multispectral transforms: scatter plot, principal component analysis and decorrelation stretch, Spatial filtering techniques, Frequency domain - Fourier transformation, Basic Image Compression techniques and different image file formats, Image classification techniques, Principles of image interpretation, SAR Interferometry (InSAR) Technique, Image merging and mosaicking techniques, Applications of Image Analysis, Limitations and future of Digital Image Processing Technique.

#### **Text Books:**

1. Introduction to Remote Sensing, James B. Campbell and Randolph H. Wynne, The Guildford Press, New York, 5<sup>th</sup> Edition, ISBN: 978-1609181765.
2. Remote Sensing and Image Interpretation, Lillesand, T.M., Kiefer, R.W. and Chapman, J.W., John Wiley & Sons, 7<sup>th</sup> Edition, ISBN:978-1118343289.

#### **Reference Books:**

1. Image Interpretation in Geology by Drury, S. A., Allen & Unwin, 2<sup>nd</sup> Edition, ISBN: 978-0412488801.
2. Introduction to Remote Sensing, Cracknell, A.P., Tylor & Francis, London, 2<sup>nd</sup> Edition, ISBN: 978-0849392559.
3. Digital Image Processing by Gonzalez, Rafael C. and Richard E. Woods, Pearson Education, London, 3<sup>rd</sup> Edition, ISBN:978-0131687288.

#### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc19\\_ce38](https://onlinecourses.nptel.ac.in/noc19_ce38) By Prof. Arun K. Saraf, IIT Roorkee
2. <https://www.geeksforgeeks.org/satellite-image-processing/>

### Minor Stream: Embedded AI/ML

| Course Code  | Course Name                                  | Level | L         | T | P        | C         | CIE | SEE | Total | Pre-requisite |
|--------------|----------------------------------------------|-------|-----------|---|----------|-----------|-----|-----|-------|---------------|
|              | Fundamentals of Embedded System Development  | FC    | 3         |   |          | 3         | 50  | 50  | 100   |               |
|              | AI, ML Data Foundation                       | FC    | 2         |   | 1        | 3         | 50  | 50  | 100   | -             |
|              | Data Engineering & Feature Engineering       | FC    | 2         |   | 1        | 3         | 50  | 50  | 100   |               |
|              | Supervised & Unsupervised Learning           | FC    | 2         |   | 1        | 3         | 50  | 50  | 100   |               |
|              | System Programming using C                   | IC    | 3         |   |          | 3         | 50  | 50  | 100   | PPSC          |
|              | Deep Learning & Neural Networks              | IC    | 2         |   | 1        | 3         | 50  | 50  | 100   | -             |
|              | Embedded OS                                  | IC    | 3         |   |          | 3         | 50  | 50  | 100   |               |
|              | Generative AI & Large Language Models        | AC    | 1         |   | 1        | 2         | 50  | 50  | 100   |               |
|              | MLOPS & AI Development                       | AC    | 2         |   | 1        | 3         | 50  | 50  | 100   |               |
|              | Applied agentic AI system                    | AC    | 2         |   | 1        | 3         | 50  | 50  | 100   |               |
|              | AI for industry 5.0 & Cyber physical systems | AC    | 2         |   | 1        | 3         | 50  | 50  | 100   |               |
| <b>Total</b> |                                              |       | <b>24</b> |   | <b>8</b> | <b>32</b> |     |     |       |               |



## Fundamentals of Embedded System Development

**Course Code:**

**L    T    P    C**  
**3    0    0    3**

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1:** Understand the concept of embedded system architectures, memory organization, and communication interfaces for embedded applications
- CO2:** Apply the concepts of the embedded product development lifecycle and design process in developing embedded solutions
- CO3:** Utilize embedded software development tools and methodologies for building and debugging embedded applications.
- CO4:** Analyze the stages involved in the boot process and development setup of embedded processors.
- CO5:** Analyze security challenges and apply suitable security techniques for securing embedded systems.

**Mapping of Course Outcomes with Program Outcomes:**

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

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

### UNIT – I

#### **Embedded System Fundamentals and Interfaces:**

Features and Applications of Embedded Systems, Microcontroller vs Microprocessor, CISC vs RISC, Von Neumann vs Harvard Architecture, Processing System in Embedded Systems, Memory Organization, I/O Ports and Interrupts, Timers and Counters, Communication Protocols (basics): UART, SPI, I2C, RS232, USB, GPIO.

### UNIT – II

#### **Embedded Product Development Lifecycle:**

Introduction to SDLC, benefits, SDLC Phases, importance, SDLC Models: Traditional models (Waterfall, spiral), modern models (Agile);

Embedded System Design Cycle: Various stages of Embedded System Design Process, Design Standards for the Embedded Systems; Co-Design Aspects: Principles of Co-design, Software Partitioning, Overview of Hardware-software Co-design, Software, Hardware; Choice of Processor, Operating System/RTOS, Various Stages of Build Process, Difference between Desktop vs Embedded Application

### **UNIT – III**

#### **Embedded Software Development Environment:**

Development Process: Concept of Host and Target: Concept of Target and Host Environment, Role of Build and Debugging Tools in Embedded Software Development, Various Debugging Tools, Simulator/ Emulator, Integrated Development Environment (IDE), V-Model in Embedded Software Development

Software Development Methodologies: Introduction, Need; Different Development Methodologies: Test-driven Development Methodology, Behaviour-driven Development Methodology, Model-driven Development Methodology, Secured Software Development Life Cycle

### **UNIT – IV**

#### **Fundamentals of Boot Process for embedded processors:**

Host & Target development setups: Linux Architecture, Host or Target Development Setup, (Linked, removable storage, standalone); System Boot Components and Understanding Workspace: GNU Cross-Platform Development Toolchain, Types of Boot Configurations, Stages in Boot Loading (BIOS, Bootloader (Uboot), Kernel, Init), Understanding Directories and Functionality.

### **UNIT – V**

#### **Securing Embedded Systems:**

Hardware Security: Challenges, Consequences of ES Exploits, Common Attacks, Level of connectivity and communication needs; Techniques to improve ES Security: Secure booting, SecOC: Secured On-Board Communication, Secure Execution, Secure Storage, Hardware Resource Partitioning.

**Text Books:**

1. **Digital Design** – M. Morris Mano, Michael D. Ciletti, 6<sup>th</sup> Edition, Pearson Education, 2018, ISBN: 978-0134549897.
2. **Switching & Finite Automata Theory** – Zvi Kohavi, 3<sup>rd</sup> Edition, McGraw-Hill (TMH), ISBN: 9780074514863.
3. **Switching and Logic Design** – C. V. S. Rao, Pearson, 2017, **ISBN: 9788131701836.**

**Reference Books:**

1. Michael Barr and Anthony Massa, Programming Embedded Systems, 2nd Edition, O'Reilly Media, 2006.
2. Christopher Hallinan, Embedded Linux Primer, 2nd Edition, Pearson/Addison-Wesley, 2010.
3. David Kleidermacher and Mike Kleidermacher, Embedded Systems Security, Newnes/Elsevier, 2012.

**Web Links:**

1. [http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1\\_ESIntroduction.pdf](http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf)
2. <http://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf>

## System Programming using C

**Course Code:**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1:** Explain advanced C programming concepts including data types, structures, unions, arrays, and pointers.
- CO2:** Apply advanced pointer techniques and variable binding concepts in C program development.
- CO3:** Analyze memory organization and implement dynamic memory management techniques in C.
- CO4:** Explain the system startup process, context management, and C program execution flow.
- CO5:** Apply Linux fundamentals, system calls, and standard C library functions in system-level programming.

**Mapping of Course Outcomes with Program Outcomes:**

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

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

### UNIT – I

#### Advanced Data Types:

Typedef and Typecasting, Structures: Definition, Declaration and Usage, Pointers to Structures  
Structure Padding, Union, Structure vs Union, Processor Endianness, Variable Length Arrays (VLA), Flexible Array Members (FAM).

### UNIT – II

#### Advanced Pointers and Function Binding:

Void Pointers, Pointer to Pointer, Pointers to Data Structures, Function Pointers  
Scope and Lifetime of Variables, Local Variables, Global Variables, Static Variables, Static Global Variables, Formal Parameters, Binding of Variables and Functions

## **UNIT – III**

### **Memory Management in C:**

Memory Architecture, Text Segment, Initialized Data Segment, Uninitialized Data Segment (BSS), Stack, Heap; Stack Memory Area and Heap Memory Area, Static and Dynamic Memory Allocation, Memory Allocation Functions: malloc(), calloc(), realloc(), free()  
Memory Fragmentation, Memory Leaks, Scope and Memory Allocation of Variables

## **UNIT – IV**

### **Context Management and System Startup:**

CPU Startup Sequence, BIOS and Functions of BIOS, Master Boot Record (MBR), Linux Bootloader, Requirements of C Startup, C Startup Code, Program Execution Flow from Power-On to Main().

## **UNIT – V**

### **Linux Fundamentals and System Programming**

Linux Architecture, Linux Kernel Basics, Linux File System, File Hierarchy Structure, Filesystem Types, C Library Functions and Assert(), System Calls, Process Control, File Management, Device Management, Information Maintenance, Communication; Object-Oriented Concepts: Encapsulation, Inheritance, Polymorphism, Overview of Object-Oriented Programming Concepts in C++

### **Textbooks:**

1. Yashavant Kanetkar, Let Us C, 19th Edition, BPB Publications.
2. E. Balagurusamy, Programming in ANSI C, 8th Edition, McGraw Hill Education.
3. Robert Love, Linux System Programming, 2nd Edition, O'Reilly Media.

### **Reference Books:**

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2nd Edition, Pearson Education.
2. W. Richard Stevens and Stephen A. Rago, Advanced Programming in the UNIX Environment, 3rd Edition, Addison-Wesley.
3. Michael Kerrisk, The Linux Programming Interface, No Starch Press.

### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/e-learning/preview/noc22\\_cs40](https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_cs40)
2. <https://www.linuxkernelfoundation.com/c-and-linux-system-programming/>

## Embedded OS

**Course Code:**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1:** Explain the fundamentals of RTOS and real-time systems.
- CO2:** Analyze memory management techniques in embedded operating systems.
- CO3:** Analyze task management and scheduling algorithms in RTOS.
- CO4:** Apply inter-task communication and synchronization mechanisms in embedded systems.
- CO5:** Analyze resource management and timer services in RTOS-based systems

**Mapping of Course Outcomes with Program Outcomes:**

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

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

### UNIT – I

#### RTOS Concepts:

Real Time Systems – Definition, Characteristics, Types, Introduction to RTOS, Single Tasking, Multitasking, Single Tasking Vs Multi Tasking, Multi-Threading Concepts, Scheduler, GPOS Vs RTOS; Context Switching, context switching flow.

### UNIT – II

#### Memory Management in Embedded Systems:

Memory Types: Heap Management, Static and Dynamic Memory, Predictability and Fragmentation, Architecture Flat Memory Model, Distinction between Kernel and User Memory, Concept of Best-fit and First-fit, Memory Protection Unit.

## **UNIT – III**

### **Task Management and Scheduling:**

Task Management: Thread, Task, and Process, Different States of a Task, System Core Clock, System Tick and Tick Interrupt, Task Priorities, Understanding Task Execution;

Scheduling Algorithms: Pre-emptive with Time Slicing, Pre-emptive Without Time Slicing, Co-operative Scheduling.

## **UNIT – IV**

### **Inter-Task Communication and Interrupt Management:**

Inter task communication: Introduction to inter task communication, Queues, mailboxes;

Interrupt Management: Events, Interrupts, Task Vs ISRs, Interrupt Nesting;

Semaphores: Binary Semaphores, Counting Semaphore.

Task Management: Task Notifications, Tasks communication objects vs Direct Task

## **UNIT – V**

### **Resource and Timer Management:**

Shared Resources: Shared Resource Corruption, Read, Modify, Write Operations, Atomic Operations, Re-entrant Functions or Thread Safe Functions, Mutual Exclusion, Critical Sections;

Mutex: Deadlock and Recursive Mutex, Starvation, Priority Inversion and Inheritance, Gatekeeper Task;

Event Groups: Event Groups for Multiple Task Synchronization, Event Group Sync;

Timer Management: Software Timers, Timer Queue, Hardware Timers, Watchdog Timers;

### **Text Books:**

1. Real Time Concepts for Embedded Systems – Qing Li, Caroline Yao, Taylor & Francis Group, CRC Press, ISBN: 9781482280821
2. Embedded/Real-Time Systems Dr. K.V.K.K. Prasad, Dream Tech Publications, Blackpad book, ISBN: 978-8177224610.
3. Embedded Systems, An Integrated Approach, Lyla B.Das, Pearson Education, ISBN: 9789332511675

**Reference Books:**

1. Embedded Systems-Architecture, Programming and Design ,Rajkamal,Tata McGraw Hill Publications, Second Edition,ISBN: 978-0070667648.
2. Real-Time Systems: Scheduling, Analysis and Verification, Cheng WileyInter science, ISBN: 9780471460848
3. Real-Time Systems: Design Principles for Distributed Embedded Applica Hermann Kopetz, Kluwer, ISBN: 9781441982377

**Web Links:**

1. <http://www.nptelvideos.in/2012/11/embedded-systems.html>
2. [http://www.dauniv.ac.in/Embedded\\_Sys.php](http://www.dauniv.ac.in/Embedded_Sys.php)
3. <https://sites.google.com/site/embeddedsystemddr/ppt>



## Minor Stream: Semiconductor Design Framework for Industrial ICs

| Course Code  | Course Name                                                            | SEM | Level | L         | T        | P        | C         | Pre-requisite |
|--------------|------------------------------------------------------------------------|-----|-------|-----------|----------|----------|-----------|---------------|
| 1            | RTL Design Principles (RDP)                                            | IV  | FC    | 3         | 0        | 0        | 3         | DELD          |
| 2            | System Design and Verification (SDV)                                   | V   | IC    | 3         | 0        | 0        | 3         | DELD          |
| 3            | Embedded Computing Principles (ECP)                                    | VI  | IC    | 3         | 0        | 0        | 3         | MPMC          |
| 4            | Product Architecture Models and Firmware (PAMF)                        | VI  | IC    | 3         | 0        | 0        | 3         | MPMC          |
| 5            | Logic Synthesis, DFT Chip Timing Analysis (CTA)                        | VII | AC    | 3         | 1        | 0        | 4         | RDP           |
| 6            | Product Design Thinking Framework (PDTF)                               | VII | IC    | 3         | 0        | 0        | 3         | RDP           |
| 7            | Physical Design and Graphic Design System (PDGDS)                      | VII | AC    | 3         | 1        | 0        | 4         | SDV           |
| 8            | SOCs Design Principles for Industrial Automation Practices (SOC DPIAP) | VII | AC    | 3         | 1        | 0        | 4         | MPMC          |
| 9            | Foundry Process of IC Manufacturing                                    | VII | AC    | 3         | 0        | 0        | 3         | ICA           |
| <b>Total</b> |                                                                        |     |       | <b>27</b> | <b>3</b> | <b>0</b> | <b>30</b> |               |

## RTL Design Principles

**Course Code:**

**L      T      P      C**  
**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Demonstrate proficiency in writing and analyzing RTL code in Verilog.
- CO2:** Design and optimize combinational and sequential circuits.
- CO3:** Examine datapath and pipeline models using Verilog HDL.
- CO4:** Demonstrate FPGA design flow and simulation using Verilog HDL
- CO5:** Build test benches and apply verification techniques to ensure design correctness.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | 1    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 2    | 2    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 3    | 3    | 2    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 1    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 3    | 2    | 2    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### **Unit – I: RTL Design and Verilog Fundamentals**

Introduction to Logic Design and Evolution, System and Logic Design Abstractions, Integrated Circuit Design and Methodologies: RTL Design, Functional Verification, Synthesis, Physical Design, Introduction to Verilog HDL, Verilog Design Description: Structural, Behavioral, and Synthesizable RTL Designs, Key Verilog Terminologies: Arithmetic, Logical, and Relational Operators.

### **Unit – II: System Design Implementation**

Logic Design without Memory elements, RTL Guidelines for Logic Design without Memory elements, Logic Design with Memory elements, RTL Guidelines for Logic Design with Memory elements, Complex design using RTL, Situation Driven Hardware Design,

**Unit-III:** Data Path and Controller-Part 1&2, Modeling Memory & Register Banks, Basic Pipeline Concepts, Pipeline Modeling, Pipeline Implementation-Part 1&2, Verilog Modeling of Processor, Design & Implement Micro Architecture from Vendor Specification.

**UNIT-IV:** Simulation Using Verilog, Introduction to PLD, FPGA as Programmable ASIC, SRAM Based FPGA, FPGA Design Flow, Logic Realization Using FPGA, Design Guidelines for FPGA-Based Designs.

**Unit-V: Introduction to RTL verification standards**

Verification Guidelines: Introduction to Verification, The Verification Process, The Verification Plan, The Verification Methodology Manual, Basic Test bench Functionality, Directed Testing, Methodology Basics, Constrained-Random Stimulus, Functional Coverage

**Text Books:**

1. Verilog HDL: A Guide to Digital Design and Synthesis, Samir Palnitkar, Pearson Education, 2nd Edition, ISBN: 978-0130449115
2. FPGA Prototyping by Verilog Examples: Xilinx Spartan-3 Version, Pong P. Chu, Wiley India, 1st Edition, ISBN: 978-8126521562.

**Reference Books:**

1. Advanced Digital Design with the Verilog HDL, Michael D. Ciletti, Pearson Education, 2nd Edition, ISBN: 978-0136019282.

**Web Links:**

1. <https://nptel.ac.in/courses/108105165>, NPTEL Course – Digital System Design with Verilog HDL
2. <http://www.asic-world.com/verilog/veritut.html>, ASIC World – Verilog HDL Tutorials
3. <https://ieeexplore.ieee.org>, IEEE Xplore – Verilog Resources.

## System Design and Verification

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Demonstrate proficiency in writing and analyzing RTL code in Verilog..
- CO2:** Develop SystemVerilog test benches using procedural statements and object-oriented programming concepts.
- CO3:** Demonstrate interface-based communication between test bench and design using SystemVerilog constructs.
- CO4:** Design advanced verification concepts including threads, IPC, virtual interfaces, and factory patterns to build scalable, reusable verification environments.
- CO5:** Analyze functional coverage techniques and advanced interface mechanisms for verification and simulation.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | 1    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO2</b> | 3    | 2    | 2    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO3</b> | 3    | 3    | 2    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO4</b> | 3    | 2    | 1    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |
| <b>CO5</b> | 3    | 2    | 2    | -    | 3    | -    | -    | 1    | 1    | -     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### **UNIT-I: Introduction to Data Types:**

Built-in Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, choosing a Storage Type, Creating New Types with typedef, User-Defined Structures, Enumerated Types, Constants, Strings, Expression Width, and Net Types.

### **Unit – II: Test bench Design and OOP Concepts**

**Procedural Statements and Routines:** Introduction, Procedural Statements, Tasks, Functions, and Void Functions, Routine Arguments, Returning from a Routine, Local Data Storage, Time Values

**Basic Object-Oriented Programming (OOP):** Introduction to OOP in System Verilog, Creating Classes, OOP Terminology, Creating New Objects, Object Deallocation, Using Objects and Static Variables vs. Global Variables, Class Routines and Defining Routines Outside of the Class, Scoping Rules, Using One Class Inside Another and Understanding Dynamic Objects, Copying Objects, Public vs. Private, Building a Test bench.

**UNIT - III: Connecting the Test bench and Design:** Introduction to Interface Constructs, Separating Test bench and Design Logic, The Interface Construct, Stimulus Timing, Interface Driving and Sampling, Connecting It All Together and Top-Level Scope, Program – Module Interactions, System Verilog Assertions and The Four-Port ATM Router.

#### **UNIT - IV: Advanced System Design and Verification**

**Threads and Inter process Communication (IPC):** Introduction to Threads and IPC and Working with Threads, Inter process Communication Mechanisms and Events, Semaphores and Mailboxes, Building a Test bench with Threads and IPC.

**Advanced Object-Oriented Programming (OOP):** Introduction to Advanced OOP Concepts and Inheritance, Factory Patterns, Type Casting and Virtual Methods, Composition, Inheritance, and Alternatives, Copying Objects and Call-backs.

**UNIT-V: Functional Coverage Strategies:** Introduction to Functional Coverage and Coverage Types, Functional Coverage Strategies and Simple Functional Coverage Example, Anatomy of a Cover Group and Triggering a Cover Group, Data Sampling, Cross Coverage and Coverage Options, Parameterized Cover Groups and Analysing Coverage Data, Measuring Coverage Statistics During Simulation

**Advanced Interfaces:** Introduction to Advanced Interfaces with Virtual Interfaces with the ATM Router, Connecting to Multiple Design Configurations, Procedural Code in Interfaces.

#### **Text Books:**

1. Writing Testbenches Using SystemVerilog, Janick Bergeron, Springer, 2nd Edition, ISBN: 978-0387290492.
2. SystemVerilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear and Greg Tumbush, Springer, 3rd Edition, ISBN: 978-1461407140.

#### **Reference Books:**

1. SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling, Stuart Sutherland, Simon Davidmann and Peter Flake, Springer, 2nd Edition, ISBN: 978-0387938196.

#### **Web Links:**

1. <https://verificationguide.com/systemverilog/>, Verification Guide – SystemVerilog Tutorials.
2. <https://www.chipverify.com/systemverilog>, ChipVerify – SystemVerilog and Verification Tutorials.
3. <https://verificationacademy.com/>, Verification Academy – SystemVerilog and UVM Resources.

## Embedded Computing Principles

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Infer the various functionalities, hardware-software architecture and trade offs of microcontrollers.
- CO2:** Program Embedded C code in development boards like Arduino, ESP32.
- CO3:** Choose the appropriate microcontrollers for different applications.
- CO4:** Program Raspberry Pi Pico using MicroPython for simple applications.
- CO5:** Develop and interface sensors, OLED and LCD displays and motor for simple embedded system prototypes.
- CO6:** Design and Develop embedded C code based on real-time applications of Microcontrollers.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO6</b> | 3    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

**UNIT-I: 8051 Microcontroller Programming:** Functional block diagram and memory organization of 8051 – I/O interfacing – Timer and Counter – Serial communication – Interrupts – Addressing Modes – Programming with 8051 microcontroller - Programmable peripheral interfaces (PIO 8255) – I/O programming – Debugging principles – Applications.

### UNIT-II: C Programming and Embedded C Fundamentals

Introduction to C programming – C based simple programs – Basics of Embedded C – Data types – Conditions – Loop – Arrays - Sprintf convert float/int to string in embedded C – Pointers and functions – Passing arrays to functions.

### UNIT-III: AVR Microcontrollers: Architecture, Programming, and Interfacing

Introduction to AVR microcontroller and architecture – AVR memory organization – Peripheral interfaces – IDEs for AVR - Basic Programs using AVR – Interfacing I/O devices and Sensors – PWM configuration – ADC configuration - Use cases

#### **UNIT-IV: Embedded Development Boards and Applications**

Fundamentals of development boards and architecture (Arduino UNO, ESP32)- Arduino IDE - Smart parking management system - Automatic animal feeder system- Line follower robotics - Pick and place robots - Obstacle sensing autonomous robot-Object identification robot - Truck load object counting systems - Gateway integrated diesel generator monitoring system - Integration of IOT data with cloud.

#### **UNIT-V: Cyber Physical System and Embedded Systems**

Fundamentals of cyber physical system (CPS) - Evolution of RISC Processors - ARM Cortex Architecture - Embedded C Programming for ARM Cortex - Interfacing ARM cortex processor with relay, buzzer, 16 x2 LCD, matrix key and stepper motors - Raspberry Pi Pico and Micro Python - Thonny IDE - Sensor interfacing with Raspberry Pi Pico.

#### **Text Books:**

1. Computers as Components: Principles of Embedded Computing System Design, Wayne Wolf, Morgan Kaufmann Publishers, 3rd Edition, ISBN: 978-0123884367.
2. Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, Jonathan W. Valvano, CreateSpace Independent Publishing, 5th Edition, ISBN: 978-1463590154.

#### **Reference Books:**

1. Programming and Customizing the AVR Microcontroller, Dhananjay V. Gadre, McGraw-Hill Education, 1st Edition, ISBN: 978-0070262096.

#### **Web Links:**

1. [https://www.espressif.com/sites/default/files/documentation/esp32\\_datasheet\\_en.pdf](https://www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf), ESP32 Datasheet and Technical Reference Manual.
2. <https://romanianlhcbgroup.nipne.ro/upgrade/outreach/Introduction%20to%20Microcontroller%20Arduino%20tutorial.pdf>, Introduction to Arduino Microcontroller Tutorial.

## Product Architecture Models and Firmware

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Illustrate the benefits of RISC V microarchitecture IP.
- CO2:** Relate RISC V ISA with other conventional controllers ISA.
- CO3:** Program supervisor and machine mode coding of RISC V.
- CO4:** Design and debug RISC V firmware.
- CO5:** Develop RISC V based Embedded system configuration.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I: Fundamentals of Product Architecture

SoC overview, MCUs of SoC, Architecture models, CISC Processor Architecture, CISC Instruction Set Architecture, RISC Processor Architecture, RISC Instruction Set Architecture, CISC vs RISC an insight, Instruction Pipe line in RISC, ARM Architecture: A case Study in RISC, Trends in RISC Processor Development, RISC -V Open-Source Architecture and Ecosystem, RISC-V Impact on Semiconductor Industry.

### UNIT – II: RISC V ISA

Introduction to RISC V ISA, Base user-level ISA, Base programmers model, Instruction length encoding, Instruction formats, Load & Store, Integer computational instructions, Memory model, System instructions, Extensions: Compression instructions, Floating point instructions, Packed SIMD.

### UNIT – III: Designing and Building Custom Firmware for the Future

Open-Source Firmware, Open-Source System Firmware Development, Open-Source Device Firmware Development, Open-Source Manageability Firmware Development, Build Tools, Configuration and Flashing Tools, Source Control Management Overview, Coding Standards.



**UNIT – IV: System Firmware Insights: Debugging Challenges and Future Innovations**

Hardware-Assisted Debugging - Generic Debugging, SoC-Specific Debugging, OxM-Specific Debugging, Software-Assisted Debugging, Core Security Design, LITE Firmware Development, Feature Kernel Design, Multithreaded Firmware Design, Hardware Innovation.

**UNIT – V: Embedded Linux System Design and Development**

Embedded Linux Basics, Toolchain & Cross Compilation, Bootloader Development & Porting, Board Support Package (BSP), Linux Kernel Internals (for Drivers), Device Driver Development, Root Filesystem & Init Systems, Build Systems, Application Development on Embedded Linux.

**Text Books:**

1. Firmware Development: A Guide to Specialized Systemic Knowledge, Subrata Banik and Vincent Zimmer, Apress, 1st Edition, ISBN: 978-1484266809.
2. Embedded Linux Primer, Christopher Hallinan, Prentice Hall, 2nd Edition, ISBN: 978-0137017836.

**Reference Books:**

1. Linux Device Drivers, Jonathan Corbet, Alessandro Rubini, and Greg Kroah-Hartman, O'Reilly Media, 3rd Edition, ISBN: 978-0596005900.
2. Embedded Linux Systems with the Yocto Project, Rodolphe Petazzoni, Bootlin.

**Web Links:**

1. The RISC-V Instruction Set Manual, Volume I: Base User-Level ISA, Andrew Waterman, RISC-V Foundation.  
[https://docs.riscv.org/reference/isa/unpriv/unpriv-index.html?utm\\_source=chatgpt.com](https://docs.riscv.org/reference/isa/unpriv/unpriv-index.html?utm_source=chatgpt.com)
2. Official documentation portal maintained by the The Linux Foundation  
<https://docs.yoctoproject.org/>

## Product Design Thinking Framework

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Infer the Principles of Design Thinking (DT) and Interpret the role of DT in Creative ideas.
- CO2:** Demonstrate Product Design Models using Design Thinking.
- CO3:** Illustrate the key framework of IC Design Flow Process.
- CO4:** Identify the IC components of different applications.
- CO5:** Examine simple Analog and Digital circuits of different applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 3    | 3    | -    | 2    | -    | -    | 3    | 3    | 3     | 2     |
| <b>CO2</b> | 2    | 3    | 3    | -    | 2    | -    | -    | 3    | 3    | 3     | 2     |
| <b>CO3</b> | 2    | 3    | 3    | -    | 2    | -    | -    | 3    | 3    | 3     | 2     |
| <b>CO4</b> | 2    | 3    | 3    | -    | 2    | -    | -    | 3    | 3    | 3     | 2     |
| <b>CO5</b> | 2    | 3    | 3    | -    | 2    | -    | -    | 3    | 3    | 3     | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I: Design Thinking Fundamentals and Framework

Course Overview - Fundamentals of Design Thinking, Design Thinking for complex problem solving, 7-stages of Design Thinking, Exploring solution space(C-K Theory) , Techniques of Empathy building, Empathy maps and user journey mapping, Integration of Design Thinking and Storyboarding, Design Thinking practicing Case-studies, Design Thinking for Professional Skills, Design Thinking practices for Coding skill, Co-curricular skill, Technical blog writing, Designing Capstone projects, Design Thinking in industrial projects, Strategy for new technology innovations.

### UNIT – II: Design Thinking in Creativity & Innovation

Unique characteristics of Design Thinking, Difference between Creativity and Innovation, Categories and misconceptions of creativity, Resilience in problem-solving, Analytical Thinking – Driven by Design Thinking, Waterfall models and Design Thinking, Agile Development models, Agile process integrated with Design Thinking, Design Thinking based Product development - Design methodology, Prototyping, UX design, Value proposition.

### UNIT – III: Mapping Product Design Process with Design Thinking

Engineering Design Problem solving, Project Introduction and Team Formation, Prototyping Planning, Concept Refinement and Storyboard, Envisioning Future, Conceptual Design, Creative

Matrix, Morphological synthesis, Concept Poster, Usability Test, Understanding Users, Competitor study, Capital Budgeting: Risk Analysis with Scenarios, Business Pitch, Pitching Strategies, IP and Partnerships, Forecasting Financial Statements.

#### **UNIT – IV: Fundamentals and Evolution of Integrated Circuits (IC)**

Transistors Overview, Transition from Discrete Components to ICs, Introduction and types of ICs (Analog, Digital, Mixed-Signal), IC Value Chain System, research and Development Phase, Design Flow Process, Manufacturing Process, Assembling, Testing and Packaging Process, Overview of IC Manufacturing- Silicon Wafer Production, Photolithography, Etching and Deposition, Doping and Ion Implantation, Chemical Mechanical Planarization (CMP), Metal Interconnects and Contacts, Wafer Testing and Inspection, Quality Control and Yield Management, Cleanroom Protocols in IC Manufacturing and IC Manufacturing Equipment.

#### **UNIT – V: IC Products – Reverse Engineering**

Introduction to Reverse Engineering (RE), Purpose and examples of Reverse engineering, RE in the Semiconductor Industry, Types of RE in IC design, IC Product Design – Recap, Techniques and Tools for Reverse Engineering, Analysis of IC Structure, Functional Analysis, Ethical and Security Considerations, Emerging Technologies in RE, Case Studies, Simulation of simple analog and digital circuits, Challenges and Limitations.

#### **Text Books:**

1. Thinking Skills: Critical Thinking and Problem Solving, Geoff Thwaites and John Butterworth, Cambridge University Press, ISBN: 978-0521529891.
2. Critical Thinking: A Student's Introduction, Gregory Bassham, William Irwin, Henry Nardone, and James M. Wallace, McGraw-Hill Education, 6th Edition, ISBN: 978-1260819403.

#### **Reference Books:**

1. Integrated Circuit Design: A Circuits and Systems Perspective, Neil H. E. Weste and David Harris, Addison-Wesley, 4th Edition, ISBN: 978-0138146467.
2. Design Thinking: Understanding How Designers Think and Work, Nigel Cross, Berg Publishers, ISBN: 978-1847886361.

#### **Web Links:**

1. Layman's Guide to IC Reverse Engineering - Siliconzoo.org.  
<https://siliconzoo.org/tutorial.html>
2. The state of art in IC Reverse Engineering - Randy Torrance and Dick James  
[https://link.springer.com/chapter/10.1007/978-3-642-04138-9\\_26](https://link.springer.com/chapter/10.1007/978-3-642-04138-9_26)

## Logic Synthesis, DFT and Chip Timing Analysis

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>1</b> | <b>0</b> | <b>4</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understand the fundamentals of logic synthesis, timing models, and Linux-based synthesis flows with practical design constraints.
- CO2:** Apply TCL scripting techniques to automate synthesis processes, write timing and area constraints, and perform logic synthesis using tools like Yosys.
- CO3:** Demonstrate VLSI testing techniques and optimize timing for combinational and sequential circuits.
- CO4:** Analyze VLSI testing methodologies, fault modeling, and test generation for combinational and sequential circuits.
- CO5:** Evaluate advanced testing techniques, including DFT, BIST, and boundary scan standards, for ensuring reliable and testable designs.
- CO6:** Inspect advanced STA topics including on-chip variations, statistical timing, learning-based timing prediction, and perform timing optimization.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO6</b> | 3    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I: Fundamentals of logic synthesis and TCL Script

Introduction to Logic Synthesis, Synthesis Flow, Compilation in the synthesis flow, Library Definition, Library Exchange Format, Library Timing Models (.lib), Basics of Timing: AT, RAT, Cycle Time; Pre layout steps, Post Layout steps, Constraining Design, Optimizing Design, Library Level attributes, Delay Calculation, Synthesized vs. Non- Synthesized RTL, Introduction to Linux, System Access & file systems ,Linux fundamentals with simple examples. Tcl – Overview, Environment Setup, Special Variables, Basic Syntax, Commands, Data Types, Variables, Operators, Decisions, Loops, Arrays, Strings, Lists, Dictionary, Procedures, Packages, Namespaces, File I/O, Error Handling, Built-in Functions, Regular Expressions, Writing TCL Scripts for synthesized designs, Writing Area and Timing Constraints, Practical Logic Synthesis in Yosys. (Tools:cygwin,yosys).

## **UNIT – II: Introduction to Testing and Design for Testability**

Introduction, VLSI Testing Process and Test Equipment, Test Economics and Product Quality and Fault Modeling, Logic and Fault Simulation and Testability Measures, Combinational and Sequential Circuit Test Generation. Memory Test-Fault Modeling & Memory Testing, DSP-Based Analog and Mixed-Signal Test Functional Testing and Static ADC and DAC Testing, Model-Based Analog and Mixed-Signal Test Analog Fault Simulation & Analog Automatic Test-Pattern Generation, Delay Test and IDDQ Test. Digital DFT and Scan **Design**, Built-In Self-Test- Random Logic BIST & Memory BIST, Boundary Scan Standard, Analog Test Bus Standard, System Test- Functional Test & Diagnostic Test and Core-Based Design.

## **UNIT – III: Designs for Synthesis and Static Timing Analysis**

Recap of VLSI design flow and course description, Synthesis Basics, Case study on chip timing, Overview of Chip timing analysis, Timing Analysis and Constraints, SDC Extensions through Tcl, Clocks, Generated Clocks, Clock Groups, Clock Characteristics, Port Delays, Completing Port Constraints, False Paths, Multi Cycle Paths, Combinational Paths, Modal Analysis, Managing Constraints, SDC Commands, Xilinx Extension to XDC (Tools:OpenTimer,Xilinx) STA Concepts, Standard Cell Library: Timing models for Combinational and Sequential cells, Advanced Timing Modeling, Power Dissipation Modeling; Interconnect Parasitic: Interconnect Models, Parasitic Representation and Mitigation; Delay Calculation, Crosstalk and Noise, Configuring the STA Environment, Timing Verification: Setup Timing Check, Hold Timing Check, Path Analysis, Removal and Recovery Timing check, Timing across Clock Domains with Examples, Multiple clocks.

## **UNIT – IV: Static Timing Analysis**

Interface Analysis: IO Interface, SRAM and DDR SDRAM Interface, Interface Video DAC; Robust Verification: On Chip Variations and Time Borrowing, Data to Data Checks and Nonsequential Checks, Clock Gating Checks, Power Management and Backannotation, Sign off Methodology, Statistical STA, Paths Failing Timing; Constraints Creation command, register to register analysis, Interface Timing Evaluation, Clock gating analysis, Asynchronous and data checks, Latch timing and slew analysis, Practical Combinational circuit Analysis: Simple circuit, BCD to 7 segment Decoder. (Tools:OpenTimer).

## **UNIT – V: Techniques for Optimization in Sequential Circuits and Chip Timing Analysis**

Timing Analysis of Sequential Circuits, Clock Skew Optimization, Basics of Retiming, Minimum area Retiming, Retiming Control Logic, Miscellaneous issues in Retiming, Practical Sequential Circuit Analysis. (Tools:IVerilog,yosys,OpenTimer) Static Timing Analysis of Sequential Circuit with GUI, Advanced On-Chip Variation in Static Timing Analysis for Deep Submicron Regime, Instruction-Based Timing Analysis in Pipelined Processors, A fast and accurate approach for common path pessimism removal in static timing analysis, LSTA: Learning-based static timing analysis for high-dimensional correlated on-chip variations, Optimizing Dynamic Timing Analysis and Reinforcement Learning.

### **Textbooks:**

1. Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Michael L. Bushnell and Vishwani D. Agrawal, Kluwer Academic Publishers, 2002, ISBN: 978-0792379997.
2. Constraining Designs for Synthesis and Timing Analysis, Sridhar Gangadharan and Sanjay Churiwala, Springer, ISBN: 978-0387938196.

**Reference Books:**

1. Static Timing Analysis for Nanometer Designs: A Practical Approach, J. Bhasker, Springer, ISBN: 978-0387938202
2. Timing Analysis and Optimization of Sequential Circuits, Naresh Maheshwari and Sachin Sapatnekar, Springer, ISBN: 978-0792382706.

**Web Links:**

1. Logic Synthesis by Srinivas Devadas, Abhijit Ghosh & Kurt Keutzer  
<https://archive.org/details/logicsynthesis0000deva>
2. VLSI Test Principles and Architectures: Design for Testability by Laung-Terng Wang, Cheng-Wen Wu & Xiaoqing Wen  
<https://shop.elsevier.com/books/vlsi-test-principles-and-architectures/wang/978-0-12-370597-6>
3. Advanced On-Chip Variation in Static Timing Analysis for Deep Submicron Regime  
<https://ieeexplore.ieee.org/document/9353065>
4. Instruction-Based Timing Analysis in Pipelined Processors  
<https://ieeexplore.ieee.org/document/8908287>
5. Static Timing Analysis of Sequential Circuit with GUI  
<https://ieeexplore.ieee.org/document/9397934>

## Physical Design and Graphic Design System

|                     |          |          |          |          |
|---------------------|----------|----------|----------|----------|
|                     | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code:</b> | <b>3</b> | <b>1</b> | <b>0</b> | <b>4</b> |

### Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Understand and apply the fundamentals of physical design, including synthesis, partitioning, placement, and routing.
- CO2:** Infer proficiency in managing design constraints, such as timing and power, and analyzing them through practical tools.
- CO3:** Demonstrate hands-on floor planning, clock tree synthesis, and layout verification tasks for VLSI designs.
- CO4:** Illustrate low-power design techniques and physical verification for industry-level projects, ensuring manufacturability and integrity.
- CO5:** Develop expertise in low-power design strategies and employ verification techniques to enhance design robustness and manufacturability for real-world applications.
- CO6:** Integrate low-power design principles and open-source EDA tools (e.g., Yosys, OpenROAD, Magic) to implement RTL-to-GDSII flow and generate industrycompatible design outputs.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 2    | 2    | -    | 3    | 3    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 2    | 3    | -    | 3    | 3    | -    | -    | -    | -     | -     |
| <b>CO6</b> | 3    | 2    | 3    | -    | 3    | 3    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I: Fundamentals of Physical Design

Digital Design Basics, Overview of VLSI Design Flow, Design Styles and Methodologies, Reading of Verilog RTL File; Physical Design Flow, Complexity analysis for algorithms, Graph Theory Terminology, Layout Layers and Design rules, Spanning Tree and Shortest path algorithms; Overview of Timing Analysis (Setup/Hold Time, Delays in Circuit Design, Timing Exceptions, Path Groups), Gating Techniques, Timing arcs and Unateness, STA in Digital Circuits, STA considering OCV and CRPR (Setup/Hold Check); Initial Design Set-up, NDM Libraries, Physical Design Workflow Files: LEF, DEF, SDC, SPEF, and GDSII.

Test case: Timing Analysis on a Simple ALU Design and CMOS Design.



## **UNIT – II: Partitioning, Chip Planning and Placement**

Introduction to Partitioning, Types of Partitioning, Partitioning Algorithms, Framework of multi-level partitioning, Evaluation Metrics; Introduction to Floorplanning and Representation, Constraints and Considerations in Floorplanning, Slicing Techniques, Polish Expression, Floorplanning Algorithms, Concept of pre-placed cells, Pin Assignments, Power and Ground Routing, Logical cell placement blockage; Introduction to Placement, Types of Placement, Placement Algorithms, Placement Optimization Techniques, Placement Quality metrics, Timing and Power driven Placement. Test Case: Given a gate design perform partitioning, create a floorplan considering macro placement and routing constraints, and optimize placement for timing and power.

## **UNIT – III: CTS and Routing**

Introduction to Clock Tree Synthesis (CTS), Clocking Schemes, Strategies to reduce Clock Skew, Clock Tree Distribution techniques, Clock Buffering Mechanism, Clock Routing Algorithms; Introduction to Routing, Types of Routing, Global Routing: Introduction and Optimization goals, Representations of Routing regions, Global Routing flow, Rectilinear Routing, Dijkstra's Algorithm, Full netlist routing, Modern Global Routing, Graph models; Detailed Routing, Horizontal and vertical constraint graphs, Sensitivity: LNT Construction Internal Use Channel routing algorithm, switch box routing, OTC Routing algorithms; Challenges in Routing, Specialized Routing, Power and Ground Routing. Test Case: Given a gate design, perform clock tree synthesis (CTS) to minimize clock skew, and then execute global and detailed routing.

## **UNIT – IV: Advanced Timing Analysis, Verification Techniques and Sign-off**

Introduction to Clock Design and their issues, Timing Constraints, Design Optimizations, ECO Flow, Pre and Post-Layout Timing, AOCV Analysis for Deep Submicron STA, Instruction-Level Timing Analysis in Pipelined Processor Architectures, Power Planning and Analysis, Timing Closure, Timing Driven Placement and Routing, Physical Synthesis, Design for Manufacturability, Parasitic Extraction for Sign-Off Timing Analysis, Testing: DFT, Physical Verification and PV Checks: LVS, DRC, Antenna, ERC, DFM, DFY and Pattern Matching, PDK and GDSII File Generation. Test Case: For a given ASIC layout, manually analyze parasitic extraction and its effect on the postlayout timing, proposing improvements for timing closure.

## **UNIT – V: Low Power Design Techniques and Open-Source Tool Integration**

Introduction to Low Power VLSI Design, Techniques to reduce power, Gate Level Design for Low Power, Algorithmic Level Design for Low Power Design. Introduction to Linux and Installation, Linux Commands for Open-Source EDA Tools and TCL Scripting, Open-Source Tool Installation, RTL to GDSII: Yosys, OpenLane, OpenROAD, KLayout, Magic, OpenSTA, Netgen, Qflow, Projects covering detailed flow from Input files, floorplan, power planning, placement, CTS, Routing, SPEF extraction, STA, and Physical verification. Hands on: Given a 50K gate design in Verilog, perform synthesis, place and route run static timing analysis and generate the final GDSII file. Hands on: Design a Power and Clock Network for a Simple RISC-V Processor.

### **Text Books:**

1. VLSI Physical Design: From Graph Partitioning to Timing Closure, Andrew B. Kahng, Springer, ISBN: 978-1402071454.
2. VLSI Physical Design Automation, Sadiq M. Sait and Habib Youssef, World Scientific, ISBN: 978-9810237608.
3. Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey, Prentice Hall, ISBN: 978-0130909961.



**Reference Books:**

1. A Practical Approach to VLSI System on Chip (SoC) Design, Veena S. Chakravarthi, Springer International Publishing, 2019, ISBN: 978-3030046170.
2. ASIC Design and Synthesis, Vaibbhav Taraate, McGraw-Hill Education, ISBN: 978-1259029530.
3. Algorithms for VLSI Physical Design Automation, N. A. Sherwani, Kluwer Academic Publishers, 3rd Edition, ISBN: 978-0792395768.

**Web Links:**

1. VLSI Physical Design: From Graph Partitioning to Timing Closure.  
<https://link.springer.com/book/10.1007/978-3-030-96415-3>
2. VLSI Physical Design - Archive.org  
[https://archive.org/details/VLSI\\_Physical\\_Design\\_From\\_Graph\\_Partitioning\\_to\\_Timing\\_Closure](https://archive.org/details/VLSI_Physical_Design_From_Graph_Partitioning_to_Timing_Closure)

## SOCs Design Principles for Industrial Automation Practices

**L      T      P      C**  
**3      1      0      4**

**Course Code:**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understanding SoC architecture and core components.
- CO2:** Programming HDL (Verilog) for digital design and simulation.
- CO3:** Illustrate synthesis, timing analysis, and testability in SoC design.
- CO4:** Determine advanced SoC trends like low-power design and AI integration.
- CO5:** Create SOC designs using industry-standard tools.
- CO6:** Evaluate complete SoC architectures with respect to performance, integration challenges, and real-world applications

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 2    | 3    | -    | 3    | 2    | -    | -    | -    | -     | -     |
| <b>CO6</b> | 3    | 2    | 3    | -    | 3    | 3    | -    | -    | -    | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I: SOC Design Methodology

Overview of VLSI design flow, Fundamental trends of soc design, An Improved Design Methodology for SOC Design ,SOC Architecture, Current SOC Design flow and major issues in soc design, SOC Constituents, Core Components, Processors (RISC vs. CISC), Controllers, Memories, SystemC, CoSpecification, System Partitioning, Co-Simulation, Hw-Sw Co-Design, Hw-Sw flow, Ha-Sw Partitioning, Embedded Memories, Protocol and Mixed signal Blocks, Radio Frequency Control Blocks, Analog Blocks, IP Cores, GAMP Software Categorization, Design Specific Blocks. Case studies: Smartphone SOC Architecture.

### UNIT – II: Processor Architecture

Processor Selection for SOC, Basic Concepts in processor Architecture, Building Data path, Simple Implementation scheme, an Overview of Pipelining, Pipelined Datapath and Control, Data Hazards: Forwarding versus Stalling, Control Hazards, Exceptions, Parallelism via Instructions, Real Stuff: The ARM Cortex-A53 and Intel Core i7 Pipelines, RISC-V Processor.

### **UNIT – III: Large and Fast Memory Hierarchy**

Introduction, Memory Technologies, The Basics of Caches, Measuring and Improving Cache Performance, Dependable Memory Hierarchy, Virtual Machines, Virtual Memory, A Common Framework for Memory Hierarchy, Using a Finite-State Machine to Control a Simple Cache, Parallelism and Memory Hierarchy: Cache Coherence Parallelism and Memory Hierarchy: Redundant Arrays of Inexpensive Disk, Parallelism and Memory Hierarchy: Redundant Arrays of Inexpensive Disks.

### **UNIT – IV: Parallel Processor and GPU**

Parallel Processors from Client to Cloud Abstract, Introduction, The Difficulty of Creating Parallel Processing Programs, SISD, MIMD, SIMD, SPMD, and Vector, Hardware Multithreading, Multicore and Other Shared Memory Multiprocessors ;Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers, and Other Message, Passing Multiprocessors, Introduction to Sensitivity: LNT Construction Internal Use Multiprocessor Network Topologies Communicating to the Outside World: Cluster Networking, Communicating to the Outside World: Cluster Networking, Multiprocessor Benchmarks and Performance Models, Real Stuff: Benchmarking and Rooflines of the Intel Core i7 960 and the NVIDIA Tesla GPU.

### **UNIT – V: Components Integration of SOC**

Bus Architecture: AXI, AHB, APB (AMBA protocols), Memory Controller: DDR Controller, SRAM Controller, Cache: L1, L2 Cache (Instruction/Data Caches), I/O Interfaces: SPI, I2C, GPIO, UART, USB, PCIe, Ethernet, Interrupt Controller: Programmable Interrupt Controller (PIC), GIC (Generic Interrupt Controller for ARM-based SoCs), DMA (Direct Memory Access): For high-speed data transfer, Timers: System Timer, Watchdog Timer, Power Management Unit (PMU): Voltage Regulators, Clock Gating, Clock Generation Unit: Phase Locked Loop (PLL), Oscillators, Clock Dividers, Debug Interface: JTAG, Debug UART, Security Features: Secure Boot, Hardware Root of Trust, Cryptographic Accelerators, GPU-Specific Units: Texture Mapping Unit, Shader Cores, Video Decode/Encode Engines.

#### **Text Books:**

1. System on Chip: Design and Verification, Prakash Rashinkar, Peter Paterson and Leena Singh, Kluwer Academic Publishers, ISBN: 978-0792377603.

#### **Reference Books:**

1. Computer Organization and Design RISC-V Edition, David A. Patterson and John L. Hennessy, Morgan Kaufmann, ISBN: 978-0128122754.

#### **Web Links:**

1. Design Methodologies for Low-Power SoC  
<https://ieeexplore.ieee.org/document/660608>
2. Static Timing Analysis of Sequential Circuit with GUI  
<https://ieeexplore.ieee.org/document/9397934>

## Foundry Process of IC Manufacturing-Fabrication

**L      T      P      C**  
**3      0      0      3**

**Course Code:**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Infer the semiconductor IC fabrication process.
- CO2:** Interpret IC layouts.
- CO3:** Apply electron devices principles to model layout.
- CO4:** Illustrate front-end and back-end processes of IC manufacturing.
- CO5:** Outline the machineries and processes of foundry operations.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 2    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     |
| CO2   | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     |
| CO3   | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| CO4   | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     |
| CO5   | 2    | 2    | 3    | -    | 3    | 2    | -    | -    | -    | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | 2    |
| CO2    | -    | 2    |
| CO3    | -    | 2    |
| CO4    | -    | 2    |
| CO5    | -    | 2    |

### UNIT – I: Semiconductor IC fabrication fundamentals

Introduction, Moor's Law, Integrated Circuits & Design, IC Fabrication overview, Photolithographic Process, Components Fabrication, Nanotechnology manufacturing, MEMS and Microsystem technologies, Microsystem Design, 3D IC design, Physical design solutions for 3D ICs.

### UNIT – II: IC Layout and Simulation Basics

Layout basics, Modeling of MOS transistor, MOSFET modeling, MOS Transistor specifications, Device Model, Parameter Extraction, Binnig Process, Mobility model, Capacitance models, Source/Drain Resistance, Effects of MOS transistor, CMOS Latch-up, SOI Technology, Model simulations.

### UNIT – III: IC Manufacturing Front-End Process

Epitaxy Growth, Thermal Processing, Microlithography, Etching, Ion Implementation, Physical Vapor deposition, Chemical Vapor deposition, Atomic Layer and Electrochemical deposition, Chemical mechanical planarization, AFM metrology.

**UNIT – IV: IC Manufacturing BE Processes**

Wafer thinning & Singulation, Packaging, Bonding, Interconnects, Automatic Test Equipment, Memory Tester, DFT test Techniques, Cloud-Based DFT Tester, ATE Data Formats and Specifications.

**UNIT – V: Process & Machinery in IC Foundries**

Gas Distribution Systems, Ultrapure Water Production and Distribution, Process Chemicals, Filtration, Chemical and Slurry Handling, CIM & Factory Automation, MES Fundamentals, Advanced Process Control, Airborne Molecular Contaminations, ESD Controls, Vacuum systems, Clean room design.

**Text Books:**

1. Analysis and Design of Digital Integrated Circuits, David A. Hodges, Horace G. Jackson and Resve A. Saleh, McGraw-Hill, ISBN: 978-0072283655.

**Reference Books:**

1. Fundamentals of Semiconductor Manufacturing and Process Control, Gary S. May and Costas J. Spanos, Wiley-IEEE Press, ISBN: 978-0471584605.

**Web Links:**

1. <https://www.geeksforgeeks.org/ic-fabrication-process/>

### UNIVERSITY ELECTIVE COURSES

| Branch | Course Code | Course Name                                                    | Level | L | T | P | C | CIE | SEE | Offered to                                      | Pre-requisite |
|--------|-------------|----------------------------------------------------------------|-------|---|---|---|---|-----|-----|-------------------------------------------------|---------------|
| CE     | 2501CE66    | Natural Disaster Management & Mitigation                       |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| CE     | 2501CE81    | Wastewater Management                                          |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| CE     | 2501CE82    | Integrated Solid Waste Management for a Smart City             |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| CE     | 2501CE83    | Watershed Management                                           |       | 3 | 0 | 0 | 3 |     |     | EEE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| EEE    | 2501EE53    | Electric Power Generation, Transmission & Distribution Systems | AC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E   |               |
| EEE    | 2501EE36    | Electric Energy Storage Systems                                | FC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E   |               |
| EEE    | 2501EE43    | Electrical safety                                              | IC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ME, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E   |               |
| EEE    | 2501EE54    | Hybrid & Electric Vehicles                                     | IC    | 3 | 0 | 0 | 3 | 50  | 50  | CE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E       |               |
| ME     | 2501ME37    | Solar Energy Systems                                           | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ME     | 2501ME58    | Industry 5.0 for Engineers                                     | AC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ME     | 2501ME73    | Organizational Behavior                                        | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ME     | 2501ME36    | Sustainable Energy Systems                                     | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ECE, CSE, IT, AIML, CSE(DS) PT, Min.E  |               |
| ECE    | 2501EC97    | Biomedical Electronics                                         | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |               |
| ECE    | 2501EC98    | Fundamentals of Wireless Communications                        | FC    | 3 |   |   | 3 | 50  | 50  | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |               |

|       |                   |                                               |    |   |  |   |   |    |    |                                                 |              |
|-------|-------------------|-----------------------------------------------|----|---|--|---|---|----|----|-------------------------------------------------|--------------|
| ECE   | 2501EC99          | Principles of Embedded Systems                | FC | 3 |  |   | 3 | 50 | 50 | CE,EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E  |              |
| ECE   | 2501ECA0          | Electronics for Healthcare                    | FC | 3 |  |   | 3 | 50 | 50 | CE,EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E  |              |
| ECE   | 2501ECA1          | Basics of VLSI Design                         | FC | 3 |  |   | 3 | 50 | 50 | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |              |
| ECE   | 2501ECA2          | System on Chip Design                         | FC | 3 |  |   | 3 | 50 | 50 | CE, EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E |              |
| ECE   | 2501ECA3          | Introduction to Quantum Computing             | FC | 3 |  |   | 3 | 50 | 50 | CE,EEE, ME, CSE, IT, DS, AIML, PT, Min.E, Ag.E  |              |
| CSE   | 2501CS03/2601DS02 | Data Structures* / Data Structures using C++# | FC | 2 |  | 2 | 4 | 50 | 50 | CE, ME, PT, Min.E                               | PPSC         |
| CSE   | 2501CS13          | Operating Systems                             | IC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | -            |
| IT    | 2501IT05          | Database Management Systems                   | IC | 2 |  | 2 | 4 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | PPSC / CP&DS |
| IT    | 2501CS07          | Computer Networks                             | AC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | -            |
| AI&ML | 2501AI02          | Artificial Intelligence                       | FC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ECE, PT, Min.E                         | -            |
| AI&ML | 2501AI05          | Machine Learning                              | AC | 2 |  | 2 | 4 | 50 | 50 | CE, ECE, PT, Min.E                              | DAUP         |
| DS    | 2501CS34          | Fundamental of Data Science                   | FC | 2 |  | 1 | 3 | 50 | 50 | CE, EEE, ME, ECE, PT, Min.E, Ag.E               | PPSC / CP&DS |

## Natural Disaster Management & Mitigation

(EEE,ME,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501CE66**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

**CO1:** Explain the aspects of disaster management and adopt remedial measures.

**CO2:** Explain disaster risk assessment and coping measures.

**CO3:** Explain the vulnerability conditions.

**CO4:** Assess the impact of hazards on structures.

**CO5:** Adopt the rehabilitation procedures.

### Mapping of Course Outcomes with Program Outcomes:

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

### UNIT – I

#### Introduction:

Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

### UNIT – II

#### Overview of Disaster Situations:

Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS-spread and transmissions -pandemic, endemic and epidemic.

### UNIT – III

#### Flood:

Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management-integrating technology and people.



## **UNIT – IV**

### **Overview of Disaster Situations:**

Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

## **UNIT – V**

### **Cyclone and Fire Disaster:**

Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

### **Text Books**

1. Disaster Management, RB Singh (Ed), Rawat Publications. (ISBN: 13-978-8131600337).
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house. (ISBN: 13-978-8189866464).

### **Reference Books:**

1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill. (ISBN:13-9780074631881).
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose. (ISBN:13-978-0953614011).
3. Anthropology of Disaster management, Sachindra Narayan, Gyan Publishing house. (ISBN: 13-978-8121206839).

### **Web Links:**

1. [https://www.iare.ac.in/sites/default/files/lecture\\_notes/dm%20notes.pdf](https://www.iare.ac.in/sites/default/files/lecture_notes/dm%20notes.pdf)

## Waste Water Management

(EEE,ME,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501CE81**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the importance of sanitation and wastewater management.
- CO2:** Explain the various methods of sewage flow estimation and pumping systems.
- CO3:** Identify the various characteristics of sewage and the treatment system.
- CO4:** Outline the various secondary treatment technologies for waste water
- CO5:** Explain the different tertiary and effluent disposal methods.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 3    |      |      |      |      |      |      |      |       |       |
| CO2   | 2    | 3    |      |      |      | 1    |      |      |      |       |       |
| CO3   | 3    | 3    | 1    |      |      | 2    |      |      |      |       |       |
| CO4   | 2    | 2    | 1    | 2    |      | 2    |      |      |      |       |       |
| CO5   | 2    | 2    | 1    |      |      | 2    |      |      |      |       |       |

### UNIT – I

#### Introduction:

Introduction to sanitation–systems of sanitation–relative merits and demerits –need for waste water management–basic terminology in waste water–generation of waste water–types – collection and conveyance of waste water– classification of sewerage systems.

### UNIT – II

#### Sewage Flow and Pumping:

Estimation of sewage flow and storm water drainage–fluctuations. Types of sewers–hydraulics of sewers– appurtenances in sewerage. Pumping of waste water:pumping stations–location–components– types of pumps and their suitability with regards to waste waters.

### UNIT – IV

#### Secondary Treatment:

Aerobic and anaerobic treatment process-comparison. Aerobic units: Activated sludge process, principles, modifications of activated sludge processes–Oxidation ponds–Trickling filters– Rotating biological contactors. Anaerobic units: UASB Reactor, principle and working.

### UNIT – V

#### Tertiary Treatment and Disposal:

Removal of Nutrients–Nitrification and Denitrification–Ion exchange–membrane processes –MF, UF, NF, RO. Disposal of sewage–Methods of disposal–Effluent Standards. Need, Scope and demand for waste water recycling.

**Text Books:**

1. Wastewater Engineering: Treatment and Resource Recovery, Metcalf & Eddy, McGraw-Hill, New York, 5<sup>th</sup> Edition. (ISBN: 13-978-0073401188).
2. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill , 2018. (ISBN: 13-978-0070495395).

**Reference Books:**

1. Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg & S.K., Khanna Publications. (ISBN:978-81-7409-230-4)
2. Environmental Engineering by D. Srinivasan, PHI Learning private Limited, New Delhi. (ISBN:13-9788120336001)
3. Elements of Environmental Engineering, K.N. Duggal, S.Chand& Company Ltd. New Delhi. (ISBN: 13-978-8121915472).
4. Wastewater Treatment for pollution control and Reuse, Soli J Areivala, Sham R Asolekar, Mc- GrawHill, New Delhi. (ISBN:9780070620995).

**Web Links:**

1. [https://web.iitd.ac.in/~arunku/files/CVL100\\_Y16/LecSep1220.pdf](https://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf)
2. <http://www.civil.iitm.ac.in/dwww/sites/default/files/presentations>
3. [https://www.researchgate.net/publication/221911472\\_Wastewater\\_Management](https://www.researchgate.net/publication/221911472_Wastewater_Management)

## Integrated Solid Waste Management for A Smart City

(EEE,ME,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501CE82**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Understand Fundamental Concepts of Solid Waste Management
- CO2:** Analyze Municipal Solid Waste Management Practices
- CO3:** Evaluate Disposal Methods and Technologies
- CO4:** Apply Knowledge of Construction and Demolition (C&D) Waste Management
- CO5:** Examine E-Waste and Hazardous Waste Management

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|------|-------|
| CO1   | 1    |      |      |      |      | 3    | 2    |      |      |      |       |
| CO2   | 1    |      |      |      |      | 3    | 2    |      |      |      |       |
| CO3   | 1    |      |      |      |      | 3    | 2    |      |      |      |       |
| CO4   | 1    |      |      |      |      | 3    | 2    |      |      |      |       |
| CO5   | 1    |      |      |      |      | 3    | 2    |      |      |      |       |

### UNIT – I

#### Introduction:

Solid Waste Management- Definition, Concept of 4Rs (reduce, reuse, recycle and recover) of waste management, Elements of a waste management system, Issues in Solid Waste Management, Integrated Waste Management Hierarchy: Source reduction, Recycling, Waste-to-Energy and Landfilling, Review of waste management under Swachh Bharat Mission and Smart Cities Program.

### UNIT – II

#### Municipal Solid Waste:

Waste Composition and Quantities, Collection, Transportation, Segregation, and Processing.

### UNIT – III

#### Disposal of Municipal Solid Waste:

Landfill, Biochemical Processes and Composting, Energy Recovery from Municipal Solid Waste, Municipal Solid Waste (MSW) Rules 2016, Current Issues in Solid Waste Management and Review of MSW Management

### UNIT – IV

#### Construction and Demolition (C&D) Waste Management:

Overview, Components; C&D Waste Management Rules 2016, Beneficial Reuse of C & D Waste Materials.

### UNIT – V

#### Electronic Waste (E-Waste) Management:

Issues and Status in India and Globally, E-Waste Management Rules 2016 and Management Challenges.

**Hazardous Wastes:**

Definition, Classification, Risk assessment, Transportation of hazardous waste, Current Management Practices: Environmental audit, Containment, Remedial alternatives.

**Text Books:**

1. Solid Waste Engineering, William A Worrell and P. Aarne Vesilind, Cengage Learning, 2<sup>nd</sup> Edition (SI Edition). (ISBN: 13-978-8131520420).
2. Integrated Solid Waste management, George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Tata McGraw Hill. (ISBN: 13-978-0070632370).

**Reference Books:**

1. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization (CPHEEO), India.
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website
3. Construction and Demolition Waste Management Rules, 2016, MoEF&CC
4. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.

**Web Links:**

1. <https://nptel.ac.in/courses/105/105/105105160/>
2. <http://swachhbharatmission.gov.in/sbmcms/index.html>
3. <http://swachhbharaturban.gov.in/>

## Watershed Management

(EEE,ME,ECE,CSE,IT,AI ML,CSE(DS), PT, Min.E.)

**Course Code: 2501CE83**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO1:** Explain the objectives and characteristics of watershed management.
- CO2:** Classify the types of soil erosion and control methods.
- CO3:** Explain different water harvesting techniques.
- CO4:** Organize the land and drought management techniques.
- CO5:** Create hydrological models

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    |      |      | 2    | 1    | 1    |      | 1    |      | 2     |       |
| CO2   | 1    |      |      | 1    | 1    | 1    |      |      |      |       |       |
| CO3   | 2    | 1    |      | 1    | 2    | 2    |      |      |      |       |       |
| CO4   | 2    | 1    | 1    | 2    | 1    | 2    |      | 1    |      | 2     |       |
| CO5   | 2    | 2    | 2    | 1    | 2    | 1    |      |      |      |       |       |

### UNIT – I

**Introduction:**

Introduction - Concept of watershed development – objectives of watershed development – need for watershed development - integrated and multidisciplinary approach for watershed management. Characteristics of Watershed: Size – shape – physiography – slope – climate – drainage – land use – vegetation – geology and soils – hydrology and hydrogeology – socio-economic characteristics – Application of artificial intelligence technology for identification of watershed characteristics.

### UNIT – II

**Principles of Erosion:** Types and causes of erosion – factors affecting erosion– estimation of soil loss due to erosion- Universal soil loss equation. Measures to Control Erosion: Contour techniques – ploughing – furrowing – trenching – bunding – terracing – gully control – check dams – rock-fill dams – brushwood dam – Gabion.

### UNIT – III

**Water Harvesting:** Techniques of rainwater harvesting – rainwater harvesting from rooftop – surface flow harvesting – subsurface flow harvesting – stop dams – farm ponds and dugout ponds – percolation tanks.

### UNIT – IV

**Land Management:** Land use and Land capability classification – management of forest – agricultural – grassland and wild land land grading operation –reclamation of saline and alkaline soils. Drought Management: Drought assessment and classification – drought analysis techniques – drought mitigation planning.

## **UNIT – V**

### **Beyond BIM - Emerging Trends**

**Watershed Modelling:** Data of watershed for modelling – application and comparison of watershed models – model calibration and validation – advances of watershed models.

#### **Text Books:**

1. Watershed Management, Das MM and M.D Saikia, PHI Learning Pvt. Ltd.(ISBN:13-978-8120346765).
2. Land and Water Management, Murthy.VVN, Kalyani Publications. (ISBN: 13-978-9327214659)

#### **Reference Books:**

1. Water Resource Engineering, Wurbs R A and James R A, Prentice Hall Publishers. (ISBN: 13-978-8120321519 ).
2. Watershed Hydrology, Black P E, Prentice Hall. (ISBN: 13-978-1575040271).
3. Watershed Management, Murthy J V S, New Age International Publishers. (ISBN:13-978-8122435184).

#### **Web Links:**

1. [https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav\\_GID=1654](https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav_GID=1654)
2. [http://agritech.tnau.ac.in/agriculture/agri\\_majorareas\\_watershed\\_watershedmgt.html](http://agritech.tnau.ac.in/agriculture/agri_majorareas_watershed_watershedmgt.html)
3. <https://yourstory.com/2017/11/watershed-management/>

## Electric Power Generation, Transmission & Distribution Systems

(CE,ME,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501EE53**

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| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Identify the different components of various power plants.
- CO2:** Analyze the performance of short, medium and long transmission lines.
- CO3:** Identify various factors related to sag and corona.
- CO4:** Distinguish between AC/ DC distribution systems and also estimate voltage drops of distribution systems.
- CO5:** Analyze the different economic factors of power generation and tariffs.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | -    | 2    | -    | -    | -    | -    | -     |
| <b>CO2</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     |
| <b>CO3</b> | 2    | 1    | 3    | -    | -    | 1    | -    | -    | -    | -    | -     |
| <b>CO4</b> | 2    | 3    | 1    | -    | -    | 1    | -    | -    | -    | -    | -     |
| <b>CO5</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     |

### UNIT – I

**Power Stations:** Principle of power generation, site selection and layout of Thermal, Nuclear, Hydro power plant, Components of Thermal and Nuclear power plant

### UNIT – II

**Performance of Transmission Lines:** Classification of Transmission Lines –Short, medium, long and their model representations –End condenser method, Nominal-T–Nominal-Pie, and A, B, C, D Constants, Surge Impedance and SIL of Long Lines.

### UNIT – III

**Corona and Sag:** Corona – Description of the phenomenon–Factors affecting corona–Critical voltages and power loss –Radio Interference. Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor

### UNIT – IV

**Distribution Systems:** Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.



## UNIT – V

**Economic Aspects of Power Generation and Tariff Methods:** Types of load, Load curve, load duration and integrated load duration curves, Important terms and factors in Load Curve. Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Characteristics and types of Tariff.

### Text Books:

1. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar &, A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd (ISBN: 978817700207).
2. Generation, Distribution & Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers (ISBN: 9789393159175).

### Reference Books:

1. Principles of Power System by V. K. Mehta & Rohit Mehta, S Chand & Company Limited, Publishers (ISBN: 9788121924962).
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi (ISBN: 978070151413).

### Web Links:

1. <https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant>
2. <https://www.euronuclear.org/1-information/energy-uses.html>
3. <https://www.slideshare.net/9anku/electrical-distribution-system>

**Electric Energy Storage Systems**  
(CE,ME,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**L      T      P      C**

**Course Code:2501EE36**

**3      0      0      3**

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO1** Analyze the characteristics of electrical energy storage technologies.
- CO2** Analyze the needs for electrical energy storage.
- CO3** Analyze the needs for electrical energy storage.
- CO4** Understand the various types of electrical energy storage systems.
- CO5** Identify various real time applications of energy storage systems.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 3    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     |

**UNIT – I**

**Electrical Energy Storage (EES) Technologies:** Characteristics of electricity, Electricity & the roles of EES, High generation cost during peak-demand periods, Need for continuous & flexible supply, Long distance between generation & consumption, Congestion in power grids, Transmission by cable.

**UNIT – II**

**Needs for Electrical Energy Storage:** Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

**UNIT – III**

**Features of Energy Storage Systems:** Classification of EES systems, Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H<sub>2</sub>), Synthetic natural gas (SNG).

**UNIT – IV**

**Types of Electrical Energy Storage systems:** Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

## UNIT – V

**Applications:** Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), New trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management & control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems & distributed generation (Virtual Power Plant), Battery SCADA aggregation of many dispersed batteries.

### Text Books:

1. Energy Storage Benefits & Market Analysis, by James M. Eyer, Joseph J. Iannucci & Garth P. Corey Sandia National Laboratories.
2. The Electrical Energy Storage by IEC Market Strategy Board.

### Reference Boks:

1. Energy Storage for the Electricity Grid: Benefits & Market Potential Assessment Guide, Jim Eyer, Garth Corey, Sandia National Laboratories.
2. Energy Storage by Mullick & Garg (ISBN: 9789027719300)

### Web Links:

1. <https://nptel.ac.in/courses/112/105/112105221/>
2. <https://nptel.ac.in/courses/112/107/112107283/>
3. <https://nptel.ac.in/content/storage2/courses/10810309>

## Electrical Safety

(CE,ME,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501EE43**

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| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
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### Course Outcomes:

**At the end of the Course, Student will be able to:**

- CO 1:** Describe electrical hazards & safety equipment.
- CO 2:** Analyze & apply various grounding & bonding techniques
- CO 3:** Select appropriate safety method for low, medium equipment's & high voltage equipment.
- CO 4:** Participate in a safety team & Carry out proper maintenance of electrical equipment by understanding various standards.
- CO 5:** Analyze the safety method for high voltage equipment's.

### Mapping of course outcomes with program outcomes:

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

### UNIT-I:

**Hazards of Electricity & Electrical Safety Equipment:** Primary & secondary hazards- arc, blast, shocks causes & effects-safety equipment flash & thermal protection, head & eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers & signs, safety tags, locking devices-voltage measuring instruments- proximity & contact testers-safety electrical one line diagram-electrician's safety kit.

### UNIT-II:

**Grounding of Electrical Systems & Equipment:** General requirements for grounding & bonding-definitions grounding of electrical equipment-bonding of electrically conducting materials & other equipment connection of grounding & bonding equipment- system grounding- purpose of system grounding-grounding electrode system- grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment- grounding of low voltage & high voltage systems.

**UNIT-III:**

**Safety Procedures & Methods:** The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation & approach distances-calculating the required level of arc protection-safety equipment, procedure for low, medium & high voltage systems- the one-minute safety audit

**UNIT-IV:**

**Safety Management & Organizing Structure:** Electrical safety program structure, development-company safety team- safety policy program implementation- employee electrical safety teams-safety meetings- safety audit accident prevention- first aid- rescue techniques-accident investigation.

**UNIT-V:**

**Electrical Maintenance & Legal Safety Requirements & Standards:** Safety related case for electrical maintenance- reliability centred maintenance (RCM) - eight step maintenance program-frequency of maintenance- maintenance requirement for specific equipment & location- regulatory bodies- national electrical safety code standard for electrical safety in work place- occupational safety & health administration standards, Indian Electricity Acts related to Electrical Safety

**Text Books:**

1. 'Electrical Safety Handbook' by John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, McGraw-Hill Education, 4<sup>th</sup> Edition (ISBN: 978071745130)
2. "Electric Safety Practice & Standards", Khaled Ismail, CRC Press, Taylor & Francis (ISBN: 9781138073999).

**Reference Books**

1. 'Electrical Safety- a guide to the causes & prevention of electric hazards', Maxwell Adams.J, The Institution of Electric Engineers, IET (ISBN: 9780852968062).
2. 'Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones & Bartlett Learning (ISBN: 9780877655800).

**Web Links:**

1. <http://nptel.ac.in/courses/103106071/5>
2. <https://www.electricalsafetyfirst.org.uk>

## Hybrid & Electric Vehicles

(CE,ECE,CSE,IT,AI ML,CSE(DS), PT, Min.E.)

|                             |          |          |          |          |
|-----------------------------|----------|----------|----------|----------|
|                             | L        | T        | P        | C        |
| <b>Course Code:2501EE54</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Describe the History of Hybrid Electric vehicles
- CO2:** Classify the various electric drivetrain topologies
- CO3:** Articulate the Energy Storage Requirements in Hybrid & Electric Vehicles
- CO4:** Illustrate the Charging Infrastructure
- CO5:** Evaluate Energy Management Strategies used in hybrid & electric vehicle

### Mapping of Course Outcomes with Program Outcomes:

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

### UNIT – I

#### Introduction:

Introduction to Hybrid Electric Vehicles: History of hybrid & electric vehicles, social & environmental importance of hybrid & electric vehicles, impact of modern drive-trains on energy supplies-Challenges & Key Technologies of EVs – Challenges for EV Industry in India

### UNIT – II

#### Electric Drive-trains:

Basic concept of electric traction - introduction to various electric drivetrain topologies - Power flow control in electric drive-train topologies - fuel efficiency analysis

#### Electric Propulsion unit:

Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC Motor drives, configuration and control of Induction Motor drives, configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency

### UNIT – III

#### Energy Storage:

Introduction to Energy Storage Requirements in Hybrid & Electric Vehicles -Battery based energy storage & its analysis - Fuel Cell based energy storage & its analysis - Super Capacitor based energy storage- Flywheel based energy storage & its analysis.

## **UNIT – IV**

### **Sizing the drive system:**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

## **UNIT – V**

### **Energy Management Strategies**

Introduction to Energy Management Strategies used in hybrid & electric vehicle, Classification of different Energy Management strategies - Comparison of different Energy Management Strategies - Implementation issues of energy strategies - Effect of charging infrastructure on grid protection & control.

### **Text Books:**

1. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley-Blackwell (ISBN: 9781119942733).
2. Energy Management Strategies for Electric & Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer (ISBN: 9781493955237).

### **Reference Books:**

1. Electric Vehicle Battery Systems, Sandeep Dhameja, Elsevier (ISBN: 9780750699167).
2. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press (ISBN: 9781138072855).
3. Hybrid electric Vehicles Principles & applications with practical perspectives, Chris Mi, M. Abul Masrur, D. Wenzhong Gao, A Dearborn, John Wiley & Sons Ltd (ISBN: 9781118970560).

## Solar Energy Systems

(CE,EEE,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501ME37**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the concept of solar radiation and its measurement
- CO2:** Describe the working principle of different types of collectors and its types
- CO3:** Explain the various solar thermal energy technologies and their applications
- CO4:** Analyze the various solar PV cell materials and conversion techniques.
- CO5:** Apply solar passive building techniques for cooling and heating applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 2    | 1    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 2    | 1    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 2    | 1    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 2    | 1    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |

### UNIT – I

**Solar Radiation and its measurement:** Solar angles, Sun path diagrams, Radiation, extra terrestrial characteristics, Solar energy measuring instruments: Pyranometer, Pyrliometer, Sunshine recorder. Estimation of average solar radiation and estimation on horizontal and tilted surfaces

### UNIT – II

**Solar Collectors for Industrial process heat:** Flat plate collector, Materials for flat plate collector and their properties, classification, evacuated tubular collectors, concentrator collectors, tracking systems, compound parabolic concentrators, parabolic trough concentrators, concentrators with point focus, Heliostats.

### UNIT – III

**Solar Thermal Technologies:** Working principle, types, design, and operation, Solar heating and cooling systems, Thermal Energy storage systems, Solar Desalination, Solar cooker, Solar Pond, Solar drying, Solar chimney, Solar water disinfection (SODIS), Solar furnaces.



#### **UNIT – IV**

**Solar Cells:** Semiconductor materials, Doping, PN junction and characteristics, Photovoltaic effect, Photovoltaic material, Parameters of solar cells, Effects of cell temperature on cell efficiency, Types of solar cells, Solar modules and arrays, Solar cell power plant, Silicon, thin film and polymer processing, Silicon wafer based solar cells, Hybrid organic- inorganic solar cells.

#### **UNIT – V**

**Solar Passive Architecture:** Thermal comfort, bioclimatic classification. Passive heating concepts: direct heat gain, indirect heat gain, isolated gain and sunspaces  
Passive cooling concepts: evaporative cooling, Radiative cooling, shading - paints and cavity walls for cooling, roof radiation traps, thermal comfort.

#### **Text Books:**

1. Solar Energy-Principles of Thermal Collection and Storage, S P Sukhatme & J K Nayak, McGraw Hill Education, 3<sup>rd</sup> Edition, 2009, ISBN : 9780070142961.
2. Principles of Solar Engineering, D.Yogi Goswami, Frank Kreith and Jan F. Kreider Taylor and Francis, 2<sup>nd</sup> Edition, 2000, ISBN : 9781560327141.

#### **Reference Books:**

1. Solar Energy- Fundamentals, Design, Modelling and Applications, G.N.Tiwari, Narosa publishing house. 1<sup>st</sup> Edition, 2002, ISBN : 9780849325093.
2. Solar Energy and Non-conventional Energy Sources, Domkundwar, Dhanpat Rai & Co, (P) Ltd., 2<sup>nd</sup> Edition, ASIN : B0BQWR83GF

#### **Web Links:**

1. <https://archive.nptel.ac.in/courses/115/103/115103123/>
2. <https://www.nrel.gov/research/re-solar.html>

## Industry 5.0 for Engineers

(CE,EEE,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501ME58**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain the basic concept of Industry 5.0.
- CO2:** Explain the concepts of Industrial IOT, IOS and Predictive Analytics
- CO3:** Explain the cyber physical systems and AI technologies
- CO4:** Analyse the applications of Industry 5.0 in various sectors
- CO5:** Analyse case studies on automation and healthcare services

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 1    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     |
| <b>CO2</b> | 1    | 1    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     |
| <b>CO3</b> | 1    | 1    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     |
| <b>CO4</b> | 1    | 3    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     |
| <b>CO5</b> | 1    | 3    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     |

### UNIT – I

**Introduction to Industry 5.0:** Introduction of Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 5.0, Comparison of Industry 5.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Automation and Transformation Processes.

### UNIT – II

**Importance of Internet of Things (IOTs):** Introduction to Internet of Things (IoT), Industrial Internet of Things (IIoT), Internet of Services, Fundamental of Predictive Analytics, Smart Logistics, Smart Devices and Products.

### UNIT – III

**Technology Evolution:** Basics of cyber Physical Systems, Process Automations and Collaborative robots, Fundamental to artificial Intelligence, Mobile Computing, Cyber Security, Ethical technology, Responsive and distributed supply chain system, Human-centric and Value-oriented approaches.

#### **UNIT – IV**

**Technology Implementation and Case Studies:** 3D printing, Solar energy sector, Healthcare sector, Maintain records related to education, finance, clean bioenergy generation and Intelligent NextG Wireless Networks.

#### **UNIT – V**

**Case studies on CNC/NC automation** - Benefits, challenges, and industry applications. In-house, Healthcare services-Examples of innovations improving patient care and operational efficiency.

#### **Text Books:**

1. Uthayan Elangovan, Industry 5.0, “The Future of the Industrial Economy”, First Edition, Taylor & Francis, ISBN: 978-1-032-04127-8, 2022.
2. Alessandro Massaro, “Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances”, Wiley-IEEE Press, 2021, ISBN: 2021028944.

#### **Reference Books:**

1. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2016.
2. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
3. Hans Bernhard Kief, Helmut Roschiwal, Karsten Schwarz, “The CNC Handbook: Digital Manufacturing and Automation from CNC to Industry 4.0”, Industrial Press Inc., U.S. ISBN 0831136367, Nov 2021.
4. Janya Chanchaichujit, Albert Tan, Fanwen Meng, Sarayoot Eaimkhong, “Healthcare 4.0 Next Generation Processes with the Latest Technologies”, Palgrave Pivot, 2019, ISBN 978-981-13-8113-3.

#### **Web Links:**

1. <http://www.mqtt.org/>
2. <https://opcfoundation.org/about/opc-technologies/opc-ua/>
3. <https://www.ethernetcat.org/default.htm>

## Organizational Behaviour

(CE,EEE,ECE,CSE,IT,AIIML,CSE(DS), PT, Min.E.)

**Course Code: 2501ME73**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>P</b> | <b>T</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Explain the roles, approaches of organizational behaviour models.
- CO2:** Summarize the behaviour of individuals and groups in organizations in terms of organizational behaviour.
- CO3:** Illustrate various stress and emotional organizational behaviour concepts, models and theories to real life management situations.
- CO4:** Analyze the functions of organizational communication and culture for effective communication and managing cultural diversity
- CO5:** Organize different groups and teams in the organization for better results.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | -    | -    | -    | -    | -    | -    | 1    | 3    | 2    | -     | -     |
| <b>CO2</b> | -    | -    | -    | -    | -    | -    | 1    | 3    | 2    | -     | -     |
| <b>CO3</b> | -    | -    | -    | -    | -    | -    | 1    | 2    | 3    | -     | -     |
| <b>CO4</b> | -    | -    | -    | -    | -    | -    | 1    | 2    | 3    | -     | -     |
| <b>CO5</b> | -    | -    | -    | -    | -    | -    | 1    | 3    | 2    | -     | -     |

### UNIT – I

**Organizational Behaviour:** Concept of Organizational Behaviour (OB)- Importance of Organizational Behaviour- Key Elements of Organizational Behaviour, Role of Managers in OB- Interpersonal Roles-Informational Roles- Decisional Roles, Approaches to Organizational Behaviour

### UNIT – II

**Interpersonal Behaviour:** Nature and meaning of Interpersonal Behaviour, Concept of Self, Transaction Analysis (TA), Benefits and uses of Transactional Analysis, Johari Window Model

**Personality:** Definition and Meaning of Personality - Importance of Personality, Determinants of Personality, Theories of Personality, Personality Traits Influencing OB.

### UNIT – III

**Emotions:** Nature and Meaning of Emotions - Characteristics of Emotions, Theories of Emotions, Emotions in the Context of OB. **Organizational Stress:** Definition and Meaning, Sources of Stress, Types of Stress, Impact of Stress on Organizations, Stress Management Techniques.

### UNIT – IV

**Organizational Communication:** Meaning and Importance of Communication, Functions, process, types, Interpersonal Communication, Organizational Communication, Tips for Effective Communication.

**Organization Culture:** Meaning and Nature of Organization Culture – Origin of Organization Culture, Functions of Organization Culture, Types of Culture, Creating and Maintaining Organization Culture, Managing Cultural Diversity

## **UNIT – V**

**Groups and Teams:** Meaning and Importance of Groups, Reasons for Group Formation, Types of Groups, Stages of Group Development, Meaning and Importance of Teams, Types of Teams, Creating an Effective Team.

### **Text Books:**

1. Organizational Behaviour, K. Ashwathappa, Himalaya Publishing House, ISBN-13. 978-8184889390.
2. Management and Organizational Behaviour - (Text and Cases), Dr.P.Subba Rao and Prof. N.Sambasiva Rao, Himalaya Publishing House, Mumbai, ISBN: 978-93-5025-951-2.

### **Reference Books:**

1. Understanding Organisational Behaviour, Udai Pareek, Oxford Higher Education, 2nd Edition, ISBN-13: 978-0195690866
2. Mc Shane & Von Glinov, Organisational Behaviour, Tata McGraw Hill, 4th Edition, ISBN-13, 978-1259927676.

### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc20\\_mg51/preview](https://onlinecourses.nptel.ac.in/noc20_mg51/preview)
2. <https://www.udemy.com/course/organisational-behaviour/>

**Sustainable Energy Systems**  
(CE,EEE,ECE,CSE,IT,AI ML,CSE(DS), PT, Min.E.)

**Course Code: 2501ME36**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO1:** Demonstrate the various components of solar thermal energy systems.
- CO2:** Describe the working of Wind turbines.
- CO3:** Explain the principle and working of Biomass and Geothermal Energy systems
- CO4:** Explain the Ocean, Tidal, Wave and hydro energy conversion systems.
- CO5:** Illustrate working of hybrid energy systems.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| CO2   | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |

**UNIT – I**

**Introduction to Renewable energy sources:** Energy demand and availability, energy crisis, renewable and non-renewable energy resources, environmental impact of conventional energy usage.

**Solar Energy:** Overview of the fundamental physics of solar radiation. Solar energy collectors.

**Solar energy storage:** Stratified storage, well mixed storage, comparison, Hot water system, solar ponds, non-convective solar pond, extraction of thermal energy and application of solar ponds.

Solar PV systems and its applications. Solar cell, module, and array.

**UNIT – II**

**Wind Energy:** Wind data and energy estimation – Betz limit - Site selection for windfarms. Horizontal and vertical axis wind mills, Wind farms- offshore, Onshore, various methods of control, and Environmental issues – Applications.

**UNIT – III**

**Biomass:** Bio-resources, Conversion process, Biomass gasifier - Types of biomass gasifiers, Biodiesel production – Ethanol production -Applications.

**Geothermal Energy:** Origin and types of geothermal energy and utilisation, Power generation from Geothermal energy, Environmental impact.

**UNIT – IV**

**Ocean, Wave & Tidal Energy:** Introduction - Resource Assessment - Power generation through OTEC systems. Wave and Tidal energy- Working principle, Availability, and energy conversion systems.

**Mini & Micro Hydropower:** Introduction, Power from water, System components of Mini and Micro Hydropower, Micro Hydropower plant in India, Potential Hydropower plant projects identified in India.

## **UNIT – V**

**Hybrid Energy Systems:** Systems for processes and power applications – solar – wind – Biomass hybrid technologies

**Fuel cell:** Working principle- types - construction and applications. Solar – Fuel cell hybrid systems.

### **Text Books:**

1. Renewable Energy: Power for a Sustainable Future, Boyle, G, Oxford University Press, 3<sup>rd</sup> Edition, 2012, ISBN : 9780199681273.
2. Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers, 6<sup>th</sup> edition, ISBN : 9788174090737.

### **Reference Books:**

1. Renewable Energy Resources, John Twidell, Tony Weir, and Anthony D. Weir, Taylor & Francis, 3<sup>rd</sup> edition, 2015, ISBN : 9780415584388.
2. Non-Conventional Energy Resources, B H Khan, TMH Publishers, 3<sup>rd</sup> Edition, 2017, ISBN : 9789352601882.

### **Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc22\\_ch27/preview](https://onlinecourses.nptel.ac.in/noc22_ch27/preview)
2. <https://www.energy.gov/eere/renewable-energy>

**Biomedical Electronics**  
(CE,EEE,ME,CSE,IT,DS,AIIML,PT,Min.E, Ag.E)

**Course Code: 2501EC97**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, students will be able to:**

- CO1:** Understand the basic medical instrumentation system and bioelectric potentials.
- CO2:** Illustrate different types of electrodes to acquire bio-signals.
- CO3:** Demonstrate clinical laboratory measurements and assistive devices.
- CO4:** Discuss the latest developments in medical imaging systems.
- CO5:** Outline patient care and safety while using biomedical equipment.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    |      |      | 1    |      |      |      |      |       |       |
| CO2   | 3    | 3    | 1    | 2    | 2    |      |      |      |      |       |       |
| CO3   | 3    | 3    | 2    | 2    | 2    |      |      |      |      |       |       |
| CO4   | 3    | 2    | 2    | 2    | 3    |      |      |      |      |       |       |
| CO5   | 3    | 3    | 1    | 2    | 2    |      |      |      |      |       |       |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    |      |
| CO2    | 2    |      |
| CO3    | 2    |      |
| CO4    | 2    |      |
| CO5    | 2    |      |

## UNIT – I

### Components of Medical Instrumentation Systems

Basic Medical Instrumentation System, Static and dynamic characteristics of medical instruments, Bio-signals and characteristics. Problems encountered with measurements from human beings. Sources of Bioelectric Potentials, Resting and Action Potentials.

## UNIT – II

### Bio-Potential Electrodes and Physiological Transducers:

Electrode potential and its equivalent circuit, Types of Electrodes: Surface Electrodes, Needle Electrodes, Micro Electrodes. Biochemical Transducers.

### Bio-Signal Acquisition:

Electrical Conduction system of the heart, Electrocardiogram, ECG leads, Einthoven triangle, Plethysmography, EEG 10-20 lead system and EMG. basics of biomedical signal acquisition, common signal artifacts and simple noise reduction techniques.



### UNIT – III

#### **Clinical laboratory Measurements:**

Blood cell Counter, Blood flow meters- Electromagnetic blood flow meter, Ultrasonic Doppler blood flow meter, automated blood pressure measurements.

#### **Physiological Assist Devices & Therapeutic Equipment:**

Pacemakers - External & internal, Defibrillators- External & internal, Hemodialysis machine.

### UNIT – IV

#### **Monitory and Imaging Equipment:**

Spirometry, Ventilators, Arrhythmia Monitor, Foetal Monitor and Incubator. X-ray machine, Computed Tomography (CT), Magnetic Resonance Imaging System, Ultrasound Imaging system.

### UNIT – V

#### **Patient Care and Safety:**

The elements of Intensive Care Monitor, Diagnosis, Calibration and reparability of Patient Monitoring equipment, Shock Hazards and Prevention, Physiological Effects and Electrical Current, Shock Hazards from Electrical Equipment, Methods of Accident Prevention, and Isolated Power Distribution System.

#### **Text Books:**

1. Leslie Cromwell, F.J. Weibell, E.A. Pfeiffer, *Biomedical Instrumentation and Measurements*.  
2nd Edition, PHI, 2004.
2. Dr. M. Arumugam, *Biomedical Instrumentation*. 2nd Edition, Anuradha publications, 2002.

#### **Reference Books:**

1. R.S. Khandpur, *Hand-book of Biomedical Instrumentation*. 2nd Edition, TMH, 2003.
2. John G. Webster, *Medical Instrumentation, Application and Design*. John Wiley, 3rd Edition, 2009.
3. Onkar N. Pandey, Rakesh Kumar, *Bio-Medical Electronics and Instrumentation*. 3rd Edition, Katson Books, 2002.

#### **Web Links:**

- 1 [https://onlinecourses.nptel.ac.in/e-learning/preview/noc25\\_bt49](https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_bt49).
- 2 [https://www.youtube.com/watch?v=Qq3t01LytU&list=PLnsf\\_0i\\_t0FC4EdRdhLwjQgp5cYytJ5Oe](https://www.youtube.com/watch?v=Qq3t01LytU&list=PLnsf_0i_t0FC4EdRdhLwjQgp5cYytJ5Oe).

**Fundamentals of Wireless Communications**  
(CE,EEE,ME,CSE,IT,DS,AIIML,PT,Min.E, Ag.E)

**Course Code:2501EC98**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:**

**At the end of the course, student will be able to:**

- CO1:** Explain the fundamentals of wireless communication systems, spectrum allocation, and wireless standards.
- CO2:** Understand Analog ,digital and multicarrier OFDM modulation techinques.
- CO3:** Compare multiple access techniques used in wireless communication systems.
- CO4:** Explain the architecture and standards of WPAN, WLAN, and WMAN technologies.
- CO5:** Compare cellular generations and LTE network architecture for modern mobile communications.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 2    |      |      |      |      |      |      |      |       | 1     |
| <b>CO2</b> | 3    | 3    | 2    | 1    | 1    |      |      |      |      |       | 2     |
| <b>CO3</b> | 3    | 3    | 2    |      |      |      |      |      |      |       | 1     |
| <b>CO4</b> | 3    | 2    | 1    | 1    | 1    |      |      |      |      |       | 1     |
| <b>CO5</b> | 3    | 3    | 2    | 2    | 1    |      |      |      |      |       | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

**UNIT – I**

**Overview of Wireless Communication:**

History of wireless communication, Current Wireless Systems: Cellular Telephone Systems, Generations, Cordless Phones, Wireless LANs, Wide Area Wireless Data Services, Broadband Wireless Access, Paging systems, Satellite Networks, Bluetooth, ZigBee, Ultra-wideband Radios. The Wireless Spectrum: Methods for Spectrum Allocation, Spectrum Allocations for Existing Systems, Standards.

**UNIT – II**

**Modulation for Wireless Communication:**

Need for Modulation, Analog Modulation, Amplitude modulation, Double sideband Supressed carrier, single sideband supressed carrier, Angle modulation, Digital modulation: Amplitude Shift Keying, Frequency Shift Keying Techniques, Phase-Shift Keying Techniques,BPSK and QPSK. Multicarrier-Modulation, Orthogonal Frequency Division Multiplexing.

### **UNIT – III**

#### **Multiple Access Techniques:**

Contention-free multiple access schemes, Frequency-Division Multiple Access (FDMA), Time-Division Multiple Access (TDMA), Code-Division Multiple Access (CDMA), Space-division, contention-based multiple access schemes (ALOHA and CSMA).

### **UNIT – IV**

#### **Wireless Personal Area Networks:**

Bluetooth, UWB and ZigBee, wireless local area networks (IEEE 802.11, network architecture, medium access methods, WLAN standards), wireless metropolitan area networks (WiMAX).

### **UNIT – V**

#### **Wireless Mobile Networks and Applications:**

Principles of Cellular Networks, First- Generation Analog, Second- Generation TDMA, CDMA, Third- Generation Systems, Fourth Generation Systems, LTE Architecture, Evolved Packet Core, LTE Resource Management.

#### **Text Books:**

1. Wireless communications- Goldsmith Andrea, Cambridge university press, 2005, ISBN: 9780511841224.
2. Wireless communication networks and systems-Cory Beard, and William Stallings, Pearson education (Global Edition), 2015, ISBN: 978-1292108728

#### **Reference Books:**

1. Wireless Communication the Fundamental and Advanced Concepts-Sanjay Kumar River Publishers, Denmark, 2015 ISBN: 9781000795325
2. Wireless communications: Principles and Practice, 2nd Edition, Theodore S. Rappaport, Pearson education, 2010.
3. Fundamentals of wireless communication.- Tse, David, and Pramod Viswanath. Cambridge university press, 2005.

#### **Web Links:**

1. <https://nptel.ac.in/courses/106106167> by Prof. David Koilpillai, IIT Madras
2. <https://nptel.ac.in/courses/117104115> by Aditya K. Jagannatham, IIT Kanpur

## Principles Of Embedded Systems

(CE,EEE,ME,CSE,IT,DS,AIIML,PT,Min.E, Ag.E)

**Course Code: 2501EC99**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1:** Summarize the building blocks of an embedded system.
- CO2:** Interpret the hardware modules required to design an embedded system.
- CO3:** Infer the firmware design approaches for an embedded system.
- CO4:** Illustrate the hardware integration with firmware.
- CO5:** Outline the process of embedded system development and choose the tools for embedded system implementation and testing.

**Mapping of Course Outcomes with Program Outcomes:**

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

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      |      |
| <b>CO2</b> |      |      |
| <b>CO3</b> |      |      |
| <b>CO4</b> |      |      |
| <b>CO5</b> |      |      |

### UNIT – I

Introduction: Embedded system-Definition, History of Embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system, core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.

### UNIT – II

Embedded Hardware Design: Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, multi processors architectures.

### **UNIT – III**

Embedded Firmware Design: Embedded Firmware design approaches, Embedded Firmware development languages, Interrupt sources, ISR concept, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C.

### **UNIT – IV**

RealTime Operating System: Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.

Hardware Software Co-Design:

Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

### **UNIT – V**

Embedded System Development: The integrated development environment, Types of files generated on cross-compilation, Deassembler/Decompiler, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools. Embedded System Implementation and Testing: The main software utility tool, CAD and the hardware, Translation tools-Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on host machine.

#### **Text Books:**

1. Introduction to Embedded Systems, Shibu.K.V, Tata McGraw Hill Education Private Limited, 2nd Edition, 2016.
2. Embedded Systems – SoC, IoT, AI and Real-Time Systems, Raj Kamal, McGraw Hill Education India 4th Edition, 2020.

#### **Reference Books:**

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, 2013.
2. Hardware Software Co-Design Principles and Practice, J.Staunstrup, Springer Publications, 2013
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 3rd Edition, 2013.

#### **Web Links:**

1. <https://www.coursera.org/learn/introduction-embedded-systems>
2. <https://www.linkedin.com/learning/introduction-to-embedded-systems-with-rust>
3. <https://www.udemy.com/course/embedded-systems-and-microcontrollers/>

**Electronics For Health Care**  
(CE,EEE,ME,CSE,IT,DS,AIIML,PT,Min.E, Ag.E)

|                              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|------------------------------|----------|----------|----------|----------|
| <b>Course Code: 2501ECA0</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**At the end of the course, student will be able to:**

**CO1:** Know about health care data and its conversion to information and to knowledge.

**CO2:** Acquire knowledge on (Electronic Health Records) EHRs and their Implementation.

**CO3:** Understand the working of electronic devices used for the patient monitoring.

**CO4:** Know the concepts of Telemedicine and therapeutic devices used inside the human body.

**CO5:** Understand and analyse the working principles, design, and clinical applications of therapeutic devices.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    | -    | 1    | -    | -    | -    | -    | 1    | -     | 1     |
| <b>CO2</b> | 1    | 1    | -    | 1    | -    | -    | -    | -    | 1    | -     | 1     |
| <b>CO3</b> | 1    | 1    | -    | 1    | -    | -    | -    | -    | 1    | -     | 1     |
| <b>CO4</b> | 1    | 1    | -    | 1    | -    | -    | -    | -    | 1    | -     | 1     |
| <b>CO5</b> | 1    | 1    | -    | 1    | -    | -    | -    | -    | 1    | -     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 2    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

**UNIT-I:**

Health care data, Information and Knowledge: Definitions and Concepts, Converting Data to Information to Knowledge, Clinical Data Warehouses, what makes Health Informatics Difficult, Why Health IT fails Sometimes, Terminology of Analytics, Challenges to Data Analytics, Research and application of analytics, Role of Informatics in analytics.

**UNIT-II:**

Electronic Health Records: Introduction, Need for Electronic Health Records, Institute of Medicine's Vision for EHRs, Electronic Health Record Key Component, Electronic Prescribing, Electronic Health Record Adoption, Electronic Health Record Adoption and Meaningful use Challenges, Electronic Health Record Examples, Logical Steps to Selecting and Implementing an HER.

**UNIT-III:**

Patient Monitoring Systems: System Concepts, Cardiac Monitor, Bedside Patient Monitoring Systems, Central Monitors, Measurement of Heart Rate, Measurement of Pulse Rate, Blood Pressure Measurement, Measurement of Temperature, Measurement of Respiration Rate, Catheterization Laboratory Instrumentation.

**UNIT-IV:**

Biomedical Telemetry and Telemedicine: Wireless Telemetry, Single Channel Telemetry Systems, Multi-channel Wireless Telemetry Systems, Multi-patient Telemetry, Implantable Telemetry Systems, Transmission of Analog Physiological Signals, Over Telephone, Telemedicine.

**UNIT-V:**

Therapeutic Devices: Need for Cardiac Pacemaker, Implantable Pacemakers, DC Defibrillator, Electronics in the Anaesthetic Machine.

**Text Books:**

1. Robret E. Hoyt MD FACP “Health Informatics” sixth edition 2007.
2. R. S. Kandpur “Biomedical Instrumentation Technology and Applications” second edition  
Tata McGraw-Hill.

**Reference Books:**

1. Edward H. Shortliffe, James J.Cimino “Biomedical Informatics, Computer applications in  
Health care and Biomedicine” third edition Springer.
2. G.V.R.K. Acharyulu, Bhimaraya Metri, L. Kalyan Viswanath REDDY “Health care and  
Hospital Management Contemporary Issues and Strategies”.

**Web Links:**

1. [https://onlinecourses.nptel.ac.in/e-learning/preview/noc26\\_ge25](https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ge25).
2. [https://onlinecourses.nptel.ac.in/e-learning/preview/noc26\\_hs82](https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_hs82).
3. [https://onlinecourses.nptel.ac.in/e-learning/preview/noc26\\_bt09](https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt09).

## Basics of VLSI Design

(CE,EEE,ME,CSE,IT,DS,AIML,PT,Min.E, Ag.E)

**Course Code: 2501ECA1**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1:** Outline the fundamental concepts related to MOS and Bi-CMOS Circuits fabrication.
- CO2:** Analyze the electrical properties of MOS and Bi-CMOS Circuits.
- CO3:** Make use of design rules for developing stick and layout diagrams.
- CO4:** Interpret the issues related to subsystem design.
- CO5:** Interpret FPGA and ASIC design approaches for semi-custom design.

**Mapping of Course Outcomes with Program Outcomes:**

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

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    |      |      |
| CO2    |      |      |
| CO3    |      |      |
| CO4    |      |      |
| CO5    |      |      |

### UNIT – I

**Introduction:** Introduction to IC Technology, MOS and related VLSI Technology, Basic MOS Transistors, Enhancement and Depletion modes of transistor action, IC production process, MOS and CMOS Fabrication processes, Bi-CMOS Technology, Comparison between CMOS and Bipolar technologies.

### UNIT – II

**Basic Electrical Properties of MOS and Bi-CMOS Circuits:**  $I_{ds}$  versus  $V_{ds}$  Relationships, Threshold Voltage, MOS transistor Trans-conductance, Output Conductance and Figure of Merit, The Pass transistor, NMOS Inverter, Alternative forms of the pull-up, The CMOS Inverter, Bi- CMOS Inverter, Transistor switches, Schematics of Inverter, NAND, NOR gates using NMOS, PMOS, and CMOS technologies.



### UNIT – III

**MOS Circuit Design Processes:** MOS Layers, Design Rules, General observations of design rules, 2 $\mu$ m Double Metal, Double Poly, CMOS rules, 1.2 $\mu$ m Double Metal, Double Poly CMOS rules, Stick Diagrams, Layout Diagrams of NAND and NOR gates and CMOS inverter.

### UNIT – IV

**Basic Circuit Concepts:** Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, The Delay Unit, Inverter Delays, Propagation Delays, Wiring Capacitances.

### UNIT – V

**IC Design:** PLAs, PLDs, FPGA, ASIC, Selection of an Appropriate Integrated Circuit.

**FPGA Design Process:** Architectures of Popular FPGAs, Choosing an FPGA, FPGA Design Process, FPGA Families of Different Vendors, FPGA Design Examples.

#### Text Books:

1. Essentials of VLSI Circuits and Systems by Kamran Eshraghian, Douglas and A. Pucknell, Sholeh Eshraghian, Prentice-Hall of India Private Limited, ISBN: 978-8120327726
2. VLSI Design, Black Book by Dr. K.V.K.K. Prasad, Kattula Shyamala, Kogent Learning Solutions Inc, ISBN: 978-9350048047

#### Reference Books:

1. CMOS Digital Integrated Circuits Analysis & Design, Sung-Mo (Steve) Kang, Yusuf Leblebici, Tata McGraw-Hill, 3rd Edition, ISBN: 978-0072460537
2. Modern VLSI Design-Wolf Wayne, Pearson Edition, 3rd Edition, ISBN: 978-0130619709
3. VLSI Design, K. LalKishore, V.S.V.Prabhakar, I.K. International Publishing House Private Limited, 1st Edition, ISBN: 978-9380026671

#### Web Links:

1. NPTEL – VLSI Physical Design- <https://nptel.ac.in/courses/106105161>
2. NPTEL – Advanced VLSI Design <https://nptel.ac.in/courses/117/101/117101004>.

## System on Chip Design

(CE,EEE,ME,CSE,IT,DS,AI ML,PT,Min.E, Ag.E)

**Course Code: 2501ECA2**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course student will be able to:**

- CO1:** Explain all the building blocks of SoC.
- CO2:** Classify the concept of processors and instruction handling.
- CO3:** Analyze vector, VLIW and superscalar processors.
- CO4:** Develop a Memory as part of SoC.
- CO5:** Illustrate the concepts of interconnect optimization and configuration in SoC.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO2</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO3</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO4</b> | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | 1     |
| <b>CO5</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

### UNIT – I

#### Introduction to the System Approach:

System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

### UNIT – II

#### Processors:

Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers:minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

## **UNIT – III**

### **Memory Design for SOC:**

Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor – memory interaction.

## **UNIT – IV**

### **Interconnect Customization:**

Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor.

## **UNIT – V**

### **Interconnect Configuration:**

Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism.

### **Text Books:**

1. Computer System Design System-on-Chip, Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd, ISBN: 978-0470643365.
2. ARM System on Chip Architecture, Steve Furber, Addison Wesley Professional, 2<sup>nd</sup> Edition, ISBN : 9780201675191 .

### **Reference Books:**

1. Design of System on a Chip: Devices and Components, Ricardo Reis, Springer 1<sup>st</sup> Edition, ISBN: 978-1441954541.
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), Jason Andrews, Newnes, BK and CDROM, ISBN: 978-0750677301.
3. System on Chip Verification–Methodologies and Techniques, Prakash Rashinkar, Peter Paterson and Leena Singh L, Kluwer Academic Publishers, ISBN: 978-0792372790.

### **Web Links:**

1. <https://www.peterindia.net/System-On-ChipLinks.html>
2. <https://www.ieee-socc.org/>
3. <http://nptel.ac.in/courses/108102045/10> (Prof. Santanu Chaudhary, IIT Delhi)

## Introduction to Quantum Computing

(CE,EEE,ME,CSE,IT,DS,AI/ML,PT,Min.E, Ag.E)

|                              |          |          |          |          |
|------------------------------|----------|----------|----------|----------|
|                              | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 2501ECA3</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Understand the fundamentals of quantum computing and qubits.
- CO2:** Build simple quantum circuits.
- CO3:** Analyze quantum circuits and algorithms.
- CO4:** Identify different quantum hardware technologies and their challenges.
- CO5:** Outline real time applications of quantum computing in various fields

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    |      |      |      |      | 2    |      |      |      |       |       |
| <b>CO2</b> | 2    | 2    |      |      | 3    |      | 2    | 1    |      | 1     | 2     |
| <b>CO3</b> | 2    |      | 1    |      |      | 2    | 2    | 1    |      | 2     | 2     |
| <b>CO4</b> | 2    | 2    | 3    |      |      | 2    | 2    | 2    |      | 2     |       |
| <b>CO5</b> | 3    | 3    | 3    | 2    |      | 2    | 2    | 3    |      | 2     |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    |      |
| <b>CO2</b> | 2    |      |
| <b>CO3</b> | 2    |      |
| <b>CO4</b> | 2    |      |
| <b>CO5</b> | 2    |      |

### UNIT – I

#### Fundamentals of Quantum Computing:

Evolution from Classical Computing to Quantum Computing, Need for Quantum Computing, Classical Bits vs Qubits, Principles of Quantum Mechanics for Computing, Superposition and Measurement, Quantum States and Bloch Sphere Representation, Introduction to Quantum Gates, Quantum Computing Platforms and Ecosystem.

### UNIT – II

#### Quantum Circuits and Computing Concepts:

Quantum Circuit Model, Single Qubit and Multi-Qubit Systems, Common Quantum Gates: Pauli, Hadamard, Phase, CNOT, Quantum Entanglement, Quantum Parallelism, Quantum

Teleportation (Conceptual Understanding), Basic Quantum Circuit Design, Introduction to Quantum Simulators.

### **UNIT – III**

#### **Quantum Algorithms:**

Introduction to Quantum Algorithms, Deutsch–Jozsa Algorithm, Grover’s Search Algorithm, Shor’s Factorization Algorithm (Overview), Quantum Fourier Transform (Basic Idea), Quantum Speedup and Computational Advantage, Hybrid Quantum-Classical Computing, Introduction to Quantum Machine Learning.

### **UNIT – IV**

#### **Quantum Hardware and Programming:**

Overview of Quantum Hardware Technologies: Superconducting Qubits, Trapped Ion Systems, Photonic Quantum Computing. Noise and Decoherence, Quantum Error Correction (Basic Concepts), Introduction to NISQ Devices, Basics of Quantum Programming using Python and Qiskit, Introduction to IBM Quantum Experience.

### **UNIT – V**

#### **Applications of Quantum Computing:**

Quantum Cryptography and Cybersecurity, Quantum Computing in Healthcare and Drug Discovery, Optimization Problems and Smart Systems, Quantum in Finance & Logistics, Quantum computing for Industrial Applications and Future Scope, Ethical and Societal Impact of Quantum Technologies.

#### **Text Books:**

1. Quantum Computation and Quantum Information – Michael A. Nielsen & Isaac L. Chuang.
2. Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press, First Edition, 2011.

#### **Reference Books:**

1. **Eric R. Johnston, Nic Harrigan, and Mercedes Gimeno-Segovia**, Programming Quantum Computers: Essential Algorithms and Code Samples, O'Reilly Media, First Edition, 2019.

#### **Web Links:**

1. [https://quantum.cloud.ibm.com/?utm\\_source=chatgpt.com](https://quantum.cloud.ibm.com/?utm_source=chatgpt.com)
2. <https://quantum.cloud.ibm.com/docs/en/guides>

## Data Structures

(CE, ME, PT, Min.E.)

**Course Code:** 2501CS03

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 2 | 4 |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Utilize structure, union to handle heterogeneous data.
- CO2:** Illustrate Time and Space complexities for different sorting Algorithms
- CO3:** Demonstrate various operations on Linked Lists
- CO4:** Explain different operations on Stack and Queue with applications.
- CO5:** Demonstrate the importance and various operation on non-linear data structures

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 1    | 1    | 2    |      |      |      |      | 1    | 1    |       |       |
| CO2   | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |
| CO3   | 1    | 2    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| CO4   | 1    | 1    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| CO5   | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 3    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT – I

**Structures and Unions:** Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type - enum variables, Using Typedef keyword, Bit Fields.

**Data Structures:** Introduction to Data Structures, Types of Data Structures.

#### Practice:

7. Write a C program to find the total, average of n students using structures
8. Copy one structure variable to another structure of the same type.
9. Read student name and marks from the command line and display the student details along with the total.

### UNIT – II

**Introduction to Linear Data Structures:** Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation, Overview of time and space complexity analysis for linear data structures.

Sorting Techniques: Quick sort, Merge sort, Radix sort

#### Practice:

5. Implement Merge sort using arrays.  
<https://www.hackerrank.com/contests/hw1/challenges/merge-sort>
6. Implement Quick sort using arrays

<https://www.hackerrank.com/challenges/quicksort1/problem>

7. Implement Radix Sort using arrays

[https://www.hackerrank.com/contests/hw1/challenges/radix-sort?utm\\_source](https://www.hackerrank.com/contests/hw1/challenges/radix-sort?utm_source)

### UNIT – III

**Linked Lists:** Singly linked lists: representation and operations, doubly linked lists and its operations and circular linked lists and its operations, Comparing arrays and linked lists, Applications of linked lists.

**Practice:**

4. Single Linked List: Perform different operations in single linked list.  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
5. Perform different operations in double linked list  
[https://leetcode.com/problems/design-linked-list/?utm\\_source](https://leetcode.com/problems/design-linked-list/?utm_source)
6. Circular Linked List  
[https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm\\_source](https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm_source)

### UNIT – IV

**Stacks:** Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, applications of stacks.

**Queues:** Introduction to queues: properties and operations, Types of Queues, implementing queues using arrays and linked lists, applications of queues.

**Practice:**

5. Stack and its operations using arrays and Linked List  
<https://www.hackerrank.com/challenges/balanced-brackets/problem>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
6. Implement a program to evaluate a postfix expression.  
<https://leetcode.com/problems/evaluate-reverse-polish-notation/description/>
7. Queue and its operations using arrays and Linked List  
<https://leetcode.com/problems/implement-queue-using-stacks/description/>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
8. Implement Circular Queue using Arrays  
<https://leetcode.com/problems/design-circular-queue/description/>

### UNIT – V

**Non-linear Data Structures:**

Trees: Definition of tree, Tree Terminology, types of trees, Binary tree traversals, Binary Search Tree – Insertion, Deletion.

Graphs: Definition and Terminology – Representation of Graphs-Adjacency Matrix and Linked list, Graph Traversals (BFT & DFT)

**Practice:**

1. Implement Binary search tree (BST).  
<https://leetcode.com/problems/insert-into-a-binary-search-tree/description/>  
<https://leetcode.com/problems/delete-node-in-a-bst/description/>
2. Implement Binary search Tree (BST) Traversals.  
<https://www.hackerrank.com/challenges/tree-inorder-traversal/problem>  
<https://www.hackerrank.com/challenges/tree-preorder-traversal/problem>  
<https://www.hackerrank.com/challenges/tree-postorder-traversal/problem>
3. Graph Traversal using Breadth First Search (BFS)  
<https://www.hackerrank.com/challenges/bfsshortreach/problem>

#### 4. Graph Traversal using Depth First Search (DFS)

<https://leetcode.com/problems/number-of-islands/description/>

#### Text Books:

1. Data Structures using C, Rema Theraja, Oxford University Press, 3rd Edition. ISBN: 978-9354979453
2. Data Structures, KV Sambasivarao, S Rama Sree, S.Chand. ISBN: 978-9358704730

#### Reference Books:

1. The Algorithm Design Manual, Steven S. Skiena, Springer Publication, Second Edition. ISBN: 978-1849967204
2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Silicon Press, ISBN: 978-0716782506
3. Data Structures and Algorithms by Maganti Venkatesh, Naresh. ISBN: 9780929306407
4. Data Structures Using C, Reema Thareja, Oxford University Press, 2nd Edition. ISBN: 978-0198099307

#### Web Links:

1. <https://nptel.ac.in/courses/106102064>
2. <https://archive.nptel.ac.in/courses/106/105/106105225/>
3. <https://www.udemy.com/topic/data-structures/>
4. <https://www.coursera.org/specializations/data-structures-algorithms>
5. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>

#### Additional Practice:

| SNO | Difficulty | Problem Name          | URL                                                                                                                                                                                               |
|-----|------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Easy       | Structs and enums     | <a href="https://www.hackerrank.com/challenges/too-high-boxes/problem">https://www.hackerrank.com/challenges/too-high-boxes/problem</a>                                                           |
| 2   | Easy       | Structs and enums     | <a href="https://www.codechef.com/problems/HS08TEST?tab=statement">https://www.codechef.com/problems/HS08TEST?tab=statement</a>                                                                   |
| 3   | Medium     | Structs and enums     | <a href="https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem">https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem</a>                         |
| 4   | Easy       | Arrays and Hashtables | <a href="https://leetcode.com/problems/two-sum/description/">https://leetcode.com/problems/two-sum/description/</a>                                                                               |
| 5   | Easy       | Arrays and Pointers   | <a href="https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source">https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source</a> |
| 6   | Medium     | Arrays and Pointers   | <a href="https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source">https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source</a>       |
| 7   | Easy       | Linked List           | <a href="https://leetcode.com/problems/merge-two-sorted-lists/description/">https://leetcode.com/problems/merge-two-sorted-lists/description/</a>                                                 |
| 8   | Medium     | Arrays and Matrix     | <a href="https://leetcode.com/problems/diagonal-traverse/description/">https://leetcode.com/problems/diagonal-traverse/description/</a>                                                           |
| 9   | Easy       | Linked List           | <a href="https://www.hackerrank.com/challenges/compare-two-linked-lists/problem">https://www.hackerrank.com/challenges/compare-two-linked-lists/problem</a>                                       |
| 10  | Medium     | Stack applications    | <a href="https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm">https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm</a>                                       |



|    |        |                    |                                                                                                                                                             |
|----|--------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11 | Medium | Binary Tree        | <a href="https://leetcode.com/problems/binary-tree-right-side-view/description/">https://leetcode.com/problems/binary-tree-right-side-view/description/</a> |
| 12 | Medium | Stack applications | <a href="https://leetcode.com/problems/remove-k-digits/description/">https://leetcode.com/problems/remove-k-digits/description/</a>                         |
| 13 | Medium | Graph Theory       | <a href="https://www.hackerrank.com/challenges/journey-to-the-moon/problem">https://www.hackerrank.com/challenges/journey-to-the-moon/problem</a>           |
| 14 | Medium | Graph Traversals   | <a href="https://leetcode.com/problems/number-of-provinces/description/">https://leetcode.com/problems/number-of-provinces/description/</a>                 |
| 15 | Medium | Graph Theory       | <a href="https://www.hackerrank.com/challenges/torque-and-development/problem">https://www.hackerrank.com/challenges/torque-and-development/problem</a>     |

|                            | Basic Programs | Aditya's Internal coding Platform(Maya) | Code chef | Hacker rank | Leet code | Geek for Geeks |
|----------------------------|----------------|-----------------------------------------|-----------|-------------|-----------|----------------|
| <b>Unit-1</b>              | 3              | 0                                       | 0         | 0           | 0         | 0              |
| <b>Unit-2</b>              | 0              | 0                                       | 0         | 3           | 0         | 0              |
| <b>Unit-3</b>              | 0              | 0                                       | 1         | 0           | 2         | 0              |
| <b>Unit-4</b>              | 0              | 0                                       | 0         | 1           | 5         | 0              |
| <b>Unit-5</b>              | 0              | 0                                       | 0         | 4           | 3         | 0              |
| <b>Additional Practice</b> | 0              | 0                                       | 1         | 5           | 8         | 1              |
| <b>Total</b>               | <b>3</b>       | <b>0</b>                                | <b>2</b>  | <b>13</b>   | <b>18</b> | <b>1</b>       |

## Data Structures using C++

(Common to EEE, ECE, CSE, AIML & CSE (DS))  
(Revised Syllabus for batches admitted from 2026 Onwards)

|                       | L | T | P | C |
|-----------------------|---|---|---|---|
| Course Code: 2601DS02 | 2 | 0 | 2 | 4 |

### Course Outcomes:

At the end of the course, student will be able to:

- CO1:** Apply C++ features for problem solving.
- CO2:** Apply various sorting techniques to solve computing problems.
- CO3:** Make use of linear data structures to solve real time problems.
- CO4:** Develop applications using Tree data structures.
- CO5:** Solve problems using Graph algorithms.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 1    | 1    | 1    |      |      |      |      | 1    | 1    |       |       |
| CO2   | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |
| CO3   | 1    | 2    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| CO4   | 1    | 1    | 2    | 1    |      |      |      | 1    | 1    |       |       |
| CO5   | 1    | 1    | 2    | 2    |      |      |      | 1    | 1    |       |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT – I

**An Overview of C++:** Structure of C++ program, Input and output in C++, Class, Objects, Members Functions, Access Specifiers, Introduction to Constructors and Destructor.

**Overview of Standard Template Library:** Introduction, STL Programming Model, Containers, Sequence Containers, Associative Containers, Algorithms, Iterators, Vectors, Lists, Maps.

#### Practice:

- Find the roots of a quadratic equation.
- Find factorial of a given number using recursion
- Palindrome Number  
<https://leetcode.com/problems/palindrome-number/description/>
- Class and Objects  
<https://www.hackerrank.com/challenges/classes-objects/problem?isFullScreen=true>
- Program to illustrate the use of Constructors and Destructors.
- C++ Class Templates

<https://www.hackerrank.com/challenges/cpp-class-template-specialization/problem?isFullScreen=true>

## UNIT – II

**Data Structures:** Introduction to Data Structures, Types of Data Structures.

**Linear Data Structures:** Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation.

**Linked Lists:** Singly linked lists: Representation and operations, Doubly linked lists and its operations and Circular linked lists and its operations, applications of linked list

### Practice:

1. Single Linked List: Perform different operations in single linked list.  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
2. Perform different operations in double linked list  
[https://leetcode.com/problems/design-linked-list/?utm\\_source](https://leetcode.com/problems/design-linked-list/?utm_source)
3. Circular Linked List  
[https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm\\_source](https://www.codechef.com/practice/course/linked-lists/LINKLISTF/problems/PREP58?utm_source)
4. Reversing a Linked List

## UNIT – III

**Stacks:** Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, applications of stacks.

**Queues:** Introduction to queues: properties and operations, Types of Queues, implementing queues using arrays and linked lists, applications of queues.

### Practice:

1. Stack and its operations using arrays and Linked List  
<https://www.hackerrank.com/challenges/balanced-brackets/problem>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
2. Implement a program to evaluate a postfix expression.  
<https://leetcode.com/problems/evaluate-reverse-polish-notation/description/>
3. Queue and its operations using arrays and Linked List  
<https://leetcode.com/problems/implement-queue-using-stacks/description/>  
[https://leetcode.com/problems/design-linked-list/description/?utm\\_source](https://leetcode.com/problems/design-linked-list/description/?utm_source)
4. Implement Circular Queue using Arrays  
<https://leetcode.com/problems/design-circular-queue/description/>

## UNIT – IV

**Trees:** Definition of tree, Tree Terminology, Representation of tree, Types of trees-Binary Tree, BST, BST, Binary tree traversals-Inorder,Preorder,Postorder Traversals.

**Binary Search Trees** – Definition, Operations: Searching, Insertion, Deletion.

### Practice:

1. Implement Binary search tree (BST).  
<https://leetcode.com/problems/insert-into-a-binary-search-tree/description/>

<https://leetcode.com/problems/delete-node-in-a-bst/description/>

2. Implement Binary search Tree (BST) Traversals.

<https://www.hackerrank.com/challenges/tree-inorder-traversal/problem>

<https://www.hackerrank.com/challenges/tree-preorder-traversal/problem>

<https://www.hackerrank.com/challenges/tree-postorder-traversal/problem>

## UNIT – V

**Graphs:** Definition and Terminology, Types of Graph, Representation of Graphs-Adjacency Matrix and Adjacency list, Graph Traversals (BFS & DFS), Bi-Connected Components.

### Practice:

1. Graph Traversal using Breadth First Search (BFS)  
<https://www.hackerrank.com/challenges/bfsshortreach/problem>
2. Graph Traversal using Depth First Search (DFS)  
<https://leetcode.com/problems/number-of-islands/description/>

### Text Books:

1. The Complete Reference C++, Herbert Schildt, TMH, Fourth Edition, ISBN-10. 0070411832.
2. Fundamentals of Data Structures in C++, Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, ISBN: 81-7515-278-8
3. Data Structures, KV Sambasivarao, S Rama Sree, S.Chand. ISBN: 978-9358704730

### Reference Books:

1. The C++ Programming Language, Bjarne Stroustrup, Pearson, Fourth Edition, ISBN : 9780133522884.
2. Object oriented programming in C++, Joydeep Farrell, Cengage, ISBN : 978-1418836269
3. Data structures and algorithms in C++, 3rd edition, Adam Drozdek, Thomson, ISBN: 9788131521267
4. The Algorithm Design Manual, Steven S. Skiena, Springer Publication, Second Edition. ISBN: 978-1849967204
5. Data Structures and Algorithms by Maganti Venkatesh, Naresh. ISBN: 9780929306407

### Web Links:

1. <http://nptel.ac.in/courses/106105151/>
2. <https://nptel.ac.in/courses/106102064>
3. <https://archive.nptel.ac.in/courses/106/105/106105225/>
4. <https://www.udemy.com/topic/data-structures/>
5. <https://www.coursera.org/specializations/data-structures-algorithms>
6. <https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html>

**Additional Practice:**

| S. NO | Difficulty | Problem Name          | URL                                                                                                                                                                                               |
|-------|------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Easy       | Arrays and Hashtables | <a href="https://leetcode.com/problems/two-sum/description/">https://leetcode.com/problems/two-sum/description/</a>                                                                               |
| 2     | Easy       | Arrays and Pointers   | <a href="https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source">https://leetcode.com/problems/remove-duplicates-from-sorted-array/description/?utm_source</a> |
| 3     | Medium     | Arrays and Pointers   | <a href="https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source">https://leetcode.com/problems/two-sum-ii-input-array-is-sorted/description/?utm_source</a>       |
| 4     | Easy       | Linked List           | <a href="https://leetcode.com/problems/merge-two-sorted-lists/description/">https://leetcode.com/problems/merge-two-sorted-lists/description/</a>                                                 |
| 5     | Medium     | Arrays and Matrix     | <a href="https://leetcode.com/problems/diagonal-traverse/description/">https://leetcode.com/problems/diagonal-traverse/description/</a>                                                           |
| 6     | Easy       | Linked List           | <a href="https://www.hackerrank.com/challenges/compare-two-linked-lists/problem">https://www.hackerrank.com/challenges/compare-two-linked-lists/problem</a>                                       |
| 7     | Medium     | Stack applications    | <a href="https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm">https://www.geeksforgeeks.org/problems/tower-of-hanoi-1587115621/1?utm</a>                                       |
| 8     | Medium     | Binary Tree           | <a href="https://leetcode.com/problems/binary-tree-right-side-view/description/">https://leetcode.com/problems/binary-tree-right-side-view/description/</a>                                       |
| 9     | Medium     | Stack applications    | <a href="https://leetcode.com/problems/remove-k-digits/description/">https://leetcode.com/problems/remove-k-digits/description/</a>                                                               |
| 10    | Medium     | Graph Theory          | <a href="https://www.hackerrank.com/challenges/journey-to-the-moon/problem">https://www.hackerrank.com/challenges/journey-to-the-moon/problem</a>                                                 |
| 11    | Medium     | Graph Traversals      | <a href="https://leetcode.com/problems/number-of-provinces/description/">https://leetcode.com/problems/number-of-provinces/description/</a>                                                       |
| 12    | Medium     | Graph Theory          | <a href="https://www.hackerrank.com/challenges/torque-and-development/problem">https://www.hackerrank.com/challenges/torque-and-development/problem</a>                                           |

|                     | Basic Programs | Aditya's Internal coding Platform(Maya) | Code chef | Hacker rank | Leet code | Geek for Geeks |
|---------------------|----------------|-----------------------------------------|-----------|-------------|-----------|----------------|
| Unit-1              | 3              | 0                                       | 0         | 2           | 1         | 0              |
| Unit-2              | 0              | 0                                       | 1         | 3           | 2         | 0              |
| Unit-3              | 0              | 0                                       | 0         | 1           | 5         | 0              |
| Unit-4              | 0              | 0                                       | 0         | 3           | 2         | 0              |
| Unit-5              | 0              | 0                                       | 0         | 1           | 1         | 0              |
| Additional Practice | 0              | 0                                       | 0         | 3           | 8         | 1              |
| Total               | 3              | 0                                       | 1         | 13          | 19        | 1              |

## Operating Systems

(CE, EEE, ME, ECE, PT, Min.E., Ag.E.)

**Course Code: 2501CS13**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Describe basic concepts of Operating Systems and its structure.
- CO2:** Analyse various issues related to inter process communication like process scheduling, resource management and deadlocks.
- CO3:** Interpret the issues and challenges of memory management.
- CO4:** Illustrate concepts of Disk management and file system implementation.
- CO5:** Explain issues related to protection and security mechanisms.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    |      |      |      |      |      |      |      | 1    |       |       |
| CO2   | 1    | 3    |      | 1    |      |      |      |      | 2    |       | 1     |
| CO3   | 1    | 3    |      | 1    |      |      |      |      | 2    |       | 1     |
| CO4   | 1    | 3    |      | 1    |      |      |      |      | 1    |       | 1     |
| CO5   | 2    | 2    |      |      |      |      |      |      | 1    |       |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 1    |      |
| CO2    | 2    |      |
| CO3    | 2    |      |
| CO4    | 2    |      |
| CO5    | 2    |      |

### UNIT – I

**Operating Systems Overview:** Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, System Boot.

**Case Study:** The above topics are discussed as case study in Windows/ Unix OS

#### Practice:

1. Basic Linux commands
2. Implementation of System calls
3. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

### UNIT – II

**Process Concept:** Process scheduling, Operations on processes, Inter-process communication.

**Process Scheduling:** Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.

**Multithreaded Programming:** Multithreading models, Thread libraries, Threading issues

**Case Study:** The above topics are discussed as case study in Windows/ Unix OS

**Practice:**

1. Simulate the following CPU scheduling algorithms: FCFS and SJF
2. Simulate the following CPU scheduling algorithms: Priority and Round Robin

### UNIT – III

**Inter-process Communication:** Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.

**Deadlocks:** Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.

**Case Study:** The above topics are discussed as case study in Windows/ Unix OS

**Practice:**

1. Simulate Bankers Algorithm for Dead Lock Avoidance
2. Write a C program that illustrates two processes communicating using shared memory.
3. Write C program to create a thread using pthreads library and let it run its function.
4. Write a C program to illustrate concurrent execution of threads using pthreads library

### UNIT – IV

**Memory-Management Strategies:** Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.

**Virtual Memory Management:** Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.

**File Systems:** Files, Directories, File system implementation, management and optimization.

**Case Study:** The above topics are discussed as case study in Windows/ Unix OS

**Practice:**

1. Simulate the Multiprogramming with a fixed number of tasks (MFT)
2. Simulate the Multiprogramming with a variable number of tasks (MVT)
3. Simulate the FIFO page replacement algorithm
4. Simulate the LRU page replacement algorithm
5. Simulate the following File allocation strategies: Sequenced, Indexed and Linked

### UNIT – V

**Secondary-Storage Structure:** Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.

**System Protection:** Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.

**System Security:** Introduction, Program threats, System and network threats.

**Practice:**

1. The above topics are discussed as case study in Windows/ Unix OS

**Text Books:**

- 1 Operating System Concepts, Abraham Silberschatz, Peter B Galvin and Greg Gagne, John Wiley and Sons Inc., 12<sup>th</sup> Edition. ISBN: 978-0470128725
- 2 William Stallings, Operating Systems: Internals and Design Principles. Prentice-Hall, 7<sup>th</sup> Edition. ISBN: 978-9332518803

**Reference Books:**

- 1 Modern Operating Systems, Tanenbaum A S, Pearson Education, 3<sup>rd</sup> Edition. ISBN: 978-0136006633
- 2 Operating Systems A Concept Based Approach, Dhamdhere D M, Tata McGraw-Hill, 3<sup>rd</sup> Edition. ISBN: 978-1259005589
- 3 Operating Systems, Nutt G, Pearson Education, 3<sup>rd</sup> Edition,. ISBN: 978-8131723593

**Web Links:**

- 1 <https://archive.nptel.ac.in/courses/106/106/106106144/>
- 2 <https://archive.nptel.ac.in/courses/106/105/106105214/>
- 3 <https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems>
- 4 <https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923>



## Database Management Systems

(CE, EEE, ME, ECE, PT, Min.E., Ag.E.)

**Course Code: 2501IT05**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Describe the Fundamental concepts of DBMS.
- CO2:** Interpret relational database using SQL.
- CO3:** Make use of normalization techniques for database design.
- CO4:** Illustrate the mechanisms of transaction management.
- CO5:** Optimize database performance with advanced indexing, query optimization, and recovery strategies.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | 3    |      | 1    |      |      | 1    |      |       |       |
| CO2   | 3    | 3    | 3    | 2    | 2    | 1    |      | 1    |      |       |       |
| CO3   | 3    | 3    | 3    | 3    | 3    | 2    |      |      |      |       | 1     |
| CO4   | 3    | 3    | 3    | 1    | 2    | 1    |      |      |      |       |       |
| CO5   | 3    | 3    | 3    | 3    | 3    | 2    |      |      |      |       | 2     |

### UNIT – I

Introduction to DBMS: History and Architecture, Data Independence, Data Models, Levels of abstraction, structure of DBMS.

Data Models : Concepts of Schema, Instance and data independence, Three tier schema architecture for data independence, Database system structure, environment, Centralized and Client Server architecture for the database.

#### Practice

1. Familiarization with installation of any DBMS.
2. Implementing a University Database System.

### UNIT – II

**Relational Model:** Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance

**BASIC SQL:** Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update), basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions (Date and Time, Numeric, String conversion).

#### Practice

1. Querying and modifying the database using Data Manipulation Language commands -select, insert, update, delete.
2. Implementation of Aggregate Functions – sum, avg, min, max, count. Use group-by and having clause.

### UNIT – III

**Entity Relationship Model:** Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

**SQL:** Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view(uptable and nonuptable), relational set operations.

#### Practice

1. Perform join operations – natural join, equi-join, outer join, left outer join, right outer join, inner join and assess the impact of query plans on the performance of join heavy queries.
2. Perform set operations - union, intersection, set difference.
3. Implementation of correlated sub-queries and nested queries.
4. Creating and querying views and materialized views.

### UNIT – IV

**Normalization:** Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF), Fifth Normal Form (5NF).

**Transaction Concept:** Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Storage, Recovery and Atomicity, Recovery algorithm.

#### Practice

1. Implement SQL queries on a normalized database schema based on the provided schema. For this example: use the schema for a university database, which includes:

- Students (StudentID, StudentName, Major)
- Courses (CourseID, CourseName, Credits)
- Enrollments (StudentID, CourseID, EnrollmentDate)
- Instructors (InstructorID, InstructorName, Phone)
- Course\_Instructors (CourseID, InstructorID)

2. (A)Implementation of Data Control Language commands – grant and revoke.

(B)Implementation of Transaction Control Language commands - commit, save point, and rollback.

### UNIT – V

**Indexing Techniques:** Introduction, B+ Trees: Search, Insert, delete algorithms, File Organization and Indexing, Cluster Indexes, Primary and Secondary Indexes, Index data Structures, Hash Based Indexing: Tree base Indexing, Comparison of File Organizations.

**Database Tuning:** Introduction, Database Performance Tuning, Query Optimization: Introduction, Query Optimization algorithms, Backup and Recovery.

#### Practice

1. Create a Primary , Secondary Index on a Column.
2. Retrieve Data Using an Index.
3. Insert Data and Update Indexes.
4. Delete Data and Impact on Indexes.

**\* Note:**The student must Complete & Submit a Database Foundations Certificate Course offered by Oracle Academy at the end of the Practice Session.

**Text Books:**

- 1 Database System Concepts ,Abraham Silberschatz, Henry Korth, and S. Sudarshan, McGraw-Hill , 8<sup>th</sup> Edition., ISBN-13: 978-1260230508.
- 2 Database Management Systems, Raghurama Krishnan, Johannes Gehrke, Mc Graw-Hill, 4<sup>th</sup> Edition, ISBN: 978-1260091195.

**Reference Books:**

1. Database Systems, RamezElmasri, Shamkant B. Navathe, 7<sup>th</sup> Edition, Pearson, ISBN: 978-0137504277.
2. Database Systems, Carlos Coronel, Steven Morris, Peter Rob, 10<sup>th</sup> Edition, Cengage, ISBN: 978-0357517864.
3. Introduction to Database Systems, C J Date, Pearson, 9<sup>th</sup> Edition, ISBN: 978-0133970777.

**Web Links:**

- 1 <https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Database%20Foundations%20Course%20Description.pdf>
- 2 <https://www.w3schools.com/sql/>
- 3 [https://onlinecourses.nptel.ac.in/noc22\\_cs91/](https://onlinecourses.nptel.ac.in/noc22_cs91/)

## Computer Networks

(CE, EEE, ME, ECE, PT, Min.E., Ag.E.)

**Course Code: 2501CS07**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Describe network topologies, reference models and media for data transmission
- CO2:** Analyze error and flow control issues in data link layer
- CO3:** Classify MAC protocols and channelization techniques
- CO4:** Apply routing algorithms and congestion control techniques for effective data transmission
- CO5:** Analyze protocols Transport and Application Layers

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 1    |      |      |      |      |      |      |      |       |       |
| CO2   |      | 2    |      |      |      |      |      |      |      |       |       |
| CO3   |      | 2    |      |      |      |      |      |      | 1    | 1     |       |
| CO4   | 1    | 2    | 2    |      |      |      |      |      | 2    |       | 1     |
| CO5   |      | 1    |      |      | 1    |      |      |      |      |       | 1     |

### UNIT – I

**Network Overview:** interfaces, protocols and services, connection-oriented and connectionless services, OSI & TCP/IP Reference Models. Local Area Networks: Topologies - star, bus, ring, media access control - deterministic and probabilistic, IEEE 802.x. wireless networking.

#### Practice:

1. Study of Network devices in detail and connect the computers in Local Area Network

### UNIT – II

**Data Link Protocols:** framing and data transparency, error detection & correction, flow control.

#### Practice:

1. Write a Program to implement the data link layer framing methods such as i) Character stuffing ii) bit stuffing.

### UNIT – III

**Media Access Control:** Random Access: ALOHA, Carrier sense multiple access (CSMA), CSMA with Collision Detection, CSMA with Collision Avoidance, Controlled Access: Reservation, Polling, Token Passing, Channelization: frequency division multiple Access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA).

#### Practice:

1. Write a Program to implement Sliding window protocols

## UNIT – IV

**Routing Algorithms:** The Optimality principle, Shortest path, Flooding, Distance vector, Link state, Hierarchical

**Congestion Control algorithms:** General principles of congestion control, Congestion prevention policies, Approaches to Congestion Control, Traffic Aware Routing, Admission **Control, Traffic Throttling:** Load Shedding

Traffic Control Algorithm: Leaky bucket & Token bucket.

### Practice:

1. Programs to implement routing protocols like shortest path.

## UNIT – V

**IP Protocols:** IP Addressing, IP & ICMP.

Transmission Control Protocol: UDP & TCP.

Application Layer: World Wide Web, HTTP, Electronic mail, Architecture, web based mail, email security, TELENET, local versus remote Logging, Domain Name System: Name Space, DNS, SNMP.

### Practice:

1. NS2 Simulator i. NS2 Simulator-Introduction ii. Simulate to Find the Number of Packets Dropped iii. Simulate to Find the Number of Packets Dropped by TCP/UDP

### Capstone Project:

Simulate and implement data link layer protocols and network routing strategies using NS2 (Network Simulator 2). It includes configuring network topologies, setting up routing protocols like AODV, DSDV, and OLSR, and analyzing their performance through metrics such as throughput, delay, and packet delivery ratio. Additionally, explore the simulation of data link layer functionalities, including MAC addressing and error detection. You may use NS2's capabilities, that insights into the behaviour of network protocols, aiding in the design and optimization of efficient communication systems.

### Text Books:

- 1 Computer Networks — Andrew S Tanenbaum and David J Wetherall, Pearson Education, 5th Edition. ISBN: 978-0132126953
- 2 Data Communications and Networking – Behrouz A. Forouzan, McGraw Hill Education, 5th Edition ISBN: 978-1259064753

### Reference Books:

- 1 Data Communications and Networks- Achut S Godbole, Atul Kahate, McGraw-Hill Education (India) Pvt Limited, 2<sup>nd</sup> Edition. ISBN: 978-0-07-123110-7
- 2 Computer Networks, Mayank Dave, CENGAGE India, 6<sup>th</sup> Edition ISBN: 978-8131509869

### Web Links:

- 1 <https://nptel.ac.in/courses/106105081>
- 2 <https://www.coursera.org/learn/fundamentals-network-communications>

## Artificial Intelligence

(CE, EEE, ECE, PT, Min.E.)

**Course Code: 2501AI02**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Illustrate the historical development of AI, key milestones and contributors.
- CO2:** Apply the basic principles of AI in problem solving
- CO3:** Apply Local Search Algorithms and Optimization Techniques.
- CO4:** Choose the appropriate representation of Knowledge.
- CO5:** Summarise the expert systems and real time applications

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 3    |      |      | 1    |      |      |      | 1    | 1    |       | 1     |
| <b>CO2</b> | 3    | 2    |      | 2    |      |      |      | 1    | 1    |       | 1     |
| <b>CO3</b> | 3    | 2    | 1    | 2    | 1    |      |      | 1    | 1    |       | 1     |
| <b>CO4</b> | 2    |      | 1    |      |      |      |      | 1    | 1    |       |       |
| <b>CO5</b> | 2    | 2    | 1    | 1    | 1    |      |      | 1    | 1    |       | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    |      |
| <b>CO2</b> | 2    | 1    |
| <b>CO3</b> | 1    | 1    |
| <b>CO4</b> | 1    |      |
| <b>CO5</b> | 1    | 1    |

### UNIT – I

#### Introduction:

What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Agents and Environments, Good Behaviour: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

#### Practice :

1. Introduction to LISP : To demonstrate simple recursive functions and list manipulation in LISP
2. Introduction to Prolog : Provide a brief introduction to Prolog syntax, including facts, rules, and queries.

### UNIT – II

#### Problem formulation:

Problem Definition Production systems, Control strategies, Search strategies. Problem characteristics, ProblemSolving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies

**Practice :**

1. Implementation of DFS for water jug problem using LISP/PROLOG
2. Implementation of BFS for tictactoe problem using LISP/PROLOG

**UNIT – III**

**Problem solving methods**

Problem graphs, Matching, Indexing and Heuristic functions Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions, , Constraints satisfaction – Measure of performance and analysis of search algorithms. Game playing.

**Practice :**

1. Implementation of TSP using heuristic approach using LISP/Prolog
2. Implementation of Hillclimbing to solve 8 Puzzle Problem

**UNIT – IV**

**Knowledge representation**

Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logicStructured representation of knowledge Basic plan generation systems – Strips Advanced plan generation systems – K strips Strategic explanations Why, why not and how explanations.

**Practice :**

1. Design a semantic network to represent knowledge about a specific domain, such as animals or transportation systems. Experiment with different node types, relationships, and attributes to encode information effectively. Implement a Python / LISP code for this program.
2. Create a framebased representation for a simple domain like a restaurant. Define frame templates for entities like menu items, customers, and orders, along with slots for attributes such as price, ingredients, and customer preferences.

**UNIT – V**

**Expert Learning**

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

**Practice :**

1. Using PYTHON / LISP , develop an expert system to help users plan travel itineraries, including transportation, accommodation, and activities. Utilize knowledge about travel destinations, transportation options, and user preferences to generate personalized travel plans.
2. Using PYTHON / LISP , create an expert system to assist students in selecting courses, majors, or career paths based on their interests, skills, and academic performance. Use knowledge about educational programs, career prospects, and academic requirements to make personalized recommendations.

**Text Books:**

- 1 Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig , Pearson, 3rd Edition, ISBN: 978-9332543515
- 2 Artificial Intelligence: Structures and Strategies for Complex Problem Solving by George F. Luger, 2<sup>nd</sup> Edition, ISBN: 978-0805347807

**Reference Books:**

- 1 Artificial Intelligence, Saroj Kaushik, Cengage Learning India, ISBN: 978-8131510995
- 2 Artificial Intelligence, Elaine Rich and Kevin Knight, Tata McGraw Hill, ISBN: 978-0-07-052263-3
- 3 Artificial Intelligence: Foundations for Computational Agents, David Poole and Alan Mackworth, Cambridge University Press, ISBN: 978-1107195394

**Web Links:**

- 1 <https://nptel.ac.in/courses/106105077>
- 2 <https://nptel.ac.in/courses/106106126>
- 3 <https://aima.cs.berkeley.edu>



## Machine Learning

(CE, ECE, PT, Min.E.)

**Course Code: 2501AI05**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>2</b> | <b>4</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Outline the Concepts of Machine Learning and Statistical Learning
- CO2:** Build Regression and Classification models for given data.
- CO3:** Apply Instance based Learning techniques and SVM techniques linear and nonlinear data.
- CO4:** Apply clustering techniques on high dimensional data to group the similar entities.
- CO5:** Make use of ensemble learning techniques to improve the performance of a model.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|------------|------|------|-----|------|------|------|------|------|------|-------|-------|
| <b>CO1</b> | 2    | 2    |     |      | 2    | 2    |      | 1    | 1    |       |       |
| <b>CO2</b> | 2    | 2    | 3   |      | 2    | 2    |      | 1    | 1    |       |       |
| <b>CO3</b> | 3    | 2    | 3   |      | 2    |      |      | 1    | 1    |       | 2     |
| <b>CO4</b> | 3    | 2    | 3   |      | 2    |      |      | 1    | 1    |       |       |
| <b>CO5</b> | 2    | 2    | 2   |      | 2    |      |      | 1    | 1    |       | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      | 1    |
| <b>CO2</b> |      | 2    |
| <b>CO3</b> |      | 2    |
| <b>CO4</b> |      | 2    |
| <b>CO5</b> |      | 2    |

## UNIT – I

### Introduction:

Machine Learning, Types of Machine Learning Systems, Main Challenges of Machine Learning. Statistical Learning: Introduction, Supervised and Unsupervised Learning, The Learning Problem, Feasibility of Learning.

### Practice :

1. Installation of Jupiter/Spider notebook and working on basic commands.
2. Loading and apply key preprocessing techniques on the dataset and also analyse the dataset.

## UNIT – II

### **Supervised Learning(Regression/Classification):Basic Methods:**

**Concept Learning:** General-to-Specific Hypotheses Ordering, Find-S and Candidate Elimination Algorithm, Version Space, and Inductive Bias.

**Bayesian Learning:** Probability Overview, MLE and MAP Estimates, Gaussian Naive Bayes Classifier, Bayesian Networks.

**Instance-based Learning:** k-Nearest Neighbour (kNN) Classifier, Voronoi Diagram and Distance-Weighted kNN, Distance Metrics and Curse of Dimensionality.

### **Practice :**

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Exercises to solve the real-world problems using Binary Classifier
4. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

## UNIT – III

**Linear Models and Regression:** Linear Classification, Linear Regression, Non-linear Transformation, Logistic Regression.

**Support Vector Machines:** Decision Boundary and Support Vector: Optimization and Primal-Dual Problem, Soft Margin and Non-linear Decision Boundary, Kernel Functions and Radial Basis Functions introduction.

### **Practice :**

1. Exercises to solve the real-world problems using Linear Regression
2. Exercises to solve the real-world problems using Logistic Regression
3. Consider Patient Dataset. Apply linear classification technique(SVM) to identify the rate of heart patients.

## UNIT – IV

**Classifier / Hypothesis Evaluation:** Accuracy, Precision, Recall and F-Measures, Scores, Sampling, Bootstrapping and ROC, Hypotheses Testing and Cross-validation.

### **Unsupervised Learning:**

**Clustering :** Partitional Clustering and Hierarchical Clustering, Cluster Types, Attributes and Salient Features, Hierarchical and Density-based Clustering Algorithms, Inter and Intra Clustering Similarity, Cohesion and Separation. MST and DBSCAN Clustering Algorithms.

### **Practice :**

1. Develop a program for Bias, Variance, Remove duplicates , Cross Validation
2. Write a program to implement One-hot Encoding.
3. Write a program to implement Categorical Encoding.

## UNIT – V

### Ensemble Learning :

Bagging and Boosting, Adaboost and Random Forest ,

**Computational Learning Theory :** Error and Noise Formalisms, Training vs. Testing, Theory of Generalization, PAC Learnability and VC Dimensions , Overfitting, Regularization and Validation.

### Practice :

1. Write a program to demonstrate the working of Random Forest classifier. Use appropriate dataset for Random Forest Classifier.
2. Use a sentiment analysis dataset from Twitter or other social media platforms, available on platforms like Kaggle and apply bagging and boosting techniques for prediction.

### Additional Practice:

1. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
2. Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using kMeans algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

### Capstone Project:

#### Student Performance Prediction System

**Objective:** Predict a student's performance (pass/fail or score range) based on input features like study time, attendance, past grades, family background, etc.

**Domain:** Education

#### Techniques & Concepts Used:

- Supervised learning (Classification – Logistic Regression, SVM)
- Data preprocessing (handling nulls, encoding categorical variables)
- Evaluation metrics (accuracy, precision, recall)

### Text Books:

- 1 Hands On Machine Learning with ScikitLearn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019, ISBN: 978-1492032649
- 2 Data Science and Machine Learning Mathematical and Statistical Methods, Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman, 2019, ISBN: 978-1138492530

### Reference Books:

- 1 Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, ISBN: 9780262018029
- 2 Machine Learning Tools, Dr Muddafa Maruli Krishna, Dr A Vanathi, Final Thawaksr, Dr Lokesh P. Gangani, publisher: Book Rivers, ISBN: 978-93-5515-730-0

### Web Links:

- 1 <https://www.deeplearning.ai/machinelearningyearning/>
- 2 <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>

## Fundamentals of Data Science

(CE, EEE, ME, ECE, PT, Min.E., Ag.E.)

**Course Code: 2501CS34**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>1</b> | <b>3</b> |

### Course Outcomes:

**At the end of the course, student will be able to:**

- CO1:** Explain fundamental concepts of Data Science.
- CO2:** Implement Data Collection and Preprocessing Techniques.
- CO3:** Demonstrate Proficiency in Data Loading, Storage, and File Handling
- CO4:** Conduct Exploratory Data Analysis (EDA) using Visualization and Statistical Techniques.
- CO5:** Make use of Neo4j, Cypher tools to manage and analyze graph data.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 3    |      |      |      |      |      |      | 2    | 2     |       |
| CO2   | 2    |      |      |      |      |      |      |      | 1    | 2     |       |
| CO3   | 2    | 2    | 2    |      |      |      |      |      | 2    | 2     |       |
| CO4   | 2    | 2    |      |      | 2    |      |      |      | 2    | 1     |       |
| CO5   | 3    |      |      |      |      |      |      |      | 1    | 1     |       |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    |      |
| CO2    | 1    |      |
| CO3    | 2    |      |
| CO4    | 2    |      |
| CO5    | 1    |      |

## UNIT – I

**Introduction To Data Science:** Definition and Scope of Data Science, History and Evolution of Data Science, Applications of Data Science, Data Science Lifecycle, Data Types and Structures, Tools and Technologies in Data Science.

### Practice:

1. Importing and Exploring Datasets - Loading datasets using libraries and performing basic exploration.
2. Basic Data Structures - Working with data structures such as arrays, lists, data frames, and matrices

## UNIT – II

**Data Collection and Preprocessing:** Data Collection Methods, Data Cleaning and Handling Missing Values, Data Transformation: Normalization and Standardization, Feature Engineering and Feature Scaling, Data Integration and Aggregation.

### Practice:

1. Computing summary statistics like mean, median, mode, and standard deviation for a sample dataset.

2. Handling missing values and outliers in a dataset using techniques like imputation and filtering.

### **UNIT – III**

**Data Loading, Storage, and File Formats :** Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in Mongo DB.

**Practice:**

1. Read data from a JSON file into a DataFrame using Pandas (pd.read\_json) or R (jsonlite). Parse nested JSON structures and convert them into a flat table format.
2. Perform web scraping on an HTML page using BeautifulSoup in Python or rvest in R. Extract data from HTML tables and convert it into a DataFrame.

### **UNIT – IV**

**Exploratory Data Analysis (EDA):** Descriptive Statistics, Data Visualization Techniques, Correlation and Covariance Analysis, Univariate, Bivariate, and Multivariate Analysis, Pattern Detection and Anomaly Identification.

**Practice:**

1. Plotting histograms and box plots to understand the distribution of a single variable.
2. Creating scatter plots and calculating correlation coefficients to study the relationship between two variables.

### **UNIT – V**

**Data Science Tools:** Neo4j for dealing with graph databases, graph query language Cypher, libraries like nltk and SQLite for handling Text mining and analytics.

**Practice:**

1. Get hands-on experience with Neo4j to understand how to manage and query graph databases.
2. Practice writing Cypher queries to interact with graph data in Neo4j.

**Text Books:**

- 1 Python for Data Analysis ,Wes McKinney, O'REILLY, ISBN:978-1-449-31979-3, 1<sup>st</sup> edition, ISBN · 9781449319793.
- 2 Doing Data Science ,Rachel Schutt & O'neil, O'REILLY, ISBN:978-1-449-35865-5, 1<sup>st</sup> edition, ISBN: 9781449358655.

**Reference Books:**

- 1 Data Science from Scratch: First Principles with Python ,Joel Grus, O'Reilly Media. ISBN: 9781492041139.
- 2 Learning the Pandas Library: Python Tools for Data Munging ,Matt Harrison, Analysis, and Visualization , O'Reilly. ISBN: 9781787123137

**Web Links:**

- 1 [https://onlinecourses.nptel.ac.in/noc24\\_cs68/preview](https://onlinecourses.nptel.ac.in/noc24_cs68/preview)
- 2 [https://onlinecourses.nptel.ac.in/noc24\\_cs133/preview](https://onlinecourses.nptel.ac.in/noc24_cs133/preview)
- 3 <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>