

**St. Francis Institute of Technology**  
(Engineering College)  
(An Autonomous Institute, Affiliated to University of Mumbai)  
S.V.P. Road, Borivli (W), Mumbai



**Bachelor of Engineering in**  
**Electronics and Computer Science**

**Second Year Scheme and Syllabus**  
w.e.f. Academic Year 2025 – 2026

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## Preamble

St. Francis Institute of Technology (SFIT) in Borivli, Mumbai, stands as a renowned engineering institute offering both undergraduate and postgraduate degree programs in engineering. Acknowledging its commitment to quality education, UGC has conferred an autonomous status to the institute vide letter no. F.2-10/2023 (AC-Policy) dated 24<sup>th</sup> April, 2024 with effect from the academic year 2024-25. In light of this achievement, SFIT is presenting a distinctive new curriculum for its undergraduate engineering degree program adhering to National Education Policy (NEP) 2020 credit framework as per Government Directive dated 4<sup>th</sup> July 2023. In line with SFIT's vision, this curriculum aims to nurture bright young minds into technological entrepreneurs and innovative leaders of tomorrow's world, while upholding the Franciscan values of integrity, peace, and love.

The SFIT curriculum prioritizes multidisciplinary learning, flexibility, research, and innovation, integrating soft skills cultivation and ethical principles while leveraging technology for enhanced learning experiences. The undergraduate degree program consists of a total of 160-176 credits. The overall credit distribution and curriculum approach in this revision align with the AICTE model curriculum

The second-year syllabus for Electronics and Computer Science typically focuses on expanding foundational knowledge while introducing more advanced topics in both electronics and computer science. The curriculum aims to balance theoretical understanding with practical applications. It emphasizes project-based learning, self-learning through online resources like NPTEL and SWAYAM, and incorporates key areas such as digital circuits, programming, data structures, and electronics systems. The goal is to equip students with both conceptual clarity and technical skills required for problem-solving in real-world scenarios.

## Abbreviations

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|               |                                                          |
|---------------|----------------------------------------------------------|
| <b>AEC</b>    | Ability Enhancement Courses                              |
| <b>AI</b>     | Artificial Intelligence and Machine Learning Engineering |
| <b>CA</b>     | Continuous Assessment                                    |
| <b>CC</b>     | Co-curricular Courses                                    |
| <b>EC</b>     | Electronics and Computer Science                         |
| <b>EEM</b>    | Entrepreneurship/Economics/Management                    |
| <b>EE</b>     | Electrical Engineering                                   |
| <b>ESE</b>    | End Semester Examination                                 |
| <b>ET</b>     | Electronics and Telecommunication                        |
| <b>FP</b>     | Field Project                                            |
| <b>IPR</b>    | Intellectual Property Rights                             |
| <b>ISE</b>    | In Semester Evaluation                                   |
| <b>MDM</b>    | Multidisciplinary Minor                                  |
| <b>ME</b>     | Mechanical Engineering                                   |
| <b>MSE</b>    | Mid Semester Examination                                 |
| <b>NPTEL</b>  | National Programme on Technology Enhanced Learning       |
| <b>OrE</b>    | Oral Examination                                         |
| <b>OEC</b>    | Open Elective Courses                                    |
| <b>PCC</b>    | Program Core Course                                      |
| <b>PE</b>     | Practical Examination                                    |
| <b>PrE</b>    | Project Examination                                      |
| <b>SWAYAM</b> | Study Webs of Active-Learning for Young Aspiring Minds   |
| <b>VEC</b>    | Value Education Course                                   |
| <b>VSEC</b>   | Vocational Skill Enhancement Course                      |

# 1 Course Structure and Curriculum

## 1.1 Definition of Credit

Table 1.1 Credit Allocation

| Schedule                       | Score      |
|--------------------------------|------------|
| 1 Hour Lecture (L) per week    | 1 Credit   |
| 1 Hour Tutorial (T) per week   | 1 Credit   |
| 1 Hour Practical (P) per week  | 0.5 Credit |
| 2 Hours Practical (P) per week | 1 Credit   |

## 1.2 Range of Credits

Table 1.2 Options for 4 years Bachelor's Engineering / Technology Degree

| Level | Course Name                                                                                                                                                         | Total Credit Assigned |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 6     | Bachelor's degree (B.E / B.Tech.) in Electronics and Computer Science with Multidisciplinary Minor                                                                  | 160-176               |
| 6     | Bachelor's degree (B.E / B.Tech.) in Electronics and Computer Science with Honors and Multidisciplinary Minor                                                       | 180-194               |
| 6     | Bachelor's degree (B.E / B.Tech.) in Electronics and Computer Science Honors with Research and Multidisciplinary Minor                                              | 180-194               |
| 6     | Bachelor's degree (B.E / B.Tech.) in Electronics and Computer Science Major Engineering Discipline with Double Minors (Multidisciplinary and Specialization Minors) | 180-194               |

## 1.3 Total Credits and Marks of B.E. in ECS Multidisciplinary Minor

Table 1.3: Total Credits and Marks of Four-year ECS Degree Program

| S. No. | Academic Year                   | Total Credits | Total Marks |
|--------|---------------------------------|---------------|-------------|
| 1      | First Year                      | 43            | 1450        |
| 2      | Second Year                     | 44            | 1475        |
| 3      | Third Year (Tentative)          | 43            | 1400        |
| 4      | Final Year (Tentative)          | 42            | 1200        |
|        | <b>Total Credits of Program</b> | <b>172</b>    | <b>5525</b> |

## 1.4 Semester-wise Credit Distribution Structure

Table 1.4 Credit Distribution of Verticals as per NEP-2020 in Second Year of B.E. in ECS

| S. No.              | Course Type | Course Code | Courses                               | Credits | Total |
|---------------------|-------------|-------------|---------------------------------------|---------|-------|
| <b>Semester-III</b> |             |             |                                       |         |       |
| 1                   | PCC         | EC3PC_CR1   | Discrete Mathematics and Graph Theory | 3       | 16    |
| 2                   |             | EC3PC_CR2   | Data Structures                       | 3       |       |
| 3                   |             | EC3PC_LR2   | Data Structures Lab                   | 1       |       |
| 4                   |             | EC3PC_CR3   | Electronic Devices and Circuits       | 3       |       |
| 5                   |             | EC3PC_LR3   | Electronic Devices and Circuits Lab   | 1       |       |
| 6                   |             | EC3PC_CR4   | Digital System Design                 | 2       |       |
| 7                   |             | EC3PC_LR4   | Digital System Design Lab             | 1       |       |

|                    |      |           |                                                  |           |    |
|--------------------|------|-----------|--------------------------------------------------|-----------|----|
| 8                  |      | EC3PC_CR5 | Computer Organization and Architecture           | 2         |    |
| 9                  | EEM  | IL3HM_CR1 | Innovation, Business Models and Entrepreneurship | 2         | 2  |
| 10                 | FP   | ILSEL_PR1 | Field Project                                    | 2         | 2  |
| 11                 | VEC  | ILSHM_CR3 | Environment & Technology                         | 2         | 2  |
|                    |      |           | <b>Total</b>                                     | <b>22</b> |    |
| <b>Semester-IV</b> |      |           |                                                  |           |    |
| 1                  | PCC  | EC4PC_CR1 | Optimization and Sampling Theory                 | 3         | 10 |
| 2                  |      | EC4PC_CR2 | Database Management System                       | 3         |    |
| 3                  |      | EC4PC_LR2 | Database Management System Lab                   | 1         |    |
| 4                  |      | EC4PC_CR3 | Microprocessors and Microcontrollers             | 2         |    |
| 5                  |      | EC4PC_LR3 | Microprocessors and Microcontrollers Lab         | 1         |    |
| 6                  | VSEC | EC4VS_LR1 | Object Oriented Programming with Java            | 2         | 2  |
| 7                  | EEM  | IL4HM_CR1 | Business Forecasting                             | 2         | 2  |
| 8                  | MDM  | -         | MDM-1*                                           | 2         | 2  |
| 9                  | OEC  | -         | OEC-1 <sup>s</sup>                               | 2         | 2  |
| 10                 | AEC  | ILSHM_CR1 | Professional Communication and Soft Skills       | 1         | 2  |
| 11                 |      | ILSHM_LR1 | Professional Communication and Soft Skills Lab   | 1         |    |
| 12                 | VEC  | ILSHM_CR2 | Human Values and Ethics                          | 2         | 2  |
|                    |      |           | <b>Total</b>                                     | <b>22</b> |    |

C-Course, L-Laboratory, T-Tutorial, P-Project

\* Refer Table No. 1.5.2

<sup>s</sup>Refer Table No. 1.5.3

## 1.5 Second Year Scheme of the Syllabus

### 1.5.1 Contact Hours and Credit Distribution of Courses

Table 1.5.1: Contact Hours and Credit Distribution of Courses

| <b>Semester III</b> |             |                                                           |               |               |              |             |                  |          |          |          |           |
|---------------------|-------------|-----------------------------------------------------------|---------------|---------------|--------------|-------------|------------------|----------|----------|----------|-----------|
| S. No.              | Course Code | Course                                                    | Contact Hours |               |              |             | Credits Assigned |          |          |          |           |
|                     |             |                                                           | Theory (C)    | Practical (L) | Tutorial (T) | Project (P) | C                | L        | T        | P        | Total     |
| 1                   | EC3PC_CR1   | Discrete Mathematics and Graph Theory                     | 3             | -             | -            | -           | 3                | -        | -        | -        | 3         |
| 2                   | EC3PC_CR2   | Data Structures                                           | 3             | -             | -            | -           | 3                | -        | -        | -        | 3         |
| 3                   | EC3PC_LR2   | Data Structures Lab                                       | -             | 2             | -            | -           | -                | 1        | -        | -        | 1         |
| 4                   | EC3PC_CR3   | Electronic Devices and Circuits                           | 3             | -             | -            | -           | 3                | -        | -        | -        | 3         |
| 5                   | EC3PC_LR3   | Electronic Devices and Circuits Lab                       | -             | 2             | -            | -           | -                | 1        | -        | -        | 1         |
| 6                   | EC3PC_CR4   | Digital System Design                                     | 2             | -             | -            | -           | 2                | -        | -        | -        | 2         |
| 7                   | EC3PC_LR4   | Digital System Design Lab                                 | -             | 2             | -            | -           | -                | 1        | -        | -        | 1         |
| 98                  | EC3PC_CR5   | Computer Organization and Architecture                    | 2             | -             | -            | -           | 2                | -        | -        | -        | 2         |
| 9                   | IL3HM_CR1   | Innovation, Business Models and Entrepreneurship (Swayam) | 2             | -             | -            | -           | 2                | -        | -        | -        | 2         |
| 10                  | ILSEL_PR1   | Field Project                                             | -             | -             | -            | 4           | -                | -        | -        | 2        | 2         |
| 11                  | ILSHM_CR3   | Environment and Technology                                | 2             | -             | -            | -           | 2                | -        | -        | -        | 2         |
| <b>TOTAL</b>        |             |                                                           | <b>17</b>     | <b>6</b>      | <b>-</b>     | <b>4</b>    | <b>17</b>        | <b>3</b> | <b>-</b> | <b>2</b> | <b>22</b> |

| Semester IV |             |                                                |               |               |              |             |                  |   |   |   |       |
|-------------|-------------|------------------------------------------------|---------------|---------------|--------------|-------------|------------------|---|---|---|-------|
| S. No.      | Course Code | Course                                         | Contact Hours |               |              |             | Credits Assigned |   |   |   |       |
|             |             |                                                | Theory (C)    | Practical (L) | Tutorial (T) | Project (P) | C                | L | T | P | Total |
| 1           | EC4PC_CR1   | Optimization and Sampling Theory               | 3             | -             | -            | -           | 3                | - | - | - | 3     |
| 2           | EC4PC_CR2   | Database Management System                     | 3             | -             | -            | -           | 3                | - | - | - | 3     |
| 3           | EC4PC_LR2   | Database Management System Lab                 | -             | 2             | -            | -           | -                | 1 | - | - | 1     |
| 4           | EC4PC_CR3   | Microprocessors and Microcontrollers           | 2             | -             | -            | -           | 2                | - | - | - | 2     |
| 5           | EC4PC_LR3   | Microprocessors and Microcontrollers Lab       | -             | 2             | -            | -           | -                | 1 | - | - | 1     |
| 6           | EC4VS_LR1   | Object Oriented Programming with Java#         | 1             | 2             | -            | -           | 1                | 1 | - | - | 2     |
| 7           | IL4HM_CR1   | Business Forecasting (Swayam)                  | 2             | -             | -            | -           | 2                | - | - | - | 2     |
| 8           | -           | MDM-1*                                         | 2             | -             | -            | -           | 2                | - | - | - | 2     |
| 9           | -           | OEC-1 <sup>s</sup>                             | 2             | -             | -            | -           | 2                | - | - | - | 2     |
| 10          | ILSHM_CR1   | Professional Communication and Soft Skills     | 1             | -             | -            | -           | 1                | - | - | - | 1     |
| 11          | ILSHM_LR1   | Professional Communication and Soft Skills Lab | -             | 2             | -            | -           | -                | 1 | - | - | 1     |
| 12          | ILSHM_CR2   | Human Values and Ethics                        | 2             | -             | -            | -           | 2                | - | - | - | 2     |
| Total       |             |                                                | 17            | 10            | -            | -           | 17               | 5 | - | - | 22    |

\* Refer Table No. 1.5.2      \$ Refer Table No. 1.5.3      #1-hour Theory classwise and 2-hour Lab batchwise

## 1.5.2 Multi-Disciplinary Minor (MDM) Courses Offered in ECS Program

Table 1.5.2: Semester-wise Credit Distribution of Multi-Disciplinary Minor Courses (MDM)

| S. No. | Minor Title                          | Sem IV (2 credits)                     | Sem V (4 credits)               |                                     | Sem VI (4 credits)                                 |                                                        | Sem VII (4 credits)                               |                                                       |
|--------|--------------------------------------|----------------------------------------|---------------------------------|-------------------------------------|----------------------------------------------------|--------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------|
| 1      | Image Processing and Computer Vision | Signals and Systems                    | Discrete Time Signal Processing | Discrete Time Signal Processing Lab | Image Processing and Machine Learning              | Image Processing Lab                                   | Computer Vision and Machine Learning              | Computer Vision and Machine Learning Lab              |
|        | Course Codes:                        | ET4MM_CX1                              | ET5MM_CX1                       | ET5MM_LX1                           | ET6MM_CX1                                          | ET6MM_LX1                                              | ET7MM_CX1                                         | ET7MM_LX1                                             |
| 2      | Electric Vehicles                    | Introduction to EV                     | EV System and Control           | EV System and Control Lab           | Energy Systems and Charging Infra                  | Energy Systems and Charging Infra Lab                  | Advanced Topic in EV                              | Advanced Topic in EV                                  |
|        | Course Codes:                        | EE4MM_CX1                              | EE5MM_CX1                       | EE5MM_LX1                           | EE6MM_CX1                                          | EE6MM_LX1                                              | EE7MM_CX1                                         | EE7MM_LX1                                             |
| 3      | Additive Manufacturing               | Introduction to Additive Manufacturing | CAD for Additive Manufacturing  | CAD for Additive Manufacturing Lab  | Additive Manufacturing for Industrial Applications | Additive Manufacturing for Industrial Applications Lab | Additive Manufacturing in Consumer and Healthcare | Additive Manufacturing in Consumer and Healthcare Lab |
|        | Course Codes:                        | ME4MM_CX1                              | ME5MM_CX1                       | ME5MM_LX1                           | ME6MM_CX1                                          | ME6MM_LX1                                              | ME7MM_CX1                                         | ME7MM_LX1                                             |

|   |               |                          |                                   |                                       |                              |                                  |                                      |                                          |
|---|---------------|--------------------------|-----------------------------------|---------------------------------------|------------------------------|----------------------------------|--------------------------------------|------------------------------------------|
| 4 | Robotics      | Introduction to Robotics | Mobile Robotics and Path Planning | Mobile Robotics and Path Planning Lab | Robot Perception and Control | Robot Perception and Control Lab | Manipulation Robotics and Automation | Manipulation Robotics and Automation Lab |
|   | Course Codes: | ME4MM_CX2                | ME5MM_CX2                         | ME5MM_LX2                             | ME6MM_CX2                    | ME6MM_LX2                        | ME7MM_CX2                            | ME7MM_LX2                                |

### 1.5.3 Open Elective Courses-1 (OEC-1) Offered in Semester-IV

Table 1.5.3: List of Open Elective-1 Courses

| Course Code | List of OEC-1 Courses                      |
|-------------|--------------------------------------------|
| IL4OE_CX1   | IPR and Patenting                          |
| IL4OE_CX2   | Cybersecurity and Laws                     |
| IL4OE_CX3   | Psychology                                 |
| IL4OE_CX4   | Personal Finance, Investments and Taxation |
| IL4OE_CX5   | Adolescent Health and Well being           |
| IL4OE_CX6   | Essentials of Management                   |
| IL4OE_CX7   | German Language                            |
| IL4OE_CX8   | French Language                            |

## 1.6 Evaluation and Examination Scheme of Second Year Syllabus

Table 1.6.1: Marks Distribution of Courses

| Semester III |             |                                                           |     |     |        |           |             |
|--------------|-------------|-----------------------------------------------------------|-----|-----|--------|-----------|-------------|
| S. No.       | Course Code | Course                                                    | ISE |     | ESE    |           | Total Marks |
|              |             |                                                           | CA  | MSE | Theory | Practical |             |
| 1            | EC3PC_CR1   | Discrete Mathematics and Graph Theory                     | 15  | 15  | 45     | -         | 75          |
| 2            | EC3PC_CR2   | Data Structures                                           | 20  | 20  | 60     | -         | 100         |
| 3            | EC3PC_LR2   | Data Structures Lab                                       | 25  | -   | -      | 25        | 50          |
| 4            | EC3PC_CR3   | Electronic Devices and Circuits                           | 20  | 20  | 60     | -         | 100         |
| 5            | EC3PC_LR3   | Electronic Devices and Circuits Lab                       | 25  | -   | -      | 25        | 50          |
| 6            | EC3PC_CR4   | Digital System Design                                     | 15  | 15  | 45     | -         | 75          |
| 7            | EC3PC_LR4   | Digital System Design Lab                                 | 25  | -   | -      | 25        | 50          |
| 8            | EC3PC_CR5   | Computer Organization and Architecture                    | 15  | 15  | 45     | -         | 75          |
| 9            | IL3HM_CR1   | Innovation, Business Models and Entrepreneurship (Swayam) | 50  | -   | -      | -         | 50          |
| 10           | ILSEL_PR1   | Field Project                                             | 25  | -   | -      | 25        | 50          |
| 11           | ILSHM_CR3   | Environment and Technology                                | 50  | -   | -      | -         | 50          |
| Total        |             |                                                           |     |     |        |           | 725         |
| Semester IV  |             |                                                           |     |     |        |           |             |
| S. No.       | Course Code | Course                                                    | ISE |     | ESE    |           | Total Marks |
|              |             |                                                           | CA  | MSE | Theory | Practical |             |
| 1            | EC4PC_CR1   | Optimization and Sampling Theory                          | 20  | 20  | 60     | -         | 100         |
| 2            | EC4PC_CR2   | Database Management System                                | 20  | 20  | 60     | -         | 100         |
| 3            | EC4PC_LR2   | Database Management System Lab                            | 25  | -   | -      | 25        | 50          |
| 4            | EC4PC_CR3   | Microprocessors and Microcontrollers                      | 15  | 15  | 45     | -         | 75          |

|              |           |                                                |    |    |    |    |            |
|--------------|-----------|------------------------------------------------|----|----|----|----|------------|
| 5            | EC4PC_LR3 | Microprocessors and Microcontrollers Lab       | 25 | -  | -  | 25 | 50         |
| 6            | EC4VS_LR1 | Object Oriented Programming with Java#         | 50 | -  | -  | 25 | 75         |
| 7            | IL4HM_CR1 | Business Forecasting (Swayam)                  | 50 | -  | -  | -  | 50         |
| 8            | -         | MDM-1*                                         | 15 | 15 | 45 | -  | 75         |
| 9            | -         | OEC-1 <sup>s</sup>                             | 15 | 15 | 45 | -  | 75         |
| 10           | ILSHM_CR1 | Professional Communication and Soft Skills     | 25 | -  | -  | -  | 25         |
| 11           | ILSHM_LR1 | Professional Communication and Soft Skills Lab | 25 | -  | -  | -  | 25         |
| 12           | ILSHM_CR2 | Human Values and Ethics                        | 50 | -  | -  | -  | 50         |
| <b>Total</b> |           |                                                |    |    |    |    | <b>750</b> |

\* Refer Table No. 1.5.2

§ Refer Table No. 1.5.3

# 1-hour Theory classwise and 2-hour Lab batchwise

### Evaluation Pattern:

Evaluations consist of the following –

- In Semester Evaluation (ISE)** which comprises of two components - Continuous assessment (CA) and Mid-Semester Examination (MSE)
  - CA - Includes home assignments, group assignments, quizzes, presentations, experiments, mock tests, tutorials, etc.
  - MSE - A written assessment covering up to 50% of the syllabus, conducted at mid-semester.
- End Semester Examination (ESE)** - A written assessment covering 100% of the syllabus, conducted at the end of the semester. Modules covered in the mid-semester exam will have a 30-40 % weightage, with the remaining 60 -70% weightage assigned to the rest of the modules.
- Practical Examination (PE), Oral Examination (OrE) and Project Examination (PrE)** – wherever applicable. These are conducted by a pair of internal and external examiner at the end of the semester.

Table 1.6.2: Components of evaluations with weightage

| Components           | Sub- Components | Weightage                                                                                                                                                                                                                                   | Marks                  |
|----------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| <b>Theory Course</b> |                 |                                                                                                                                                                                                                                             |                        |
| ISE                  | CA              | 20% <sup>@</sup>                                                                                                                                                                                                                            | 20/15*                 |
|                      | MSE             | 20%                                                                                                                                                                                                                                         | 20/15*                 |
| ESE                  |                 | 60%                                                                                                                                                                                                                                         | 60/45*                 |
| <b>Lab Course</b>    |                 |                                                                                                                                                                                                                                             |                        |
| ISE                  | CA              | 60% <sup>#</sup>                                                                                                                                                                                                                            | 15/30 <sup>&amp;</sup> |
|                      | Mock Test       | 40%                                                                                                                                                                                                                                         | 10/20 <sup>&amp;</sup> |
| ESE <sup>§</sup>     | PE/OrE          | 100%                                                                                                                                                                                                                                        | 25/50 <sup>&amp;</sup> |
| <b>Mini Project</b>  |                 |                                                                                                                                                                                                                                             |                        |
| ISE                  | CA              | 100% <ul style="list-style-type: none"> <li>Internal mid Sem evaluation (includes partial demo<sup>#</sup>): 20%</li> <li>Internal end Sem evaluation (full demo<sup>#</sup>): 40%</li> <li>Report: 20%</li> <li>Attendance: 20%</li> </ul> | 25/50 <sup>&amp;</sup> |
| ESE <sup>§</sup>     | PrE             | 100%                                                                                                                                                                                                                                        | 25/50 <sup>&amp;</sup> |

Note: Duration of MSE is 1 hour and ESE is 2.5/2 hours\*

<sup>@</sup> Includes – (CA1 of 10 marks conducted before MSE) + (CA2 of 10 marks conducted after MSE)

\* For 3 credit course/2 credit course

& For marks 25/50/100 as per scheme

# Rubrics can be defined by the faculty with approval from HOD

\$Pair of internal and external examiner should conduct Practical/Oral/Project exams

## 1.7 Second Year Exit Courses

### Certification after completion of Second Year exit courses: Diploma in Embedded Systems

Table 1.7.1: Contact Hours and Credit Distribution for Exit Courses after Second Year

| S. No. | Course Code | Course                          | Contact Hours |               |              |             | Credits Assigned |   |   |   |       |
|--------|-------------|---------------------------------|---------------|---------------|--------------|-------------|------------------|---|---|---|-------|
|        |             |                                 | Theory (C)    | Practical (L) | Tutorial (T) | Project (P) | C                | L | T | P | Total |
| 1      | EC4EX_CR1   | Embedded System Design          | 3             | -             | -            | -           | 3                | - | - | - | 3     |
| 2      | EC4EX_LR1   | Embedded System Design Lab      | -             | 2             | -            | -           | -                | 1 | - | - | 1     |
| 3      | EC4EX_PR1   | Internship                      | -             | -             | -            | 8           | -                | - | - | 4 | 4     |
|        | OR          |                                 |               |               |              |             |                  |   |   |   |       |
|        | EC4EX_PR2   | Project - IoT based Application | -             | -             | -            | 8           | -                | - | - | 4 | 4     |
| Total  |             |                                 |               |               |              |             |                  |   |   |   | 8     |

Table 1.7.2: Marks Distribution of Exit Courses after Second Year

| S. No. | Course Code | Course                          | ISE |     | ESE    |           | Total Marks |
|--------|-------------|---------------------------------|-----|-----|--------|-----------|-------------|
|        |             |                                 | CA  | MSE | Theory | Practical |             |
| 1      | EC4EX_CR1   | Embedded System Design          | 20  | 20  | 60     | -         | 100         |
| 2      | EC4EX_LR1   | Embedded System Design Lab      | 25  | -   | -      | 25        | 50          |
| 3      | EC4EX_PR1   | Internship                      | 50  | -   | -      | 100       | 150         |
| OR     |             |                                 |     |     |        |           |             |
| 4      | EC4EX_PR2   | Project - IoT based Application | 50  |     | -      | 100       | 150         |
| Total  |             |                                 |     |     |        |           | 300         |

#### Guidelines for Exit:

- As per NEP 2020 Four Year Multidisciplinary Engineering Curriculum Framework, SFIT offers multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured.
- Multiple Exits: Students will have the flexibility to enter a programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.
- Eligibility for Exit after second year:**
  - Students exiting the Second Year Programme after securing minimum 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 8 credits in skill-based vocational courses (skill-based courses, internship, mini projects etc.) offered during summer vacation after the second year.
  - Breakdown of the 8 Additional Credits:**
    - Option 1:** Two 4-credit (3+1) courses.
    - Option 2:** One 4-credit (3+1) course OR a certified industry internship worth 4 credits (minimum 60 hours).
  - Exit options shall be provided with Diploma to the students at the end of the fourth semester, in the four-year degree programme.

## 2 Semester-III Course Syllabus

### 2.1 Discrete Mathematics and Graph Theory (EC3PC\_CR1)

#### Teaching Scheme

| Course Code | Course Name                           | Contact Hours       | Credits |
|-------------|---------------------------------------|---------------------|---------|
| EC3PC_CR1   | Discrete Mathematics and Graph Theory | 03 <sup>&amp;</sup> | 03      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                               |
|--------|----------------------------------------------------------------------------------------------------------|
| 1      | To <i>develop</i> the ability to reason logically and understand the notion of mathematical thinking.    |
| 2      | To <i>explain</i> the concept of relations and functions and its applications.                           |
| 3      | To <i>teach</i> relations, functions, Diagraph, posets and lattice.                                      |
| 4      | To <i>define</i> the use of groups and codes and its applications to basic encoding-decoding techniques. |
| 5      | To <i>teach</i> concepts of graph theory and its applications in solving real world problems.            |

#### Course Outcomes

|                             |                                                                                                                      |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                      |
| CO1                         | <i>understand</i> the notion of mathematical thinking, mathematical proofs and <i>apply</i> them in problem solving. |
| CO2                         | <i>analyze</i> the concept of relations and functions and <i>solve</i> problems.                                     |
| CO3                         | <i>solve</i> problems by identifying the appropriate structures of posets and lattices.                              |
| CO4                         | <i>understand</i> binary operations on groups and rings and <i>use</i> it in coding.                                 |
| CO5                         | <i>analyze</i> the discrete structures mathematically and <i>apply</i> its principles to <i>identify</i> solutions.  |

#### Course Contents

| Module | Unit                                             | Detailed Contents                                    | Hours |
|--------|--------------------------------------------------|------------------------------------------------------|-------|
| 1.0    | Prerequisite                                     |                                                      | 04    |
|        | Introductory concepts from algebra and calculus. |                                                      |       |
|        | 1.1                                              | Propositional logic, Predicate logic, Laws of logic. |       |

|            |                                |                                                                                                                                                                     |           |
|------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | 1.2                            | iQuantifiers, Normal forms, Mathematical induction.                                                                                                                 |           |
| <b>2.0</b> | <b>Relations and Functions</b> |                                                                                                                                                                     | <b>05</b> |
|            | 2.1                            | Basic concepts of set theory, Inclusion-exclusions, Venn diagrams.                                                                                                  |           |
|            | 2.2                            | Relations: Definition, Types of relations, Representation of relations, Closures of relations, Warshall's algorithm, Equivalence relations and Equivalence classes. |           |
|            | 2.3                            | Recursively defined functions. Functions: Definition, types of functions, Composition of functions, Identity and inverse function.                                  |           |
| <b>3.0</b> | <b>Posets and Lattice</b>      |                                                                                                                                                                     | <b>06</b> |
|            | 3.1                            | Partial order relations, Poset, Hasse diagram.                                                                                                                      |           |
|            | 3.2                            | Chain and anti-chains, Lattice, Types of lattice, Sub-lattice.                                                                                                      |           |
| <b>4.0</b> | <b>Algebraic Structures</b>    |                                                                                                                                                                     | <b>05</b> |
|            | 4.1                            | Algebraic structures with one binary operation: Semi group.                                                                                                         |           |
|            | 4.2                            | Monoid groups, Subgroups, Abelian group, Cyclic group, Isomorphism; Algebraic structures with two binary operations: Ring.                                          |           |
|            | 4.3                            | Coding Theory: Coding, binary information and error detection, decoding and error correction.                                                                       |           |
| <b>5.0</b> | <b>Graph Theory</b>            |                                                                                                                                                                     | <b>06</b> |
|            | 5.1                            | Types of graphs, Graph representation, Sub-graphs.                                                                                                                  |           |
|            | 5.2                            | Operations on graphs, Walk, Path, Circuit, Connected-Disconnected graph, Components, Homomorphism and Isomorphism of graphs.                                        |           |
|            | 5.3                            | Euler and Hamiltonian Graphs, Planar graph, Cut-set, Cut vertex, Applications.                                                                                      |           |
|            | <b>Total Hours</b>             |                                                                                                                                                                     | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Discrete Mathematical Structures, VII Ed., Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, Pearson Education, 2019.
2. Elements of Discrete Mathematics, A Computer Oriented Approach, IV Ed., D P Mohapatra, PHI Learning, 2014.
3. Elements of Discrete Mathematics, II Ed., C. L. Liu, McGraw- Hill Book Company, 2000.
4. Discrete Mathematics and Applications, V Ed., K. H. Rosen, Tata McGraw Hill Publication, 2003.

### Reference Books

1. Discrete Mathematical Structures, II Ed., Y N Singh, Wiley India, 2017.
2. Discrete Mathematics for Computer Scientists and Mathematicians, II Ed., J. L. Mott, A. Kandel, T. P. Baker, Prentice Hall of India, 1986.
3. Discrete Mathematical Structures with Applications to Computer Science, I Ed., J. P. Trembley, R. Manohar, Tata McGraw Hill Education, 2001.

### Web Resources

1. NPTEL course on Discrete Mathematics, Dr. Anil Shukla, Prof. Sudarshan Iyengar, IIT Ropar  
<https://nptel.ac.in/courses/106106183>
2. NPTEL course on Discrete Mathematical Structures, Prof. Kamala Krithivasan, IIT Madras.  
<https://nptel.ac.in/courses/106/106/106106094/>
3. Coursera course on Introduction to Discrete Mathematics for Computer Science Specialization, UC SanDiego.  
<https://www.coursera.org/specializations/discrete-mathematics>

& 2-hour Theory classwise and 1-hour tutorial batchwise

## 2.2 Data Structures (EC3PC\_CR2)

### Teaching Scheme

| Course Code | Course Name     | Contact Hours | Credits |
|-------------|-----------------|---------------|---------|
| EC3PC_CR2   | Data Structures | 03            | 03      |

### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 20    | Continuous | 20    | 1               | 60    | 2.5             | 100         |

### Course Objectives

| S. No. | Objectives                                                                                                                                                    |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> data structures and its types and <i>explain</i> abstract data types.                                                                     |
| 2      | To <i>acquaint</i> with linear data structures like stacks and queues and <i>explain</i> its applications.                                                    |
| 3      | To <i>teach</i> various operations related to linked list like insertion, deletion, searching and traversing and <i>demonstrate</i> appropriate applications. |
| 4      | To <i>familiarize</i> with non-linear data structures like trees and graphs and <i>explore</i> its applications.                                              |
| 5      | To <i>understand</i> various sorting and searching algorithms.                                                                                                |

### Course Outcomes

|                             |                                                                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                          |
| CO1                         | <i>comprehend</i> the basic concepts of data structures, abstract data types (ADT) and <i>identify</i> various types of data structures. |
| CO2                         | <i>explain</i> linear data structures, ie. stack and queue and <i>explore</i> its applications.                                          |
| CO3                         | handle operations on linked list and <i>develop</i> applications using linked list.                                                      |
| CO4                         | <i>familiarize</i> with non-linear data structures like trees and graphs and <i>solve</i> problems using the appropriate type of trees.  |
| CO5                         | <i>describe</i> various sorting and searching algorithms and <i>identify</i> suitable technique for a given set of data.                 |

### Course Contents

| Module | Unit                            | Detailed Contents                                              | Hours |
|--------|---------------------------------|----------------------------------------------------------------|-------|
| 1.0    | Prerequisites                   |                                                                |       |
|        | C, C++ Programming              |                                                                |       |
|        | Introduction to Data Structures |                                                                | 04    |
|        | 1.1                             | Introduction to data structures and abstract data types (ADT), |       |

|                    |                                         |                                                                                                                                                                                                                                                                                                                                                  |           |
|--------------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    |                                         | types of data structures - Linear and Nonlinear, Operations on data structures,                                                                                                                                                                                                                                                                  |           |
|                    | 1.2                                     | Concept of static arrays vs dynamic arrays, structures, array data type: single and multidimensional arrays.                                                                                                                                                                                                                                     |           |
| <b>2.0</b>         | <b>Stack and Queues</b>                 |                                                                                                                                                                                                                                                                                                                                                  | <b>08</b> |
|                    | 2.1                                     | Stacks: Basic structure of stack, applications, Basic operations on stack, Representation of stack using arrays, Well form-ness of parenthesis, Infix to postfix, Conversion and postfix evaluation. Tower of Hanoi.                                                                                                                             |           |
|                    | 2.2                                     | Queues: Operations on queue, Array implementation of queue, Types of queues - Circular queue, Priority queue, Applications of queue: Interrupt handling, job scheduling.                                                                                                                                                                         |           |
| <b>3.0</b>         | <b>Linked List</b>                      |                                                                                                                                                                                                                                                                                                                                                  | <b>09</b> |
|                    | 3.1                                     | Representation of linked list, linked list v/s array, types of linked list - singly linked list, circular linked list, doubly linked list (linear and circular), Operations on singly linked list, implementation of stack and queue using singly linked list.                                                                                   |           |
| <b>4.0</b>         | <b>Trees and Graphs</b>                 |                                                                                                                                                                                                                                                                                                                                                  | <b>09</b> |
|                    | 4.1                                     | Trees: Tree terminologies, Binary tree, Types of binary tree, Binary tree representation: Array and linked representation of binary trees, Binary tree traversals algorithms: In-order, Pre-order, Post-order, Binary search Tree, Operations on binary search tree, Applications of binary tree – Heap tree, Expression tree, Huffman encoding. |           |
|                    | 4.2                                     | Graphs: Graph terminologies, Representation of graph, Graph traversals -Depth First Search (DFS) and Breadth First Search (BFS), Graph Application-Topological Sorting.                                                                                                                                                                          |           |
| <b>5.0</b>         | <b>Searching and Sorting Techniques</b> |                                                                                                                                                                                                                                                                                                                                                  | <b>09</b> |
|                    | 5.1                                     | Searching techniques: Linear search, Binary search, Hashing: Concept, hash functions, collision resolution.                                                                                                                                                                                                                                      |           |
|                    | 5.2                                     | Sorting techniques: Bubble, Insertion, Selection, Quick sort, Merge sort.                                                                                                                                                                                                                                                                        |           |
| <b>Total Hours</b> |                                         |                                                                                                                                                                                                                                                                                                                                                  | <b>39</b> |

## Suggested Learning Resources

### Textbooks

1. Data Structures using C, V Ed., Aaron M Tenenbaum, Yedidiah Langsam, Moshe J Augenstein, Pearson Publication, 2009.
2. Introduction to Data Structure and its Applications, II Ed., Jean Paul Tremblay, P. G. Sorenson, McGraw-Hill Higher Education, 2001.
3. Data Structures using C, III Ed., Reema Thareja, Oxford University Press, 2018.
4. Data Structures: A Pseudocode Approach with C, II Ed., Richard F. Gilberg, Behrouz A. Forouzan, Cengage Learning, 2005.

## Reference Books

1. C and Data Structures, II Ed., Prof. P. S. Deshpande, Prof. O. G. Kakde, DreamTech press, 2017.
2. Data Structure using C, II Ed., E. Balaguruswamy, Tata McGraw-Hill Education, 2011.
3. Data Structures using C and C++, III Ed., Rajesh K Shukla, McGraw-Hill Education, 2014.

## Web Resources

1. NPTEL course on Introduction to Data Structures and Algorithms, Prof. Naveen Garg, IIT Delhi.  
<https://nptel.ac.in/courses/106102064>
2. Coursera course on Data Structures and Algorithms Specialization, UC San Diego  
<https://www.coursera.org/specializations/data-structures-algorithms>
3. A2Z-DSA course playlist  
[https://www.youtube.com/playlist?list=PLgUwDviBI0oF6QL8m22w1hIDC1vJ\\_BHz](https://www.youtube.com/playlist?list=PLgUwDviBI0oF6QL8m22w1hIDC1vJ_BHz)

## 2.3 Data Structures Lab (EC3PC\_LR2)

### Teaching Scheme

| Course Code | Course Name         | Contact Hours | Credits |
|-------------|---------------------|---------------|---------|
| EC3PC_LR2   | Data Structures Lab | 02            | 01      |

### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | 25  | -   | -   | 50          |

### Course Objectives

| S. No. | Objectives                                                                                             |
|--------|--------------------------------------------------------------------------------------------------------|
| 1      | To <i>learn</i> and <i>understand</i> linear data structures used in programming languages.            |
| 2      | To <i>learn</i> and <i>understand</i> linear data structure linked list used in programming languages. |
| 3      | To <i>learn</i> and <i>understand</i> non-linear data structure trees used in programming languages.   |
| 4      | To <i>learn</i> and <i>differentiate</i> between various sorting techniques.                           |
| 5      | To <i>learn</i> and <i>differentiate</i> between various searching techniques.                         |

### Course Outcomes

|                             |                                                                                                                                                                                             |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                                                                             |
| CO1                         | <i>understand, classify</i> and <i>apply</i> the concepts of static linear data structures like stack, queue for an appropriate application.                                                |
| CO2                         | <i>understand, classify</i> and <i>apply</i> the concepts of dynamic linear data structures like linked lists for an appropriate application.                                               |
| CO3                         | <i>understand, classify</i> and <i>apply</i> the concepts of non-linear data structure- tree for an appropriate application.                                                                |
| CO4                         | <i>select</i> and <i>apply</i> appropriate sorting techniques for a given application - Insertion sort / selection sort/ merge sort/ quick sort                                             |
| CO5                         | <i>select</i> and <i>apply</i> an appropriate searching and indexing technique to store and search data efficiently - Binary search algorithm / hashing techniques for a given application. |

### Suggested List of Experiments

| S. No. | Suggestive List of Experiments                                                                                                                                          |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Write a program to implement stack using array (static data structure).                                                                                                 |
| 2      | Write a program to implement queue using array (static data structure).                                                                                                 |
| 3      | Write a program to implement linked list using menu driven approach (dynamic data structure) - insertion, deletion, searching, count no. of nodes and reverse the list. |
| 4      | Write a program to implement linked list to perform polynomial operations like addition/multiplication.                                                                 |
| 5      | Write a program to implement stacks using menu driven program with the help of linked list to perform PUSH, POP, PEEK and DISPLAY operations.                           |

|    |                                                                                                                                                                       |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6  | Write a program to implement queue using menu driven program with the help of linked list to perform ENQUEUE, DEQUEUE and DISPLAY operations.                         |
| 7  | Write a menu driven program to implement binary search tree to perform following operations – counting, creation, traversal, searching, insertion, deletion, display. |
| 8  | Write a menu driven program to implement AVL tree to perform following operations – creation, traversal, searching, insertion, deletion, display.                     |
| 9  | Write a program to implement insertion sort on the given data.                                                                                                        |
| 10 | Write a program to implement selection sort on the given data.                                                                                                        |
| 11 | Write a program to implement merge sort on the given data.                                                                                                            |
| 12 | Write a program to implement quick sort on the given data.                                                                                                            |
| 13 | Write a program to implement linear search technique.                                                                                                                 |
| 14 | Write a program to implement binary search technique.                                                                                                                 |
| 15 | Write a program to implement hashing techniques and collision resolution techniques.                                                                                  |

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

## Suggested Learning Resources

### Textbooks

1. Data Structures through C in Depth, S. K Srivastava, Deepali Srivastava, BPB Publications, 2011.
2. Data Structure using C, II Ed., Yedidya Langsam, Moshej Augenstein, Aaron M. Tenenbaum, Pearson Education, 2009.
3. Fundamentals of Data Structures in C, II Ed., Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, W. H. Freeman and Company, 2008.

### Reference Books

1. Data Structures using C, II Ed., Reema Thareja, Oxford University Press, 2017.
2. Data Structures and Algorithm Analysis in C, IV Ed., Mark A. Weiss, Pearson, 2014.

### Web Resources

1. NPTEL course on Design and analysis of algorithms, Prof. Madhavan Mukund, Chennai Mathematical Institute.  
[https://swayam.gov.in/nd1\\_noc19\\_cs47/preview](https://swayam.gov.in/nd1_noc19_cs47/preview)
2. Coursera course on Data Structures, UC DanDiego  
<https://www.coursera.org/learn/data-structures>
3. NPTEL course on Data Structures and Algorithms, Prof. Naveen Garg, IIT Delhi  
<https://nptel.ac.in/courses/106102064>
4. Online Data Structure courses  
<https://www.edx.org/learn/data-structures>

## 2.4 Electronic Devices and Circuits (EC3PC\_CR3)

### Teaching Scheme

| Course Code | Course Name                     | Contact Hours | Credits |
|-------------|---------------------------------|---------------|---------|
| EC3PC CR3   | Electronic Devices and Circuits | 03            | 03      |

### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 20    | Continuous | 20    | 1               | 60    | 2.5             | 100         |

### Course Objectives

| S. No. | Objectives                                                                                                                               |
|--------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>deliver</i> the knowledge of basic semiconductor devices.                                                                          |
| 2      | To <i>perform</i> DC and AC analysis of BJT and MOSFET amplifier circuits.                                                               |
| 3      | To <i>teach</i> fundamental principles of operational amplifier.                                                                         |
| 4      | To <i>develop</i> an overall approach for students from selection of integrated circuits, specification, functionality and applications. |
| 5      | To <i>introduce</i> and <i>motivate</i> students to the use of emerging electronic devices.                                              |

### Course Outcomes

|                             |                                                                                                              |
|-----------------------------|--------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                              |
| CO1                         | <i>understand</i> construction, characteristics and working of semiconductor devices such as BJT and MOSFET. |
| CO2                         | <i>select</i> appropriate circuit for given application.                                                     |
| CO3                         | <i>derive</i> and determine various performance-based parameters and their significance for Op-Amp.          |
| CO4                         | <i>use</i> various configurations of Op-Amp for different applications.                                      |
| CO5                         | troubleshoot specified applications using various linear ICs.                                                |

### Course Contents

| Module     | Unit                                                                                              | Detailed Contents                                                                                                                                                                                                                                         | Hours     |
|------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisite</b>                                                                               |                                                                                                                                                                                                                                                           |           |
|            | Construction, operation and characteristics of PN junction diode and bipolar junction transistor. |                                                                                                                                                                                                                                                           |           |
| <b>1.0</b> | <b>Biasing Circuits of BJTs and MOSFETs</b>                                                       |                                                                                                                                                                                                                                                           | <b>08</b> |
|            | 1.1                                                                                               | BJT construction and structure, symbol, operation, voltages and currents, V-I characteristics of common emitter (CE), common base (CB) and common collector (CC) configuration, Early effect. Concept of DC load line, Q point and regions of operations, |           |

|            |                                                                           |                                                                                                                                                                                                      |           |
|------------|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            |                                                                           | Analysis and design of biasing circuits for BJT.                                                                                                                                                     |           |
|            | 1.2                                                                       | JFET: Construction, symbol, operation, V-I and transfer characteristic.                                                                                                                              |           |
|            | 1.3                                                                       | MOSFET: Construction, operation, symbol, V-I and transfer characteristics of the D-MOSFET and E-MOSFET.                                                                                              |           |
| <b>2.0</b> | <b>Small Signal Amplifiers</b>                                            |                                                                                                                                                                                                      | <b>08</b> |
|            | 2.1                                                                       | Concept of AC load line and Amplification, Small signal analysis ( $Z_i$ , $Z_o$ , $A_v$ and $A_i$ ) of CE amplifiers using hybrid $\pi$ model only.                                                 |           |
|            | 2.2                                                                       | Small signal analysis ( $Z_i$ , $Z_o$ , $A_v$ ) of CS (for E-MOSFET) amplifiers.                                                                                                                     |           |
|            | 2.3                                                                       | Introduction to multistage amplifiers. Cascade and cascade only. (Concept, advantages and disadvantages).                                                                                            |           |
| <b>3.0</b> | <b>Operational Amplifiers</b>                                             |                                                                                                                                                                                                      | <b>08</b> |
|            | 3.1                                                                       | Internal block diagram of op-amp, characteristics of op-amp, ideal & practical op-amp parameters / specifications (no detailed description or any analysis).                                         |           |
|            | 3.2                                                                       | Operational amplifier, Equivalent circuit, Circuit symbols and terminals. Op-Amp IC-741 pin diagram and pin function.                                                                                |           |
|            | 3.3                                                                       | Operational amplifier open loop and closed loop configurations (theoretical description only), the concept of virtual ground.                                                                        |           |
| <b>4.0</b> | <b>Applications of Operational Amplifiers &amp; Special Purpose IC555</b> |                                                                                                                                                                                                      | <b>08</b> |
|            | 4.1                                                                       | Adder, summing amplifier, averaging circuit, subtractor, integrator (ideal), differentiator (ideal), op-amp instrumentation amplifier (only mathematical analysis for derivation of output voltage). |           |
|            | 4.2                                                                       | IC-555 timer internal block diagram and pin configuration.                                                                                                                                           |           |
| <b>5.0</b> | <b>Applications of IC555 &amp; Emerging Electronic Devices</b>            |                                                                                                                                                                                                      | <b>07</b> |
|            | 5.1                                                                       | Operation of IC555 as astable and monostable multivibrator with mathematical analysis and problems on astable and monostable multivibrators.                                                         |           |
|            | 5.2                                                                       | Single Electron Transistor (SET) and Quantum Dots (Theoretical description only – Construction, structure and nature of operation, characteristics, and applications).                               |           |
|            | 5.3                                                                       | Memristor and Spintronic devices (Theoretical description only – Construction, structure and nature of operation, characteristics, and applications).                                                |           |
|            | <b>Total Hours</b>                                                        |                                                                                                                                                                                                      | <b>39</b> |

## Suggested Learning Resources

### Textbooks

1. Electronic Circuit Analysis and Design, II Ed., Donald A. Neamen, Tata McGraw Hill, 2012.
2. Microelectronic Circuits Theory and Applications, VII Ed., Adel S. Sedra, Kenneth C. Smith, Arun N Chandorkar, Oxford University Press, 2020.
3. Nano-electronic Device Applications Handbook, I Ed. James Morris & Krzysztof Iniewski,

CRC Press, 2011.

4. Op-Amps and Linear Integrated Circuits, IV Ed., Ramakant A. Gayakwad, Pearson Prentice Hall, 2011.

### Reference Books

1. Electronic Devices and Circuit Theory, XI Ed., Robert Boylestad, Pearson, 2016.
2. Operational Amplifiers, II Ed., George Clayton, Steve Winder, NewnesBali, 2004.
3. Analysis & Design of Analog Integrated Circuits Gray, Hurst, Lewise, Meyer, V Ed., Wiley, 2010.
4. Integrated Circuits, II Ed., K. R. Botkar, Khanna Publishers, 2014.
5. Electronic Devices and Circuits, III Ed., S. Salivahanan, N. Suresh Kumar, Tata McGraw Hill Education, 2011.
6. Linear Integrated Circuits, IV Ed., D. Roy Choudhury, S. B. Jain, New Age International Publishers, 2019.
7. Design with Operational Amplifiers & Analog Integrated Circuits, IV Ed., Sergio Franco, Tata McGraw Hill Education, 2015.
8. Operational Amplifiers with Linear Integrated Circuits, IV Ed., William D. Stanley, Pearson, 2012.

### Web Resources

1. NPTEL course on Analog Electronic Circuit, Prof. Shouribrata Chatterjee, IIT Delhi.  
[https://swayam.gov.in/nd1\\_noc20\\_ee89/preview](https://swayam.gov.in/nd1_noc20_ee89/preview)
2. NPTEL course on Introduction to Transistors: BJT  
<https://youtu.be/mwITd4JkUjw>
3. Introduction to Op-amp, Indian Institute of Science, Bengaluru  
<https://youtu.be/7iOPteIA2m0>
4. IC-555 Timer  
[https://youtu.be/WFsPI8\\_ZKbc](https://youtu.be/WFsPI8_ZKbc)
5. Nano Electronic Devices  
<https://www.youtube.com/watch?v=UKmwJO9ZhKg&list=PLmCESm-x-l81lchCqyBT1blXaBkwnqZ1F>
6. Electronics Nanoelectronics Devices and Materials  
[https://youtu.be/nnq5asbB\\_Ow](https://youtu.be/nnq5asbB_Ow)

## 2.5 Electronic Devices and Circuits Lab (EC3PC\_LR3)

### Teaching Scheme

| Course Code | Course Name                         | Contact Hours | Credits |
|-------------|-------------------------------------|---------------|---------|
| EC3PC_LR3   | Electronic Devices and Circuits Lab | 02            | 01      |

### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | 25  | -   | -   | 50          |

### Course Objectives

| S. No. | Objectives                                                                                                                                                                                    |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>make</i> students familiar with equipments and measuring instruments.                                                                                                                   |
| 2      | To <i>provide</i> hands on experience to develop laboratory setup for performing given experimental using various equipments, electronic devices and measuring instruments.                   |
| 3      | To <i>develop</i> an ability among students to gather appropriate data, <i>analyze</i> the same to relate theory with practical and <i>develop</i> trouble shooting abilities among students. |
| 4      | To <i>develop</i> an overall approach for students from selection of integrated circuits, specification, functionality and applications.                                                      |
| 5      | To <i>introduce</i> and <i>motivate</i> students to the use of emerging electronic devices.                                                                                                   |

### Course Outcomes

|                             |                                                                                                     |
|-----------------------------|-----------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                     |
| CO1                         | <i>interpret</i> the characteristics of semiconductor devices.                                      |
| CO2                         | <i>analyze</i> electronics circuits using BJT and FET (DC and AC analysis).                         |
| CO3                         | <i>analyze</i> and <i>identify</i> the linear and nonlinear applications of operational amplifiers. |
| CO4                         | <i>design</i> an application with the use of Op-Amp and IC-555.                                     |
| CO5                         | <i>simulate</i> basic circuits using electronic devices through software simulation.                |

### Suggested List of Experiments

| S. No. | Suggestive List of Experiments                                                          |
|--------|-----------------------------------------------------------------------------------------|
| 1      | To study input and output characteristics of CE configuration of BJT.                   |
| 2      | To perform analysis and design fixed bias, voltage divider bias for CE amplifier.       |
| 3      | To study CE amplifier as voltage amplifier. (Calculate $A_v$ , $A_i$ , $R_i$ , $R_o$ ). |
| 4      | To study CS MOSFET as voltage amplifier and measure its performance parameters.         |
| 5      | To determine the gain of Op-Amp as closed loop inverting and non-inverting amplifier.   |
| 6      | To build/test adder circuit using Op-Amp IC-741.                                        |

|    |                                                                                   |
|----|-----------------------------------------------------------------------------------|
| 7  | To build/test integrator circuit using Op-Amp IC-741.                             |
| 8  | To build/test differentiator circuit using Op-Amp IC-741.                         |
| 9  | To build/test astable multivibrator using IC-555 for the given specifications.    |
| 10 | To build/test monostable multivibrator using IC-555 for the given specifications. |
| 11 | To simulate V-I characteristics of memristor using nanohub.org                    |
| 12 | To simulate and study BJT characteristics.                                        |
| 13 | To simulate and study MOSFET characteristics.                                     |
| 14 | To simulate and study CE amplifier.                                               |
| 15 | To simulate and study Op-Amp as closed loop inverting amplifier.                  |

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

## Suggested Learning Resources

### Textbooks

1. Electronic Circuit Analysis and Design, II Ed., Donald A. Neamen, Tata McGraw Hill, 2012.
2. Microelectronic Circuits Theory and Applications, VII Ed., Adel S. Sedra, Kenneth C. Smith, Arun N Chandorkar, Oxford University Press, 2020.
3. Nano-electronic Device Applications Handbook, I Ed. James Morris & Krzysztof Iniewski, CRC Press, 2011.
4. Op-Amps and Linear Integrated Circuits, IV Ed., Ramakant A. Gayakwad, Pearson Prentice Hall, 2011.

### Reference Books

1. Electronic Devices and Circuit Theory, XI Ed., Robert Boylestad, Pearson, 2016.
2. Operational Amplifiers, II Ed., George Clayton, Steve Winder, Newnes Bali, 2004.
3. Analysis & Design of Analog Integrated Circuits Gray, Hurst, Lewis, Meyer, V Ed., Wiley, 2010.
4. Integrated Circuits, II Ed., K. R. Botkar, Khanna Publishers, 2014.
5. Electronic Devices and Circuits, III Ed., S. Salivahanan, N. Suresh Kumar, Tata McGraw Hill Education, 2011.
6. Linear Integrated Circuits, IV Ed., D. Roy Choudhury, S. B. Jain, New Age International Publishers, 2019.
7. Design with Operational Amplifiers & Analog Integrated Circuits, IV Ed., Sergio Franco, Tata McGraw Hill Education, 2015.
8. Operational Amplifiers with Linear Integrated Circuits, IV Ed., William D. Stanley, Pearson, 2012.

### Web Resources

1. NPTEL course on Analog Electronic Circuit, Prof. Shouribrata Chatterjee, IIT Delhi.  
[https://swayam.gov.in/nd1\\_noc20\\_ee89/preview](https://swayam.gov.in/nd1_noc20_ee89/preview)

2. Introduction to Op-amp, Indian Institute of Science, Bengaluru  
<https://youtu.be/7iOPteIA2m0>
3. IC-555 Timer  
[https://youtu.be/WFsPI8\\_ZKbc](https://youtu.be/WFsPI8_ZKbc)
4. Nano Electronic Devices  
<https://www.youtube.com/watch?v=UKmwJO9ZhKg&list=PLmCESm-x-l81lchCqyBT1blXaBkwnqZ1F>
5. Circuit Simulation link  
<https://www.circuitlab.com/>

## 2.6 Digital System Design (EC3PC\_CR4)

### Teaching Scheme

| Course Code | Course Name           | Contact Hours | Credits |
|-------------|-----------------------|---------------|---------|
| EC3PC_CR4   | Digital System Design | 02            | 02      |

### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

### Course Objectives

| S. No. | Objectives                                                                                                                       |
|--------|----------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>understand</i> number system representations and their inter-conversions used in digital electronic circuits.              |
| 2      | To <i>analyze</i> digital logic processes and to <i>implement</i> logical operations using various combinational logic circuits. |
| 3      | To <i>analyze, design</i> and <i>implement</i> logical operations using various sequential logic circuits.                       |
| 4      | To <i>understand</i> various logic families and Programmable Logic Devices (PLD).                                                |
| 5      | To <i>learn</i> basic concepts in Verilog Hardware Description Language (VHDL).                                                  |

### Course Outcomes

|                             |                                                                                                                                                                |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                                                |
| CO1                         | <i>perform</i> code conversion and <i>apply</i> Boolean algebra, SOP and POS representation, K-Map for the implementation and minimization of logic functions. |
| CO2                         | <i>analyze, design</i> and <i>implement</i> combinational logic circuits.                                                                                      |
| CO3                         | <i>analyze, design</i> and <i>implement</i> sequential logic circuits.                                                                                         |
| CO4                         | <i>understand</i> TTL & CMOS logic families, PLDs, CPLD and FPGA.                                                                                              |
| CO5                         | <i>understand</i> basics of VHDL and its programming with combinational and sequential logic circuits.                                                         |

### Course Contents

| Module     | Unit                                          | Detailed Contents                                                          | Hours     |
|------------|-----------------------------------------------|----------------------------------------------------------------------------|-----------|
|            | <b>Prerequisite</b>                           |                                                                            |           |
|            | Number Systems, Logic Gates, Boolean algebra. |                                                                            |           |
| <b>1.0</b> | <b>Fundamentals of Digital Design</b>         |                                                                            | <b>04</b> |
|            | 1.1                                           | Codes: Excess-3 Code, Gray Code, Weighted code, Parity Code: Hamming Code. |           |
|            | 1.2                                           | Universal Gates: Realization using NAND, NOR gates.                        |           |

|                    |                                                      |                                                                                                                                                                                                                                                                   |           |
|--------------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 1.3                                                  | SOP and POS representation, K Map up to four variables.                                                                                                                                                                                                           |           |
| <b>2.0</b>         | <b>Combinational Logic Circuits</b>                  |                                                                                                                                                                                                                                                                   | <b>05</b> |
|                    | 2.1                                                  | Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder, Magnitude Comparator.                                                                                                                        |           |
|                    | 2.2                                                  | Multiplexer, cascading of Multiplexer, demultiplexer, decoder.                                                                                                                                                                                                    |           |
|                    | 2.3                                                  | MSI devices: IC7483, IC74151, IC74138, IC7485.                                                                                                                                                                                                                    |           |
| <b>3.0</b>         | <b>Sequential Logic Circuits</b>                     |                                                                                                                                                                                                                                                                   | <b>07</b> |
|                    | 3.1                                                  | Sequential Logic: Latches and Flip-Flops. RS, JK, Master slave flip flops, T & D flip flops with various triggering methods.                                                                                                                                      |           |
|                    | 3.2                                                  | Registers: SISO, SIPO, PISO, PIPO, Universal Shift Register. Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD N, BCD Counter.                                                                                          |           |
|                    | 3.3                                                  | Sequential Logic Design: Mealy and Moore Machines, clocked synchronous state machine analysis, state reduction techniques (inspection, partition and implication chart method) and state assignment, sequence detector, Clocked synchronous state machine design. |           |
| <b>4.</b>          | <b>Logic Families and Programmable Logic Devices</b> |                                                                                                                                                                                                                                                                   | <b>04</b> |
|                    | 4.1                                                  | Logic Families: Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out and Fan-in), transfer characteristics of TTL NAND, Operation of TTL NAND gate.                                    |           |
|                    | 4.2                                                  | Programmable Logic Devices: Concept of PAL and PLA, Introduction to CPLD and FPGA architectures.                                                                                                                                                                  |           |
| <b>5.0</b>         | <b>Introduction to VHDL</b>                          |                                                                                                                                                                                                                                                                   | <b>06</b> |
|                    | 5.1                                                  | Basics of VHDL/Verilog Programming.                                                                                                                                                                                                                               |           |
|                    | 5.2                                                  | Design and implementation of logic gates, adder, subtractor, multiplexer and flip flop using VHDL/Verilog.                                                                                                                                                        |           |
| <b>Total Hours</b> |                                                      |                                                                                                                                                                                                                                                                   | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Digital Design Principles and Practices, V Ed., John F. Warkerly, Pearson Education, 2018.
2. Digital Design, V Ed., Morris Mano, Michael D. Ciletti, Pearson Education, 2013.
3. Modern Digital Electronics, IV Ed., R. P. Jain, Tata McGraw Hill Education, 2010.
4. Fundamentals of Digital Circuits, IV Ed., A. Anand Kumar, PHI, 2016.
5. Digital Electronics and Design with VHDL, I Ed., Volnei A. Pedroni, Morgan Kaufmann Publisher, 2008.
6. Fundamentals of Digital Logic with Verilog Design, III Ed., Stephen Brown, Zvonko Vranesic, MGH, 2014.

### Reference Books

1. Digital Fundamentals, XI Ed., Thomas L. Floyd, Pearson Prentice Hall, 2015.

2. Digital Electronics Principles and Applications, I Ed., Mandal, McGraw Hill Education, 2010.
3. Digital Systems Principles and Applications, IX Ed., Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, PHI, 2009.
4. Digital Principles and Applications, VIII Ed., Donald P. Leach, Albert Paul Malvino, Gautam Saha, McGraw Hill, 2015.
5. Fundamentals of Digital Logic Design with VHDL, II Ed., Stephen Brown, Zvonko Vranesic, TMH, 2009.
6. A Verilog HDL Primer, III Ed., J. Bhasker, Star Galaxy Press, 1997.

### **Web Resources**

1. NPTEL course Digital Circuits, Prof. Santanu Chattopadhyay, IIT Kharagpur  
[https://swayam.gov.in/nd1\\_noc20\\_ec70/preview](https://swayam.gov.in/nd1_noc20_ec70/preview)
2. Prof Neeraj Goel, NPTEL NOC IITM  
<https://youtu.be/BoIOLczVulQ?feature=shared>
3. IIT, Kharagpur & MHRD Govt. of India  
<https://youtu.be/CL3ups78jrs?feature=shared>
4. Prof. Indranil Sengupta, IIT Kharagpur  
<https://youtu.be/NCrIyaXMA8?feature=shared>

## 2.7 Digital System Design Lab (EC3PC\_LR4)

### Teaching Scheme

| Course Code | Course Name               | Contact Hours | Credits |
|-------------|---------------------------|---------------|---------|
| EC3PC_LR4   | Digital System Design Lab | 02            | 01      |

### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | 25  | -   | -   | 50          |

### Course Objectives

| S. No. | Objectives                                                                                                                 |
|--------|----------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>familiarize</i> with basic building blocks of Digital System Design and verify the operation of various digital ICs. |
| 2      | To <i>train</i> on design and implementation of combinational circuits.                                                    |
| 3      | To <i>teach</i> the functionality of flip flops and their conversion                                                       |
| 4      | To <i>demonstrate</i> design and implementation of sequential circuits.                                                    |
| 5      | To <i>introduce</i> simulation software like VHDL/Verilog to <i>design</i> basic digital circuits.                         |

### Course Outcomes

|                             |                                                                                                                                                                 |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                                                 |
| CO1                         | <i>perform</i> code conversion and able to apply Boolean algebra, SOP and POS representation, K Map for the implementation and minimization of logic functions. |
| CO2                         | <i>construct</i> combinational circuits and <i>verify</i> their functionalities.                                                                                |
| CO3                         | <i>verify</i> the functionality of various flip flops and <i>perform</i> flip flop conversion.                                                                  |
| CO4                         | <i>design</i> and <i>implement</i> counter and shift registers using MSI.                                                                                       |
| CO5                         | <i>simulate</i> various combinational and sequential circuits and <i>analyze</i> the results using Verilog HDL.                                                 |

### Suggested List of Experiments

| S. No. | Suggestive List of Experiments                                                         |
|--------|----------------------------------------------------------------------------------------|
| 1      | To implement Boolean function in SOP and POS form.                                     |
| 2      | To implement digital circuits to perform Binary to Gray and Gray to Binary operations. |
| 3      | To implement half adder, full adder by using K-map technique.                          |
| 4      | To implement half subtractor, full subtractor by using K-map technique.                |
| 5      | To design and implement BCD adder using 4-bit Binary Adder IC-7483.                    |
| 6      | To implement logic equations using Multiplexer IC 74151.                               |
| 7      | To verify the comparator IC 7485.                                                      |

|    |                                                                               |
|----|-------------------------------------------------------------------------------|
| 8  | To verify truth table of SR and JK flip flops.                                |
| 9  | To verify truth table of T and D flip flops.                                  |
| 10 | To implement universal shift register using IC 74194.                         |
| 11 | To implement MOD N counter using IC 7490.                                     |
| 12 | To simulate basic logic gates using Verilog HDL.                              |
| 13 | To design and simulate half adder, full adder by using Verilog HDL.           |
| 14 | To design and simulate half Subtractor, full Subtractor by using Verilog HDL. |
| 15 | To design and simulate Multiplexer/Demultiplexer using Verilog HDL.           |

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

## Suggested Learning Resources

### Textbooks

1. Digital Design Principles and Practices, V Ed., John F. Warkerly, Pearson Education, 2018.
2. Digital Design, Morris Mano, V Ed., Michael D. Ciletti, Pearson Education, 2013.
3. Modern Digital Electronics, IV Ed., R. P. Jain, Tata McGraw Hill Education, 2010.
4. Fundamentals of Digital Circuits, IV Ed., A. Anand Kumar, PHI, 2016.
5. Digital Electronics and Design with VHDL, I Ed., Volnei A. Pedroni, Morgan Kaufmann Publisher, 2008.
6. Fundamentals of Digital Logic with Verilog Design, III Ed., Stephen Brown, Zvonko Vranesic, MGH 2014.

### Reference Books

1. Digital Fundamentals, XI Ed., Thomas L. Floyd, Pearson Prentice Hall, 2015.
2. Digital Electronics Principles and Applications, I Ed., Mandal, McGraw Hill Education, 2010.
3. Digital Systems Principles and Applications, IX Ed., Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss, PHI, 2009.
4. Digital Principles and Applications, VIII Ed., Donald P. Leach, Albert Paul Malvino, Gautam Saha, McGraw Hill, 2015.
5. Fundamentals of Digital Logic Design with VHDL, II Ed., Stephen Brown, Zvonko Vranesic, TMH, 2009.
6. A Verilog HDL Primer, III Ed., J. Bhasker, Star Galaxy Press, 1997.

### Web Resources

1. NPTEL course on Digital Systems, Prof. N.J. Rao, IISc Bangalore  
<https://nptel.ac.in/courses/10610809>
2. NPTEL course on Digital Systems Design, Prof. D. Roychoudhury, IIT Kharagpur  
<https://nptel.ac.in/courses/117105080>
3. Digital Electronics and Logic Design Tutorials  
<https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/>

4. Digital Circuits Tutorial  
[https://tutorialspoint.com/digital\\_circuits/index.htm](https://tutorialspoint.com/digital_circuits/index.htm)
5. Prof. Indranil Sengupta, IIT Kharagpur  
<https://youtu.be/NCrIyaXMA8?feature=shared>

## 2.8 Computer Organization and Architecture (EC3PC\_CR5)

### Teaching Scheme

| Course Code | Course Name                            | Contact Hours | Credits |
|-------------|----------------------------------------|---------------|---------|
| EC3PC_CR5   | Computer Organization and Architecture | 02            | 02      |

### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

### Course Objectives

| S. No. | Objectives                                                                                            |
|--------|-------------------------------------------------------------------------------------------------------|
| 1      | To <i>conceptualize</i> the basics of architectural and organizational features of a computer system. |
| 2      | To <i>illustrate</i> data representation and analyze arithmetic techniques used in computer systems.  |
| 3      | To <i>familiarize</i> with the design and function of processor components and control unit.          |
| 4      | To <i>teach</i> memory and I/O organization in a computer system.                                     |
| 5      | To <i>introduce</i> advancements and emerging trends in computer architecture and organization.       |

### Course Outcomes

|                             |                                                                                                                                               |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                               |
| CO1                         | <i>describe</i> and <i>differentiate</i> between architecture and organization of a computer system.                                          |
| CO2                         | <i>comprehend</i> representation of integers and floating-point numbers and <i>perform</i> binary arithmetic operations.                      |
| CO3                         | <i>understand</i> CPU organization and <i>explain</i> stages of instruction execution and the role of control unit for instruction execution. |
| CO4                         | <i>categorize</i> memory system, <i>explore</i> memory hierarchy and <i>study</i> I/O module and data transfer techniques.                    |
| CO5                         | <i>gain</i> knowledge of advancements in the field of computer architecture and organization.                                                 |

### Course Contents

| Module | Unit                                                   | Detailed Contents                                                                                                | Hours |
|--------|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-------|
| 1.0    | Prerequisites                                          |                                                                                                                  | 04    |
|        | Number systems and its conversion.                     |                                                                                                                  |       |
|        | Introduction to Computer Organization and Architecture |                                                                                                                  |       |
|        | 1.1                                                    | Introduction of computer organization and architecture:<br>Difference between computer architecture and computer |       |

|            |                                           |                                                                                                                                                                                                  |           |
|------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            |                                           | organization, Basic Organization of Computer - Block Level Description.                                                                                                                          |           |
|            | 1.2                                       | Evolution of x86 Computers, Von Neumann model.                                                                                                                                                   |           |
| <b>2.0</b> | <b>Data Representation and Arithmetic</b> |                                                                                                                                                                                                  | <b>06</b> |
|            | 2.1                                       | Representation of signed and unsigned integers in binary, Two's complement representation, IEEE 754 single & double precision floating point number representation.                              |           |
|            | 2.2                                       | Binary arithmetic - Addition and subtraction, multiplication using Booth's algorithm, division of integers using restoring and non-restoring division.                                           |           |
| <b>3.0</b> | <b>Processor Design and Control Unit</b>  |                                                                                                                                                                                                  | <b>06</b> |
|            | 3.1                                       | CPU Architecture, Instruction formats, instruction set types, addressing modes, basic and modified instruction cycle, CISC vs RISC.                                                              |           |
|            | 3.2                                       | Control Unit Design - Soft wired (Microprogrammed) and hardwired control unit design methods.                                                                                                    |           |
|            | 3.3                                       | Introduction to parallel processing, Flynn's classifications, instruction pipelining, pipeline hazards.                                                                                          |           |
| <b>4.0</b> | <b>Memory and I/O Organization</b>        |                                                                                                                                                                                                  | <b>06</b> |
|            | 4.1                                       | Memory Organization – Characteristics of memory systems, memory hierarchy, Classification of primary and secondary memory, Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. |           |
|            | 4.2                                       | I/O Organization - Input/output systems, I/O module-need & functions, Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA.                                           |           |
| <b>5.0</b> | <b>Advancements and Emerging Trends</b>   |                                                                                                                                                                                                  | <b>04</b> |
|            | 5.1                                       | Parallelism and Multiprocessing - SIMD vs. MIMD, shared memory and distributed memory systems, multi-core processors, GPUs, Heterogeneous computing.                                             |           |
|            | 5.2                                       | Emerging Trends - Quantum computing basics and its impact on computer architecture, Neuromorphic computing.                                                                                      |           |
|            | <b>Total Hours</b>                        |                                                                                                                                                                                                  | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Computer Organization and Architecture: Designing for Performance, X Ed., William Stallings, Pearson, 2016.
2. Computer Organization and Design – A Quantitative Approach ", VI Ed., D. A. Patterson, J. L. Hennessy, Morgan Kaufmann, 2017.
3. Computer Organization, V Ed., Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Tata McGraw-Hill.
4. Computer Architecture and Organization, III Ed., John P. Hayes, McGraw-Hill. J.P. Hayes, 1998.

### Reference Books

1. Computer Architecture and Organization: Design Principles and Applications, Computer Architecture and Organization: Design Principles and Applications, B. Govindarajulu, Tata McGraw-Hill, 2004.
2. Computer System Architecture and Organization, I Ed., Dr. M. Usha, T. S. Srikanth, Wiley-India, 2014.
3. Introduction to Computer Organization and Architecture. III Ed., Ramesh Gaonkar, Prentice Hall, 2014.
4. Fundamentals of Computer Organization and Design, II Ed., Sivarama P. Dandamudi, Springer, 2011.
5. Structured Computer Organization, VI Ed., Andrew S. Tanenbaum, Pearson, 2013.

### **Web Resources**

1. NPTEL course on Computer Architecture and Organization, Prof. Indranil Sengupta, Prof. Kamalika Datta, IIT Kharagpur.  
[https://onlinecourses.nptel.ac.in/noc20\\_cs64/preview](https://onlinecourses.nptel.ac.in/noc20_cs64/preview)
2. NPTEL course on Computer Organization and Architecture: A Pedagogical Aspect, Prof. Santhosh Biswas, Prof. Jatindra Kumar Deka , Prof. Arnab Sarkar, IIIT Bhilai, IIT Guwahati, IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc21\\_cs37/preview](https://onlinecourses.nptel.ac.in/noc21_cs37/preview)

## 2.9 Innovation, Business Models and Entrepreneurship (IL3HM\_CR1)

### Teaching Scheme

| Course Code | Course Name                                      | Contact Hours | Credits |
|-------------|--------------------------------------------------|---------------|---------|
| IL3HM_CR1   | Innovation, Business Models and Entrepreneurship | 02            | 02      |

### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 50    | Continuous | -     | -               | -     | -               | 50          |

### Course Objectives

| S. No. | Objectives                                                                                                                                               |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> key innovation concepts, <i>understand</i> types of innovation, and <i>explore</i> the importance of creativity in business.         |
| 2      | To <i>learn</i> about the challenges and steps in managing innovation, and <i>understand</i> divergent/convergent thinking and design thinking.          |
| 3      | To <i>explore</i> experimentation in innovation, <i>foster</i> idea champions, and <i>understand</i> co-creation and prototyping in product development. |
| 4      | To <i>understand</i> business models, entrepreneurship, and strategies like Blue Ocean Strategy, and <i>learn</i> to address business model failures.    |
| 5      | To <i>learn</i> about technological innovation management, sustainability in entrepreneurship, and the role of intellectual property.                    |

### Course Outcomes

|                             |                                                                                                                                   |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                   |
| CO1                         | <i>define</i> and <i>analyze</i> types of innovation and <i>assess</i> their impact on businesses.                                |
| CO2                         | <i>understand</i> innovation processes, <i>apply</i> creative thinking methods, and <i>use</i> design thinking to solve problems. |
| CO3                         | <i>implement</i> experiments, <i>promote</i> collaboration, and <i>create/test</i> prototypes for innovation.                     |
| CO4                         | <i>design</i> business models, <i>apply</i> differentiation strategies, and <i>identify</i> reasons for business model failure.   |
| CO5                         | <i>analyze</i> technological innovations, <i>incorporate</i> sustainability, and <i>handle</i> IPR effectively.                   |

### Course Contents

| Module | Unit                      | Detailed Contents | Hours |
|--------|---------------------------|-------------------|-------|
|        | <b>Prerequisites: Nil</b> |                   |       |

|                    |                                                                                                                                                                                                                                                                                                                                                                |           |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>1.0</b>         | <b>Foundations of Innovation and Creativity</b>                                                                                                                                                                                                                                                                                                                | <b>07</b> |
|                    | Analyzing the Current Business Scenario, Innovation and Creativity: An Introduction, Innovation in the Current Environment, Types of Innovation, School of Innovation.                                                                                                                                                                                         |           |
| <b>2.0</b>         | <b>Innovation Management and Design Thinking</b>                                                                                                                                                                                                                                                                                                               | <b>05</b> |
|                    | Challenges of Innovation, Steps of Innovation Management, Idea Management System, Divergent vs. Convergent Thinking, Design Thinking and Entrepreneurship.                                                                                                                                                                                                     |           |
| <b>3.0</b>         | <b>Experimentation, Co-Creation, and Prototyping</b>                                                                                                                                                                                                                                                                                                           | <b>05</b> |
|                    | Experimentation in Innovation Management, Idea Championship, Participation for Innovation, Co-Creation for Innovation, Prototyping to Incubation.                                                                                                                                                                                                              |           |
| <b>4.0</b>         | <b>Business Models, Entrepreneurship, and Strategies</b>                                                                                                                                                                                                                                                                                                       | <b>05</b> |
|                    | What is a Business Model?, Who is an Entrepreneur?, Social Entrepreneurship, Blue Ocean Strategy I & II, Business Models and Value Proposition, Business Model Failure: Reasons and Remedies                                                                                                                                                                   |           |
| <b>5.0</b>         | <b>Technological Innovation, Sustainability, and Intellectual Property</b>                                                                                                                                                                                                                                                                                     | <b>04</b> |
|                    | Marketing of Innovation, Technology Innovation Process, Technological Innovation Management Planning & Strategies, Technology Forecasting, Sustainability Innovation and Entrepreneurship, Innovation Sustainable Conditions, SMEs' Strategic Involvement in Sustainable Development, Creation and Management of IPR, Patents and Copyrights, Patents in India |           |
| <b>Total Hours</b> |                                                                                                                                                                                                                                                                                                                                                                | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. 8 Steps to Innovation: Going from Jugaad To Excellence, I Ed., Rishikesh T. Krishnan, Vinay Dabholkar, HarperCollins, 2015.
2. Innovation and Entrepreneurship: Practice and Principles, I Ed., Peter Drucker, Routledge Classics, 2015.

### Reference Books

1. HBS series on Innovation and Entrepreneurship, IV Ed., John R. Bessant, Joe Tidd, Wiley, 2024.

### Web Resources

1. NPTEL course on Innovation, Business Models and Entrepreneurship, Prof. Rajat Agrawal, Prof. Vinay Sharma, IIT Roorkee.  
[https://onlinecourses.nptel.ac.in/noc21\\_mg63/preview](https://onlinecourses.nptel.ac.in/noc21_mg63/preview)

## 2.10 Field Project (ILSEL\_PR1)

### Teaching Scheme

| Course Code | Course Name   | Contact Hours | Credits |
|-------------|---------------|---------------|---------|
| ILSEL_PR1   | Field Project | 04            | 02      |

### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | -   | -   | 25  | 50          |

### Course Objectives

| S. No. | Objectives                                                                                                 |
|--------|------------------------------------------------------------------------------------------------------------|
| 1      | To <i>identify</i> real-world problems in society through observations and interaction with the community. |
| 2      | To <i>propose</i> technology-based solutions to societal issues.                                           |
| 3      | To <i>provide</i> exposure to interdisciplinary problem-solving and <i>promote</i> teamwork.               |
| 4      | To <i>enhance</i> communication skills.                                                                    |

### Course Outcomes

|                             |                                                                                                           |
|-----------------------------|-----------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                           |
| CO1                         | <i>interact</i> with society at large and <i>identify</i> socio-economic issues prevalent in the society. |
| CO2                         | <i>relate</i> theoretical knowledge for generation of technological solutions to real-life problems.      |
| CO3                         | <i>collaborate</i> and <i>contribute</i> effectively in a team based activity.                            |
| CO4                         | <i>present</i> their solutions in technical reports, presentations, and demonstrations.                   |
| CO5                         | <i>recognise</i> the need for lifelong learning in the broad context of technological change.             |

### Guidelines

#### A. Process of field project/community engagement projects identification

- A coordinator to be appointed at the department level to guide students in field project/community engagement projects.
- Students should form a group of 3-4 students. A faculty mentor to be assigned to each group.
- Collaborate with NSS Cell to arrange visits/trips to explore community/society-based issues and/or for data/sample collection. Engage with local communities or stakeholders to gather information and insights. Preferably, the mentors should also accompany the students.
- Topic approval presentation must be carried out for finalization of the topic.
- The approach should be to identify a community/society based real-life problem and to propose a technological solution to solve the problem.

#### B. Continuous Monitoring and Assessment (ISE)

- The mentor should assess the progress of the students on a weekly basis and record their

observations in the logbook.

### C. End Semester Examination

- A report (max. 25 pages) to be prepared by each group.
- A presentation summarizing the objectives, methodology, findings, and community impact to be carried out. The external examiner should preferably be from the industry.

| Assessment Tool | Components                                           | Marks     |
|-----------------|------------------------------------------------------|-----------|
| CA              | Logbook                                              | 10        |
|                 | Topic Approval presentation and mid sem presentation | 10        |
|                 | Attendance                                           | 5         |
|                 | <b>TOTAL</b>                                         | <b>25</b> |
| ESE             | Report                                               | 10        |
|                 | Presentation                                         | 15        |
|                 | <b>Total</b>                                         | <b>25</b> |

## 2.11 Environment & Technology (ILSHM\_CR2)

### Teaching Scheme

| Course Code | Course Name              | Contact Hours | Credits |
|-------------|--------------------------|---------------|---------|
| ILSHM_CR2   | Environment & Technology | 02            | 02      |

### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 50    | Continuous | -     | -               | -     | -               | 50          |

### Course Objectives

| S. No. | Objectives                                                                                                                                                                                              |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>understand</i> the interconnections between environmental science and technological advancements.                                                                                                 |
| 2      | To <i>investigate</i> the role of sustainable technologies in mitigating environmental issues.                                                                                                          |
| 3      | To <i>study</i> the concepts of renewable energy, waste management, pollution control, and conservation technologies, <i>analyze</i> and <i>interpret</i> environmental data using computational tools. |

### Course Outcomes

|                             |                                                                                                                         |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                         |
| CO1                         | <i>describe</i> the fundamental principles of environmental science and its relationship with technology.               |
| CO2                         | <i>design</i> and <i>develop</i> computer-based systems for environmental data collection, analysis and decision-making |
| CO3                         | <i>understand</i> waste management methods and pollution control technologies.                                          |
| CO4                         | <i>identify</i> and <i>assess</i> renewable energy technologies and their potential for reducing carbon footprints      |
| CO5                         | <i>develop</i> skills in problem-solving, critical thinking, and communication                                          |

### Course Contents

| Module | Unit                                                                                              | Detailed Contents | Hours |
|--------|---------------------------------------------------------------------------------------------------|-------------------|-------|
|        | Prerequisites:                                                                                    |                   |       |
|        | Basic programming skills (Python), Introductory courses in environmental Science and mathematics. |                   |       |
| 1.0    | Introduction to Environment and Technology                                                        |                   | 05    |

|            |                                                                                                                                                                                                                                                                                                                                                                            |           |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | Environmental science & engineering and its significance, Definition and scope of technology in environmental contexts, Technological innovations in environmental protection and sustainability, History of environmental concerns and technological responses.                                                                                                           |           |
| <b>2.0</b> | <b>Technology Applications in Environment Monitoring and Modeling</b><br>Electronic sensors for environmental monitoring (temperature, humidity, air & water quality), Sensor networks and data acquisition IoT-based environmental monitoring systems, Concept of modeling, Water quantity/ water quality prediction, air pollution forecasting, using latest Technology. | <b>05</b> |
| <b>3.0</b> | <b>Solid Waste Management and Pollution Control Technologies</b><br>Solid waste management technologies: recycling, composting, and waste-to-energy, Electronics waste and hazardous waste management technologies, Role of information technology in waste management systems.                                                                                            | <b>06</b> |
| <b>4.0</b> | <b>Renewable Energy Technologies</b><br>Solar, wind, hydro, and geothermal energy technologies, Biomass and bioenergy as sustainable energy solutions, Energy storage technologies and their environmental implications, Technological innovations in energy efficiency.                                                                                                   | <b>05</b> |
| <b>5.0</b> | <b>Case Studies and Project Development</b><br>Real-world case studies of technology applications in environmental engineering, Group project.                                                                                                                                                                                                                             | <b>05</b> |
|            | <b>Total Hours</b>                                                                                                                                                                                                                                                                                                                                                         | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Computer Modeling Applications for Environmental Engineer, II Ed., Kindle Edition, Isam Mohammed Abdel-Magid Ahmed, Mohammed Isam Mohammed Abdel-Magid.
2. Introduction to Environmental Engineering and Science, III Ed., Gilbert M. Masters, Wendell P. Ela., Pearson India, 2015.
3. Environmental Science and Technology: Concepts and Applications Second Edition, Frank R. Spellman, Nancy E. Whiting, 2006.
4. Waste Management Practices: Municipal, Hazardous, and Industrial, John Pichtel.
5. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle.

### Reference Books

1. Online Journals: Environmental Science & Technology, Journal of Cleaner Production, Renewable and Sustainable Energy Reviews.
2. "Environmental Engineering and Computer Application", Kennis Chan, CRC Press, 2015.
3. "Information Technologies in Environmental Engineering - New Trends and Challenges", Paulina Golinska, Marek Fertsch, Jorge Marx-Gómez, Springer, 2011.
4. Information Technology in Environmental Engineering: Selected Contributions to the Sixth International Conference on Information Technologies in Environmental Science and

Engineering, 2016.

### **Web Resources**

1. Ministry of Environment, Forest and Climate Change  
<https://moef.gov.in/>
2. U.S. Environmental Protection Agency  
<https://www.epa.gov/>
3. United Nations Environment Programme (UNEP)  
<https://www.unep.org/>
4. International Energy Agency (IEA)  
<https://www.iea.org/>
5. World Resources Institute (WRI).  
<https://www.wri.org/>

### 3 Semester-IV Course Syllabus

#### 3.1 Optimization and Sampling Theory (EC4PC\_CR1)

##### Teaching Scheme

| Course Code | Course Name                      | Contact Hours | Credits |
|-------------|----------------------------------|---------------|---------|
| EC4PC_CR1   | Optimization and Sampling Theory | 03            | 03      |

##### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 20    | Continuous | 20    | 1               | 60    | 2.5             | 100         |

##### Course Objectives

| S. No. | Objectives                                                                                                                            |
|--------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> the concept of optimization and its solution.                                                                     |
| 2      | To <i>teach</i> the concept of simplex method and <i>familiarize</i> learners to solve linear optimization problems using the method. |
| 3      | To <i>build</i> mathematical skills for obtaining solutions of non-linear programming problems.                                       |
| 4      | To <i>introduce</i> concepts of testing of hypothesis and <i>apply</i> different probability distributions to test the hypothesis.    |
| 5      | To <i>prepare</i> the learners to <i>test</i> significance difference between, goodness of fit and independence of attributes.        |

##### Course Outcomes

|                             |                                                                                                                                              |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                              |
| CO1                         | <i>form</i> linear optimization problems for real world problems and <i>use</i> graphical method to solve and analyze the solution.          |
| CO2                         | <i>convert</i> linear programming problems into canonical form, <i>use</i> simplex method to solve it and <i>form</i> dual of the LPP.       |
| CO3                         | <i>apply</i> the knowledge of non-linear optimization techniques to <i>solve</i> unconstrained and constrained optimization problems.        |
| CO4                         | <i>formulate</i> hypothesis use different probability distributions to test the mean.                                                        |
| CO5                         | <i>implement</i> the concept testing of hypothesis to test the difference between the means, goodness of fit and independence of attributes. |

## Course Contents

| Module     | Unit                                                       | Detailed Contents                                                                                                                                        | Hours     |
|------------|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Pre-requisite</b>                                       |                                                                                                                                                          |           |
|            | Matrices, Random variables, and probability distributions. |                                                                                                                                                          |           |
| <b>1.0</b> | <b>Introduction to Optimization</b>                        |                                                                                                                                                          | <b>07</b> |
|            | 1.1                                                        | Definition, Types of optimization problems, Applications of optimization.                                                                                |           |
|            | 1.2                                                        | Objective functions and constraints, Feasible regions and optimality conditions.                                                                         |           |
|            | 1.3                                                        | Application based problems on optimization of signal strength and Plotting objective & constraints using Python programming.                             |           |
| <b>2.0</b> | <b>Linear Programming</b>                                  |                                                                                                                                                          | <b>08</b> |
|            | 2.1                                                        | LPP formulation, Standard and canonical LPP, Types of LPP solutions.                                                                                     |           |
|            | 2.2                                                        | Solution of LPP using Simplex method, Problems involving slack and surplus variables. Duality and Dual of LPPs.                                          |           |
|            | 2.3                                                        | Application based problems on LPP under capacity constraints, material constraints, transportation problems using Python programming.                    |           |
| <b>3.0</b> | <b>Non-linear Programming</b>                              |                                                                                                                                                          | <b>08</b> |
|            | 3.1                                                        | Convex and non-convex functions. Unconstrained solutions: Gradient Descent method, Newton’s method (One dimensional).                                    |           |
|            | 3.2                                                        | Constrained solutions: Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions.                                                                        |           |
|            | 3.3                                                        | Application based problems on minimization of error in control systems.                                                                                  |           |
| <b>4.0</b> | <b>Sampling Theory - I</b>                                 |                                                                                                                                                          | <b>08</b> |
|            | 4.1                                                        | Basics of sampling theory: Introduction, test of hypothesis, level of significance, critical region, one-tailed and two-tailed tests, degree of freedom. |           |
|            | 4.2                                                        | Probability distributions: t distribution, z distribution, chi-square distribution.                                                                      |           |
|            | 4.3                                                        | Application based problems on noise estimation using sampling theory and using Python programming.                                                       |           |
| <b>5.0</b> | <b>Sampling Theory - II</b>                                |                                                                                                                                                          | <b>08</b> |
|            | 5.1                                                        | Test significance of mean and difference between means of two samples.                                                                                   |           |
|            | 5.2                                                        | Test goodness of fit and independence of attributes.                                                                                                     |           |
|            | 5.3                                                        | Case study on quality check in industry and testing network congestion.                                                                                  |           |
|            | <b>Total Hours</b>                                         |                                                                                                                                                          | <b>39</b> |

## **Suggested Learning Resources**

### **Textbooks**

1. Engineering Optimization -Theory and Practice, IV Ed. Singiresu S. Rao, John Wiley, 2016.
2. Probability, Statistics and Random Processes, IV Ed., T. Veerarajan, Mc. Graw Hill Education, 2019.

### **Reference Books**

1. Advanced Engineering Mathematics, X Ed., Erwin Kreyszig, Wiley Eastern Limited, 2011.
2. Advanced Engineering Mathematics, VI Ed., R. K. Jain, S. R. K. Iyengar, Narosa Publishing House, 2017.
3. An Introduction to Optimization, IV Ed., Edwin K. P. Chong, Stanislaw H. Zak, Wiley, 2013.
4. An Introduction to Probability and Statistics, II Ed., Vijay Rohatgi, Wiley, 2006.

### **Web Resources**

1. NPTEL course on Constrained and Unconstrained Optimization, Prof. Adrijit Goswami, Prof. Debjani Chakraborty, IIT Kharagpur.  
<https://nptel.ac.in/courses/111105100>
2. NPTEL course on Introduction to Probability Theory and Statistics, Prof. S. Dharmaraja, IIT Delhi.  
<https://nptel.ac.in/courses/111102160>

## 3.2 Database Management System (EC4PC\_CR2)

### Teaching Scheme

| Course Code | Course Name                | Contact Hours | Credits |
|-------------|----------------------------|---------------|---------|
| EC4PC_CR2   | Database Management System | 03            | 03      |

### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 20    | Continuous | 20    | 1               | 60    | 2.5             | 100         |

### Course Objectives

| S. No. | Objectives                                                                                                                        |
|--------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> the basic concepts of databases.                                                                              |
| 2      | To <i>develop</i> entity relationship (ER) and Extended Entity-Relationship (EER) data model and its mapping to relational model. |
| 3      | To <i>learn</i> relational algebra and <i>apply</i> normalization techniques.                                                     |
| 4      | To <i>formulate</i> SQL queries.                                                                                                  |
| 5      | To <i>understand</i> concept of transaction, concurrency control and recovery techniques.                                         |

### Course Outcomes

|                             |                                                                                                                                              |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                              |
| CO1                         | <i>explain</i> the basic concepts and the applications of database management systems.                                                       |
| CO2                         | <i>design</i> ER and EER diagrams for real life applications and <i>construct</i> relational model.                                          |
| CO3                         | <i>write</i> relational algebra queries and <i>apply</i> the concept of normalization to relational database to improve the database design. |
| CO4                         | <i>formulate</i> SQL queries in order to retrieve, manipulate, and analyze data stored in a relational database.                             |
| CO5                         | <i>describe</i> the concept of transaction, concurrency and recovery.                                                                        |

### Course Contents

| Module     | Unit                                            | Detailed Contents                                                                                                                                         | Hours     |
|------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites: Nil</b>                       |                                                                                                                                                           |           |
| <b>1.0</b> | <b>Introduction to Database Concepts</b>        |                                                                                                                                                           | <b>04</b> |
|            | 1.1                                             | Characteristics of database systems, File system v/s Database system, Data abstraction and data independence, DBMS architecture and models, Applications. |           |
| <b>2.0</b> | <b>Database Design and Relational Databases</b> |                                                                                                                                                           | <b>08</b> |

|                    |                                                          |                                                                                                                                                                                                    |           |
|--------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 2.1                                                      | Entity-Relationship (ER) Model: Entities, Attributes, types of keys. Relationships: Types, constraints, Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation   |           |
|                    | 2.2                                                      | Relational Databases: Relational schema, concept of keys, Relations and their properties, Constraints: NOT NULL, UNIQUE, CHECK, and DEFAULT, Mapping the ER and EER Model to the Relational Model. |           |
| <b>3.0</b>         | <b>Relational Algebra and Normalization</b>              |                                                                                                                                                                                                    | <b>09</b> |
|                    | 3.1                                                      | Relational algebra: Operators, relational algebra queries.                                                                                                                                         |           |
|                    | 3.2                                                      | Pitfalls in relational database designs, Concept of normalization, function dependencies, 1NF, 2NF, 3NF, BCNF.                                                                                     |           |
| <b>4.0</b>         | <b>Structured Query Language (SQL)</b>                   |                                                                                                                                                                                                    | <b>09</b> |
|                    | 4.1                                                      | Overview of SQL, data definition commands, integrity constraints: key constraints, domain constraints, referential integrity, check constraints.                                                   |           |
|                    | 4.2                                                      | Data manipulation commands, data control commands.                                                                                                                                                 |           |
|                    | 4.3                                                      | Set and string operations, aggregate function-group by, having, views in SQL, joins, nested and complex queries, triggers.                                                                         |           |
| <b>5.0</b>         | <b>Transactions Management, Concurrency and Recovery</b> |                                                                                                                                                                                                    | <b>09</b> |
|                    | 5.1                                                      | Transactions: Concept, transaction states, ACID properties: Atomicity, Consistency, Isolation, Durability, Transaction states and lifecycle, Transaction control commands.                         |           |
|                    | 5.2                                                      | Concurrency Control: Issues in concurrent transactions: Lost updates, Temporary inconsistency, Uncommitted data, Inconsistent retrievals, Locking mechanisms.                                      |           |
|                    | 5.3                                                      | Recovery System: Log based recovery, Deadlock handling.                                                                                                                                            |           |
| <b>Total Hours</b> |                                                          |                                                                                                                                                                                                    | <b>39</b> |

## Suggested Learning Resources

### Textbooks

1. Database System Concepts, VII Ed., Ibrahim Silberschatz, Henry F. Korth, S. Sudarshan, McGraw Hill Education, 2019.
2. Fundamentals of Database Systems, VII Ed., Ramez Elmasri, Shamkant B. Navathe, Pearson, 2015.
3. Database Management Systems, III Ed., Raghu Ramkrishnan, Johannes Gehrke, Tata McGraw Hill Education, 2002.

### Reference Books

1. Database Systems Design, Implementation and Management, X Ed., Peter Rob, Carlos Coronel, Cengage Learning, 2012.
2. SQL and PL/SQL for Oracle 11g, Black Book, Dr. P.S. Deshpande, Dreamtech Press, 2011.
3. Database Management Systems, II Ed., G. K. Gupta, McGraw Hill Education, 2011.

### **Web Resources**

1. NPTEL course on Data Base Management System, IIT Kharagpur, Prof. Partha Pratim Das  
<https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-cs58/>
2. DBMS Complete Playlist  
<https://www.youtube.com/playlist?list=PLxCzCOWd7aiFAN6I8CuViBuCdJgiOkT2Y>
3. DBMS Complete Playlist - Jenny  
<https://www.youtube.com/playlist?list=PLdo5W4Nhv31b33kF46f9aFjoJPOkdlsRc>  
<https://www.mooc-list.com/tags/dbms>

### 3.3 Database Management System Lab (EC4PC\_LR2)

#### Teaching Scheme

| Course Code | Course Name                    | Contact Hours | Credits |
|-------------|--------------------------------|---------------|---------|
| EC4PC_LR2   | Database Management System Lab | 02            | 01      |

#### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | 25  | -   | -   | 50          |

#### Course Objectives

| S. No. | Objectives                                                                                                        |
|--------|-------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>identify</i> and <i>construct</i> detailed problem definitions, ER/EER diagrams for real life applications. |
| 2      | To <i>construct</i> conceptual data model for real life applications.                                             |
| 3      | To <i>apply</i> SQL to store and retrieve data efficiently.                                                       |
| 4      | To <i>implement</i> database connectivity using JDBC.                                                             |
| 5      | To <i>understand</i> the concepts of transaction processing- concurrency control & recovery procedures.           |

#### Course Outcomes

|                              |                                                                                                                             |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                             |
| CO1                          | <i>define</i> problem statements and <i>construct</i> the conceptual model for real life application.                       |
| CO2                          | <i>create</i> and <i>populate</i> a RDBMS using SQL and write SQL queries for efficient information retrieval.              |
| CO3                          | <i>implement</i> complex SQL queries and <i>apply</i> view, triggers and procedures to demonstrate specific event handling. |
| CO4                          | <i>demonstrate</i> database connectivity using JDBC.                                                                        |
| CO5                          | <i>demonstrate</i> the concept of concurrent transactions.                                                                  |

#### Course Contents

| S. No. | Suggestive List of Experiments                                                                                                                                          |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | a) Students to be given assignments to construct detailed problem definitions for real life applications.<br>b) Construction of ER/EER diagrams for the given problems. |
| 2      | Mapping ER/EER to relational schema model.                                                                                                                              |
| 3      | Assignment based on relational Algebra.                                                                                                                                 |
| 4      | a) Create database using basic DDL Queries in SQL.<br>b) Construction of Database-Keys and applying integrity constraints.                                              |
| 5      | Apply basic DML queries in order to populate and manipulate database.                                                                                                   |

|    |                                                                                                                       |
|----|-----------------------------------------------------------------------------------------------------------------------|
| 6  | Implement complex SQL queries using group by, nested queries, recursive queries, joins on populated database.         |
| 7  | Implement Triggers and views.                                                                                         |
| 8  | a) Implement Functions and Procedures in SQL.<br>b) Implement Security and authorization using Grant & Revoke in SQL. |
| 9  | Design and implementation of a full-fledged database with front-end using JDBC for the real-life application.         |
| 10 | a) Assignment based on conversion of relations to different normal forms.<br>b) Execute TCL commands.                 |

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

## Suggested Learning Resources

### Textbooks

1. Database System Concepts, VII Ed., Ibrahim Silberschatz, Henry F. Korth, S. Sudarshan, McGraw Hill Education, 2019.
2. Fundamentals of Database Systems, VII Ed., Ramez Elmasri, Shamkant B. Navathe, Pearson, 2015.
3. Database Management Systems, III Ed., Raghu Ramkrishnan, Johannes Gehrke, Tata McGraw Hill Education, 2002.

### Reference Books

1. Database Systems Design, Implementation and Management, X Ed., Peter Rob, Carlos Coronel, Cengage Learning, 2012.
2. SQL and PL/SQL for Oracle 11g, Black Book, Dr. P.S. Deshpande, Dreamtech Press, 2011.
3. Database Management Systems, G. K. Gupta, McGraw Hill Education, 2011.

### Web Resources

1. Data Base Management System, Prof. Partha Pratim Das Prof. Samiran Chattopadhyay Prof. Kausik Datta, IIT Kharagpur  
<https://nptel.ac.in/courses/106/105/106105175/>
2. <https://www.mooc-list.com/tags/dbms>
3. <https://www.classcentral.com/course/swayam-database-management-system-9914>

### 3.4 Microprocessors and Microcontrollers (EC4PC\_CR3)

#### Teaching Scheme

| Course Code | Course Name                          | Contact Hours | Credits |
|-------------|--------------------------------------|---------------|---------|
| EC4PC_CR3   | Microprocessors and Microcontrollers | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                    |
|--------|---------------------------------------------------------------------------------------------------------------|
| 1      | To <i>study</i> the concepts and basic architecture of a microprocessor and microcontroller.                  |
| 2      | To <i>write</i> assembly language programs for microprocessors and microcontrollers for various applications. |
| 3      | To <i>know</i> the importance of different peripheral devices and their interfacing to 8051.                  |
| 4      | To <i>build</i> microprocessor and microcontroller-based systems.                                             |
| 5      | To <i>understand</i> architecture of 32-bit microcontroller ARM Cortex M3.                                    |

#### Course Outcomes

|                             |                                                                                                  |
|-----------------------------|--------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                  |
| CO1                         | <i>explain</i> 16-bit microprocessor architectures and fundamental concepts of microcontrollers. |
| CO2                         | <i>develop</i> assembly language programming skills for microprocessors and microcontroller.     |
| CO3                         | <i>interface</i> various devices in microcontroller systems                                      |
| CO4                         | design and <i>implement</i> microprocessor and microcontroller-based systems.                    |
| CO5                         | <i>understand</i> the architecture and aspects of Cortex M3 microcontroller.                     |

#### Course Contents

| Module     | Unit                                  | Detailed Contents                                                                                                                                                                | Hours     |
|------------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites</b>                  |                                                                                                                                                                                  |           |
|            | Binary number system.                 |                                                                                                                                                                                  |           |
| <b>1.0</b> | <b>Introduction to Microprocessor</b> |                                                                                                                                                                                  | <b>05</b> |
|            | 1.1                                   | Microprocessor-based System: CPU, I/O Devices, Clock, Memory, Concept of address, data and control bus.                                                                          |           |
|            | 1.2                                   | 8086 Microprocessor: Architecture, Pin description, Memory segmentation, Pipelining, Interrupts and Interrupt Service Routines (ISR), Dedicated interrupts, Software interrupts. |           |

|            |                                                              |                                                                                                 |           |
|------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------|
| <b>2.0</b> | <b>8086 Programming</b>                                      |                                                                                                 | <b>06</b> |
|            | 2.1                                                          | Addressing modes                                                                                |           |
|            | 2.2                                                          | Instruction Set and Assembler Directives                                                        |           |
|            | 2.3                                                          | Assembly language programming                                                                   |           |
| <b>3.0</b> | <b>8051 Microcontroller</b>                                  |                                                                                                 | <b>05</b> |
|            | 3.1                                                          | Differences between a Microprocessor and Microcontroller, Architecture of 8051 microcontroller. |           |
|            | 3.2                                                          | Memory organization of 8051 microcontroller.                                                    |           |
|            | 3.3                                                          | Instruction set of 8051 microcontroller.                                                        |           |
|            | 3.4                                                          | Programs related to arithmetic, logical, branch and delay.                                      |           |
| <b>4.0</b> | <b>8051 Interfacing and Applications</b>                     |                                                                                                 | <b>06</b> |
|            | 4.1                                                          | Display interfacing: 7-segment LED display, 16x2 generic alphanumeric LCD display.              |           |
|            | 4.2                                                          | Analog devices interfacing: 8-bit ADC and DAC. Stepper motor interfacing.                       |           |
|            | 4.3                                                          | Waveform (Ramp, triangular & Sine wave) generation program using DAC.                           |           |
| <b>5.0</b> | <b>Advanced Microcontroller Architecture (ARM CORTEX-M3)</b> |                                                                                                 | <b>04</b> |
|            | 5.1                                                          | Comparison of CISC & RISC architectures.                                                        |           |
|            | 5.2                                                          | Overview of ARM family.                                                                         |           |
|            | 5.3                                                          | ARM Cortex-M3 architecture.                                                                     |           |
|            | <b>Total Hours</b>                                           |                                                                                                 | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Microprocessor and Interfacing, II Ed., Douglas Hall, Tat McGraw Hill, 2014.
2. The 8051 Microcontroller & Embedded Systems III Ed., M. A. Mazidi, J. G. Mazidi, R. D. Mckinlay, Pearson Publications, 2018.
3. The 8051 Microcontroller & Embedded System using Assembly & 'C', III Ed., C. Kenneth J. Ayala and D. V. Gadre, Cengage Learning, 2018.
4. The Definitive Guide to ARM CORTEX-M3 & CORTEX-M4 Processors, III Ed., Joseph You, Elsevier, 2014.

### Reference Books

1. 8086 Microprocessor Programming and Interfacing the PC, V Ed., Kenneth Ayala, Cengage Learning, 2010.
2. Microcomputer Systems: 8086/8088 family Architecture, Programming and Design, II Ed., Liu & Gibson, Prentice Hall, 2002.
3. The 8051 Microcontrollers, IV Ed., Satish Shah, Pearson Education, 2016.
4. ARM Architecture", Reference Manual, II Ed., David Seal, Addison Wesley, 2009.
5. Microcontrollers: Architecture, Programming, Interfacing and System Design, III Ed., Raj Kamal, Pearson Education, 2017.

### Web Resources

1. NPTEL courses on Microprocessors and Microcontrollers, Prof. Santanu Chattopadhyay, IIT Kharagpur.  
<https://archive.nptel.ac.in/courses/108/105/108105102/>
2. NPTEL course on Embedded System Design With ARM, Prof. Indranil Sengupta, Prof. Kamalika Dutta, IIT Kharagpur.  
<https://archive.nptel.ac.in/courses/106/105/106105193/>
3. MCS@51 Microcontroller, Family User Manual, Intel.  
<https://web.mit.edu/6.115/www/document/8051.pdf>

### 3.5 Microprocessor and Microcontroller Lab (EC4PC\_LR3)

#### Teaching Scheme

| Course Code | Course Name                            | Contact Hours | Credits |
|-------------|----------------------------------------|---------------|---------|
| EC4PC_LR3   | Microprocessor and Microcontroller Lab | 02            | 01      |

#### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | 25  | -   | -   | 50          |

#### Course Objectives

| S. No. | Objectives                                                                                                    |
|--------|---------------------------------------------------------------------------------------------------------------|
| 1      | To <i>write</i> assembly language programs for microprocessors and microcontrollers for various applications. |
| 2      | To <i>know</i> the importance of different peripheral devices and their interfacing to 8051.                  |
| 3      | To <i>maintain</i> microcontroller used in different application.                                             |
| 4      | To <i>develop</i> assembly language program using assembler.                                                  |

#### Course Outcomes

|                             |                                                                                 |
|-----------------------------|---------------------------------------------------------------------------------|
| The student will be able to |                                                                                 |
| CO1                         | <i>develop</i> programming skills for microprocessors and microcontrollers.     |
| CO2                         | <i>interface</i> various devices in microprocessor and microcontroller systems. |
| CO3                         | <i>build</i> programming skill using various assembler tools.                   |
| CO4                         | <i>design and implement</i> a microprocessor and microcontroller-based system.  |

#### Course Contents

| S. No. | Suggestive List of Experiments                                                                                        |
|--------|-----------------------------------------------------------------------------------------------------------------------|
| 1      | Write an assembly language program to add/subtract two 8-bit/16-bit numbers using 8086 microprocessor.                |
| 2      | Write an assembly language program to add two BCD numbers using 8086 microprocessor.                                  |
| 3      | Write an assembly language program for signed/unsigned multiplication of two 8-bit numbers using 8086 microprocessor. |
| 4      | Write assembly language program to perform block transfer using 8086 microprocessor.                                  |
| 5      | Write an assembly language program to find sum of series of 5 numbers using 8086 microprocessor.                      |
| 6      | Write an assembly language program to find smallest number from the array of 'n' numbers using 8086 microprocessor.   |
| 7      | Write an assembly language program to arrange the string in reverse order by using 8086 microprocessor.               |

|    |                                                                                                                                                      |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8  | Write an ALP to transfer data from source to destination location of internal/external data memory using 8051 microcontroller.                       |
| 9  | Write an ALP to find smallest/largest number from the given data bytes stored in internal/external data memory locations using 8051 microcontroller. |
| 10 | Develop an ALP to generate pulse and square wave by using Timer delay using 8051 microcontroller.                                                    |
| 11 | Interface 7-segment display to show decimal number with 8051 microcontroller.                                                                        |
| 12 | Interface LCD with 8051 microcontroller to display the characters and decimal numbers.                                                               |
| 13 | Interface the given keyboard with 8051 and display the key pressed.                                                                                  |
| 14 | Interface DAC with 8051 microcontroller and observe following waveforms: square wave, triangular wave, saw-tooth wave.                               |
| 15 | Interface stepper motor to 8051 microcontroller and rotate in clockwise and anti-clockwise direction at the given angles.                            |

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

## Suggested Learning Resources

### Textbooks

1. Microprocessor and Interfacing, II Ed., Douglas Hall, Tat McGraw Hill, 2014.
2. The 8051 Microcontroller & Embedded systems, III Ed., M. A. Mazidi, J. G. Mazidi, R. D. Mckinlay, Pearson Publications, 2018.
3. The 8051 Microcontroller & Embedded System using Assembly & 'C', III Ed., C. Kenneth J. Ayala and D. V. Gadre, Cengage Learning, 2018.

### Reference Books

1. 8086 Microprocessor Programming and Interfacing the PC, V Ed., Kenneth Ayala, Cengage Learning, 2010.
2. Microcontrollers: Architecture, Programming, Interfacing and System Design, III Ed., Raj Kamal, Pearson Education, 2017.

### Web Resources

1. 8086 Assembly language programming  
<https://youtube.com/playlist?list=PLIGqj2KrYnpSAqx7fcq4AJJI5rjG9CT&feature=shared>
2. Interfacing of 7 segment display with microcontroller 8051  
<https://www.youtube.com/watch?v=LUtx6ukDmSc&pp=ygUGIzgwNTE3>
3. Interfacing of LCD display with microcontroller 8051  
<https://www.youtube.com/watch?v=ktUbTEglyPI>
4. Interfacing of keyboard with 8051 microcontroller  
<https://www.youtube.com/watch?v=2SUhAtDvMxE&pp=ygUcI2ludGVyZmFjaW5na2V5Ym9hcmR3aXRoODA1MQ%3D%3D>
5. Interfacing of stepper motor with 8051 microcontroller  
<https://www.youtube.com/watch?v=Xj8QoHL2lPE>

### 3.6 Object Oriented Programming with Java (EC4VS\_LR1)

#### Teaching Scheme

| Course Code | Course Name                           | Contact Hours  | Credits |
|-------------|---------------------------------------|----------------|---------|
| EC4VS_LR1   | Object Oriented Programming with Java | 3 <sup>#</sup> | 02      |

#### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 50  | 25  | -   | -   | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                  |
|--------|---------------------------------------------------------------------------------------------|
| 1      | To <i>teach</i> fundamentals of object-oriented concepts in the Java programming language.  |
| 2      | To <i>discuss</i> concepts of classes & objects, constructors, arrays, strings and vectors. |
| 3      | To <i>explain</i> the use of inheritance, polymorphism, packages and interfaces.            |
| 4      | To <i>introduce</i> use of exception handling and multithreading, input output streams.     |
| 5      | To <i>familiarize</i> the graphical user interfaces in Java using swings and AWT.           |

#### Course Outcomes

|                             |                                                                                              |
|-----------------------------|----------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                              |
| CO1                         | <i>recall</i> the fundamentals of object-oriented concepts in the Java programming language. |
| CO2                         | <i>use</i> the concepts of classes & objects, constructors, arrays, strings and vectors.     |
| CO3                         | <i>apply</i> concepts of inheritance, polymorphism, packages and interfaces.                 |
| CO4                         | <i>construct</i> java program on exception handling and multithreading, input output stream. |
| CO5                         | <i>design</i> graphical user interfaces in Java using swings and AWT.                        |

#### Course Contents

| Module     | Unit                                                         | Detailed Contents                                                                                                                                        | Hours     |
|------------|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Pre-requisite</b>                                         |                                                                                                                                                          |           |
|            | Basic programming in C, OOPs concepts.                       |                                                                                                                                                          |           |
| <b>1.0</b> | <b>Fundamentals of Java Programming</b>                      |                                                                                                                                                          | <b>02</b> |
|            | 1.1                                                          | Java Virtual Machine (JVM), Java Development Kit (JDK), Java Runtime Environment (JRE).                                                                  |           |
|            | 1.2                                                          | Basic programming constructs, variables, data types, operators, unsigned right shift operator, expressions.                                              |           |
|            | 1.3                                                          | Control statements and iterations statements.                                                                                                            |           |
| <b>2.0</b> | <b>Class, Object, Constructors: Array, String and Vector</b> |                                                                                                                                                          | <b>03</b> |
|            | 2.1                                                          | Class & Object: Reference variables, passing parameters to methods and returning parameters from the methods, Static and non-static members and methods. |           |

|            |                                                                 |                                                                                                                                                                                                                                   |           |
|------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | 2.2                                                             | Arrays & Vectors: One-dimensional and two-dimensional arrays, irregular arrays, dynamic arrays.                                                                                                                                   |           |
|            | 2.3                                                             | Strings: String functions.                                                                                                                                                                                                        |           |
| <b>3.0</b> | <b>Inheritance, Polymorphism, Packages and Interfaces</b>       |                                                                                                                                                                                                                                   | <b>03</b> |
|            | 3.1                                                             | Inheritance: Types of inheritance in Java, member access, use Super keyword, Abstract classes and methods, using final.<br>Polymorphism: types of overloading, compile time and run-time polymorphism.                            |           |
|            | 3.2                                                             | Packages: Defining packages, creating packages and importing and accessing packages.                                                                                                                                              |           |
|            | 3.3                                                             | Interfaces: defining, implementing and extending interfaces, variables in interfaces.                                                                                                                                             |           |
| <b>4.0</b> | <b>Exception handling, Multithreading, Input Output streams</b> |                                                                                                                                                                                                                                   | <b>03</b> |
|            | 4.1                                                             | Exception handling: Exception-Handling fundamentals, exception types, exception class hierarchy, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions.          |           |
|            | 4.2                                                             | Multithreading: The Java Thread Model and thread life cycle, implementing Runnable, extending thread, creating multiple threads, synchronization.                                                                                 |           |
|            | 4.3                                                             | Input Output streams: Streams, byte streams and character, the predefined streams, reading console input-output.                                                                                                                  |           |
| <b>5.0</b> | <b>GUI programming in JAVA</b>                                  |                                                                                                                                                                                                                                   | <b>02</b> |
|            | 5.1                                                             | Event handling using event class & AWT: Working with windows, using AWT controls for GUI design.                                                                                                                                  |           |
|            | 5.2                                                             | Swing class in JAVA: A simple swing application, painting in swing, designing swing GUI application using buttons, JLabels, checkboxes, radio buttons, JScrollPane, JList, JComboBox, trees, TablesScroll pane menus and toolbar. |           |
|            | <b>Total Hours</b>                                              |                                                                                                                                                                                                                                   | <b>13</b> |

# 1-hour Theory classwise and 2-hour Lab batchwise

| <b>S. No.</b> | <b>Suggestive List of Experiments</b>                                                                                  |
|---------------|------------------------------------------------------------------------------------------------------------------------|
| 1             | To write any three java programs that covers classes, methods, operators, control structures and iteration statements. |
| 2             | To write a program to demonstrate java class, array, vector, string.                                                   |
| 3             | To write a java program to demonstrate constructors.                                                                   |
| 4             | To write a java program to demonstrate inheritance.                                                                    |
| 5             | To write a java program to demonstrate class & interface.                                                              |
| 6             | To write a java program to demonstrate java packages.                                                                  |
| 7             | To write a program to demonstrate the concept of overloading and overriding.                                           |
| 8             | To write a program to demonstrate I/O stream.                                                                          |

|    |                                                             |
|----|-------------------------------------------------------------|
| 9  | To write java program for exception handling.               |
| 10 | To write a program to demonstrate multithreading.           |
| 11 | To Write a program to demonstrate event driven programming. |
| 12 | To Write a program to demonstrate java AWT.                 |

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list. Additionally, a group activity (a team of 3-4 students) has to be assigned to develop a mini-project for front-end/ /back-end application using Java.

## **Suggested Learning Resources**

### **Textbooks**

1. Programming with Java - A Primer, V Ed., E. Balaguruswamy, Tata Mc Graw Hill Education, 2019.
2. Java-The Complete Reference, X Ed., Herbert Schildt, Tata McGraw Hill Education, 2018.

### **Reference Books**

1. Beginning Java, V Ed., Ivor Horton, Wiley India, 2014.
2. Java Programming - Black Book, III Ed., D.T. Editorial Services, Dreamtech Press, 2011.
3. Let us Java, IV Ed., Yashvant Kanetkar, BPB Publications. 2019.

### **Web Resources**

1. NPTEL course on Programming In Java, Prof. Debasis Samanta, IIT Kharagpur  
<https://archive.nptel.ac.in/courses/106/105/106105191/>
2. Java Tutorial by w3Schools  
<https://www.w3schools.com/java/default.asp>

\* 1-hour Theory classwise and 2-hour lab batchwise

### 3.7 Business Forecasting (IL4HM\_CR3)

#### Teaching Scheme

| Course Code | Course Name          | Contact Hours | Credits |
|-------------|----------------------|---------------|---------|
| IL4HM_CR3   | Business Forecasting | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 50    | Continuous | -     | -               | -     | -               | 50          |

#### Course Objectives

| S. No. | Objectives                                                                                                              |
|--------|-------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> the fundamentals of business forecasting and data-driven decision-making.                           |
| 2      | To <i>learn</i> various methods of time series forecasting, including moving averages and exponential smoothing.        |
| 3      | To <i>understand</i> and <i>apply</i> regression analysis and methods for handling seasonality in time series data.     |
| 4      | To <i>introduce</i> advanced techniques such as ACF, PACF, and ARIMA models for time series analysis.                   |
| 5      | To <i>explore</i> the use of machine learning, Monte Carlo simulations, and predictive analytics tools for forecasting. |

#### Course Outcomes

|                             |                                                                                                                                 |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                 |
| CO1                         | <i>understand</i> the role of forecasting in business and <i>differentiate</i> between qualitative and quantitative approaches. |
| CO2                         | <i>apply</i> moving average techniques and exponential smoothing for accurate time series forecasting.                          |
| CO3                         | <i>implement</i> regression models and seasonal indices to improve the accuracy of forecasts.                                   |
| CO4                         | <i>use</i> ACF, PACF, and ARIMA models to <i>identify</i> patterns and forecast future trends in time series data.              |
| CO5                         | <i>apply</i> machine learning techniques and Monte Carlo simulations to enhance forecasting accuracy and manage risk.           |

#### Course Contents

| Module | Unit               | Detailed Contents | Hours |
|--------|--------------------|-------------------|-------|
|        | Prerequisites: Nil |                   |       |

|                    |                                                                   |                                                                                                                             |           |
|--------------------|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>1.0</b>         | <b>Introduction to Business Forecasting &amp; Data Analytics</b>  |                                                                                                                             | <b>04</b> |
|                    | 1.1                                                               | Introduction to Business Forecasting, Data-Driven Decision Making and Essentials of Predictive Analytics.                   |           |
|                    | 1.2                                                               | Types of Forecasting: Qualitative Approaches and Quantitative Approaches.                                                   |           |
| <b>2.0</b>         | <b>Time Series Analysis and Forecasting Techniques</b>            |                                                                                                                             | <b>05</b> |
|                    | 2.1                                                               | Components of a Time Series and Measures of Forecast Accuracy.                                                              |           |
|                    | 2.2                                                               | Moving Average Methods: Simple, Weighted, and Exponential Moving Average.                                                   |           |
|                    | 2.3                                                               | Exponential Smoothing, Trend Projections and Holt Model.                                                                    |           |
| <b>3.0</b>         | <b>Regression, Seasonality, and Decomposition Methods</b>         |                                                                                                                             | <b>06</b> |
|                    | 3.1                                                               | Regression Analysis.                                                                                                        |           |
|                    | 3.2                                                               | Measure of Goodness and Standard Error.                                                                                     |           |
|                    | 3.3                                                               | Seasonality: Seasonal Index, and Quarterly Average Method, Seasonality and Trend: Holt Winter Method. Decomposition Method. |           |
| <b>4.0</b>         | <b>Advanced Forecasting and Time Series Models</b>                |                                                                                                                             | <b>05</b> |
|                    | 4.1                                                               | ACF and PACF                                                                                                                |           |
|                    | 4.2                                                               | ARIMA                                                                                                                       |           |
| <b>5.0</b>         | <b>Machine Learning, Risk Analytics, and Predictive Analytics</b> |                                                                                                                             | <b>06</b> |
|                    | 5.1                                                               | Introduction to Machine Learning, Logistic Regression; Human Judgement in Time Series Analysis.                             |           |
|                    | 5.2                                                               | Monte Carlo Simulation and Risk Analytics.                                                                                  |           |
|                    | 5.3                                                               | Predictive Analytics using @Risk software/Python.                                                                           |           |
| <b>Total Hours</b> |                                                                   |                                                                                                                             | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Business Forecasting, IX Ed., John E Hanke, Dean Wichern, Pearson Education, 2008.
2. Essentials of Business Analytics- Descriptive, Predictive and Prescriptive Analytics, II Ed., Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, Cengage Learning, 2016.

### Reference Books

1. Business Analytics, (PART 4: Regressions Analysis and Time Series Forecasting), V Ed., Albright and Winston, Cengage Learning, 2015.
2. Forecasting Methods and Applications, III Ed., Spyros G. Makridakis, Steven C. Wheelwright, Rob J. Hyndman, John Willey and Sons, 1997.
3. An Introduction to Management Science: Quantitative Approaches to Decision Making, XIII Ed., David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, and Kipp Martin, Cengage Learning, 2012.
4. Quantitative Analysis for Management, X Ed., Barry Render, Ralph M. Stair, Pearson Education, 2008.

### Web Resources

1. NPTEL course on Business Forecasting, Prof. Pankaj Dutta, IIT Bombay

[https://onlinecourses.nptel.ac.in/noc24\\_mg66/preview](https://onlinecourses.nptel.ac.in/noc24_mg66/preview)

### 3.8 Multidisciplinary Minor Courses

#### 3.8.1 Signals and Systems (ET4MM\_CX1)

##### Teaching Scheme

| Course Code | Course Name         | Contact Hours | Credits |
|-------------|---------------------|---------------|---------|
| ET4MM_CX1   | Signals and Systems | 02            | 02      |

##### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

##### Course Objectives

| S. No. | Objectives                                                                                                                           |
|--------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>understand</i> fundamental concepts of signals and systems in both continuous-time (CT) and discrete-time (DT) domains.        |
| 2      | To <i>analyze</i> linear time-invariant (LTI) systems using time-domain methods (convolution, differential/difference equations).    |
| 3      | To <i>apply</i> transform techniques (Fourier, Laplace, Z-Transform) for system and signal analysis in frequency domain.             |
| 4      | To <i>develop</i> the ability to model and characterize systems, understand their stability, causality, and response.                |
| 5      | To <i>provide</i> a strong foundation for advanced courses in Digital Signal Processing, Communication Systems, and Control Systems. |

##### Course Outcomes

| The student will be able to |                                                                                                                                                                                             |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1                         | <i>classify</i> and <i>analyze</i> signals and systems based on type, properties, and behavior (CT/DT, periodic/apperiodic, causal/non-causal, stable/unstable).                            |
| CO2                         | <i>analyze</i> continuous-time and discrete-time linear time-invariant systems in the time domain using impulse/step responses, convolution, system equations, and basic sampling concepts. |
| CO3                         | <i>represent</i> and <i>analyze</i> signals in frequency domain using Fourier Series and Fourier Transform.                                                                                 |
| CO4                         | <i>apply</i> Laplace and Z-transform techniques to <i>analyze</i> continuous-time and discrete-time systems and to <i>solve</i> differential and difference equations.                      |
| CO5                         | <i>analyze</i> discrete-time systems using Z-Transform, <i>determine</i> transfer function, stability, and <i>design/realize</i> FIR and IIR systems.                                       |

##### Course Contents

| Module     | Unit                                                                | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                     | Hours     |
|------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites</b>                                                |                                                                                                                                                                                                                                                                                                                                                                                                                       |           |
|            | Basic Engineering Mathematics, Basics of signal.                    |                                                                                                                                                                                                                                                                                                                                                                                                                       |           |
| <b>1.0</b> | <b>Signals &amp; Systems Basics</b>                                 |                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>05</b> |
|            | 1.1                                                                 | Definition of signals and systems, Continuous-Time (CT) and Discrete-Time (DT) signals, Periodic, Aperiodic signals, Signal classification: even, odd, energy, power, causal, non-causal, Deterministic, random signals, Elementary signals: step, impulse, ramp, exponential, sine, cosine.                                                                                                                          |           |
|            | 1.2                                                                 | System classification: linear, non-linear, time-invariant, time-variant, causal, non-causal, stable, unstable, LTI system properties: memory, invertibility.                                                                                                                                                                                                                                                          |           |
| <b>2.0</b> | <b>Time-Domain Analysis of Linear Time-Invariant Systems</b>        |                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>05</b> |
|            | 2.1                                                                 | Introduction to Linear Time-Invariant (LTI) systems: concepts of linearity and time-invariance; classification of continuous-time (CT) and discrete-time (DT) systems.<br>Impulse and step responses of CT and DT LTI systems.<br>Convolution integral (CT) and convolution sum (DT) with simple illustrative examples.<br>Differential (CT) and difference (DT) equation representation of LTI systems (basic form). |           |
|            | 2.2                                                                 | Introduction to sampling: concept of sampling, sampling of continuous-time signals, brief overview of ideal sampling.<br>Concepts of system stability and causality.                                                                                                                                                                                                                                                  |           |
| <b>3.0</b> | <b>Fourier Series and Fourier Transform – Basics and Properties</b> |                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>05</b> |
|            | 3.1                                                                 | Continuous-Time Fourier Series (CTFS): formulation and basic properties.<br>Discrete-Time Fourier Series (DTFS): formulation and basic properties.                                                                                                                                                                                                                                                                    |           |
|            | 3.2                                                                 | Continuous-Time Fourier Transform (CTFT) and Discrete-Time Fourier Transform (DTFT): concept, formulation, magnitude and phase spectra.<br>Important Fourier properties: linearity, time shifting, frequency shifting, and convolution property.                                                                                                                                                                      |           |
|            | 3.3                                                                 | Energy and power of signals: Parseval’s theorem, basic concept of energy and power spectral density (PSD) and their significance.                                                                                                                                                                                                                                                                                     |           |
| <b>4.0</b> | <b>Laplace Transform &amp; Continuous-Time System Analysis</b>      |                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>05</b> |
|            | 4.1                                                                 | Laplace Transform: Definition transform of standard signals, basic properties, inverse Laplace transform (partial fractions), solution of linear differential equations.                                                                                                                                                                                                                                              |           |
|            | 4.2                                                                 | Z-Transform: Definition, transform of standard sequences, basic properties, inverse Z-transform (partial fractions), solution of linear difference equations.                                                                                                                                                                                                                                                         |           |
| <b>5.0</b> | <b>Digital Structures for FIR and IIR Filters</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>06</b> |

|  |                    |                                                                                                                                                                                                                                                   |           |
|--|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|  | 5.1                | Basic building blocks for digital filter realization: adders, multipliers, and delay elements. Introduction to FIR and IIR filter FIR filter structures: direct form, cascade form, and lattice realization; concept of linear-phase FIR filters. |           |
|  | 5.2                | IIR filter structures: direct form-I, direct form-II, cascade form, parallel form, and lattice realization (basic concept). Comparison of FIR and IIR filter structures in terms of stability, memory requirement, and computational complexity.  |           |
|  | <b>Total Hours</b> |                                                                                                                                                                                                                                                   | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Signals and Systems, II Ed., Simon Haykin, Barry Van Veen, Wiley, 2007.
2. Signals and Systems, II Ed., Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, Prentice-Hall, 1996.
3. Linear Systems and Signals, II Ed., B. P. Lathi, Oxford University Press, 2005.
4. Schaum's Outline: Signals and Systems, II Ed., Hwei P. Hsu, McGraw-Hill, 2003.
5. Fundamentals of Signals and Systems, I Ed., Michel J. Robert, McGraw-Hill, 2008.

### Reference Books

1. Digital Signal Processing, IV Ed., John G. Proakis, Dimitris Manolakis, Pearson, 2006.
2. Signals, Systems and Inference, I Ed., Hwei P. Hsu, 1st Edition, McGraw-Hill, 2003.
3. Introduction to Signal and Systems, I Ed., Mark A. Pinsky, Samuel Karlin, Dover, 2001.
4. Signals and Systems for Bioengineers, II Ed., John Semmlow, Academic Press, 2007.
5. Principles of Linear Systems and Signals, II Ed., B. P. Lathi, Oxford University Press, 2005.

### Web Resources

1. NPTEL course on Principles of Signals and Systems, Prof. Aditya Jagannatham, IIT Kanpur  
<https://nptel.ac.in/courses/108104100>
2. Signals and Systems, Prof. V.M. Gadre, IIT Bombay  
<https://nptel.ac.in/courses/117101055>
3. MIT Open Courseware on Signals and Systems  
<https://www.youtube.com/watch?v=-FHm2pQmiSM&list=PLU14u3cNGP61kdPAOC7CzFjJZ8f1eMUxs>

### 3.8.2 Introduction to Electric Vehicle (EE4MM\_CX1)

#### Teaching Scheme

| Course Code | Course Name                      | Contact Hours | Credits |
|-------------|----------------------------------|---------------|---------|
| EE4MM_CX1   | Introduction to Electric Vehicle | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                               |
|--------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> students to the history, evolution, and significance of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs). |
| 2      | To <i>familiarize</i> students with various drivetrain topologies and power flow analysis in EVs and HEVs.                               |
| 3      | To <i>impart</i> knowledge about different energy sources, storage systems, and propulsion technologies used in EVs.                     |
| 4      | To <i>provide</i> an overview of autonomous electric vehicles, their core technologies, and future trends.                               |
| 5      | To <i>analyze</i> Indian government policies, financial incentives, and case studies related to EV adoption.                             |

#### Course Outcomes

| The student will be able to |                                                                                                                   |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------|
| CO1                         | <i>explain</i> the history, evolution, and importance of EVs and HEVs, including their impact on the environment. |
| CO2                         | <i>analyze</i> different drivetrain topologies, power flow control, and fuel efficiency in EVs and HEVs.          |
| CO3                         | <i>apply</i> knowledge of energy storage technologies and propulsion systems for EV applications.                 |
| CO4                         | <i>evaluate</i> the core technologies of autonomous electric vehicles, their challenges, and future trends.       |
| CO5                         | <i>assess</i> Indian government policies, incentives, and case studies to determine their impact on EV adoption.  |

## Course Contents

| Module     | Unit                                                          | Detailed Contents                                                                                                                                                                                                                                                                                                                             | Hours     |
|------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites: Nil</b>                                     |                                                                                                                                                                                                                                                                                                                                               |           |
| <b>1.0</b> | <b>History and Evolution of Electric Vehicles</b>             |                                                                                                                                                                                                                                                                                                                                               | <b>05</b> |
|            | 1.1                                                           | History of EVs: Basics of vehicles mechanisms, history of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV.                                                                                                                                                                                       |           |
|            | 1.2                                                           | Need and Importance of EVs: Power/Energy supplies requirements for EV/HEV applications. State of the art and Indian and global scenario in EV/HEV. Electric Vehicle and environment.                                                                                                                                                          |           |
| <b>2.0</b> | <b>Drive Train Topology</b>                                   |                                                                                                                                                                                                                                                                                                                                               | <b>05</b> |
|            | 2.1                                                           | Vehicle Transmission: Configurations of Electric Vehicles and various electric drive-train topologies.                                                                                                                                                                                                                                        |           |
|            | 2.2                                                           | Hybrid Electric Vehicles: Concept of hybrid electric drivetrains system, various hybrid drive-train topologies. Power Flow in EV and HEV: Power flow control in drive-train topologies, Fuel efficiency analysis.                                                                                                                             |           |
| <b>3.0</b> | <b>Energy Sources and Propulsion of EVs</b>                   |                                                                                                                                                                                                                                                                                                                                               | <b>06</b> |
|            | 3.1                                                           | Peaking Power Sources and Energy Storage: Requirements of energy supplies and storage in EV/HEV, review of batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV.                                                                                                                                                |           |
|            | 3.2                                                           | DC and AC Machines for Propulsion Applications: Electric system components for EV/HEV, types and suitability of DC and AC machines for EV/HEV applications.                                                                                                                                                                                   |           |
| <b>4.0</b> | <b>Overview of Autonomous Electric Vehicles</b>               |                                                                                                                                                                                                                                                                                                                                               | <b>05</b> |
|            | 4.1                                                           | Introduction to Autonomous Vehicles: Autonomous vehicles, core technologies behind autonomous vehicles.                                                                                                                                                                                                                                       |           |
|            | 4.2                                                           | Synergy between Autonomous Systems and EVs: Benefits of autonomous electric vehicles, challenges in developing autonomous electric vehicles, current and future trends in autonomous EVs.                                                                                                                                                     |           |
| <b>5.0</b> | <b>Indian Government Policies for Electric Vehicles (EVs)</b> |                                                                                                                                                                                                                                                                                                                                               | <b>05</b> |
|            | 5.1                                                           | Introduction to Electric Vehicle Policies in India: Need for EV policies in India, National-Level EV Policies- FAME scheme and its phases, NITI Aayog involvement, National Electric Mobility Mission Plan (NEMMP), rate of deployment of EVs on-board chargers. Production-Linked Incentive (PLI) scheme for automobile and auto components. |           |
|            | 5.2                                                           | Financial incentives and subsidies for EV adoption, case studies of popular EVs on road.                                                                                                                                                                                                                                                      |           |
|            | <b>Total Hours</b>                                            |                                                                                                                                                                                                                                                                                                                                               | <b>26</b> |

## **Suggested Learning Resources**

### **Textbooks**

1. Electric and Hybrid Vehicles: Design Fundamentals, I Ed., Iqbal Hussein, CRC Press, 2003.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, III Ed., Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, CRC Press, 2018.
3. Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, I Ed., Sheldon S Williamson, Springer 2013.
4. Electric Vehicle Technology Explained, II Ed., J. Larminie, J. Lowry, Wiley, 2012.

### **Reference Books**

1. Modern Power Electronics and AC Drives, I Ed., B. K Bose, Pearson Education 2002.
2. Hybrid Electrical Vehicle Principles and Application with Practical Perspectives, I Ed., C. Mi, M. Abul, D. W. Gao, Wiley, 2011.
3. Energy Storage, I Ed., Robert A. Huggins, Springer 2010.

### **Web Resources**

1. NPTEL course on Introduction to Hybrid and Electric Vehicles, Prof. Praveen Kumar, Prof. S. Majhi, IIT Guwahati.  
<https://nptel.ac.in/courses/108/103/108103009>
2. NPTEL course on EV – Vehicle Dynamics and Electric Motor Drives, Prof. Amit Jain, Prof. Avanish Tripathi, IIT Delhi.  
[https://onlinecourses.nptel.ac.in/noc24\\_ee30/preview](https://onlinecourses.nptel.ac.in/noc24_ee30/preview)
3. Electric Vehicles and Renewable Energy, Prof. Ashok Jhunjunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha, Prof. L Kannan, IIT Madras.  
<https://nptel.ac.in/courses/108106182>

### 3.8.3 Introduction to Additive Manufacturing (ME4MM\_CX1)

#### Teaching Scheme

| Course Code | Course Name                            | Contact Hours | Credits |
|-------------|----------------------------------------|---------------|---------|
| ME4MM_CX1   | Introduction to Additive Manufacturing | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                         |
|--------|--------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> the fundamentals and classifications of Additive Manufacturing (AM) technologies.              |
| 2      | To <i>provide</i> knowledge of various AM systems including liquid-based, solid-based, and powder-based processes. |
| 3      | To <i>develop</i> understanding of AM machine specifications, working principles, and process parameters.          |
| 4      | To <i>familiarize</i> students with materials used in AM and their properties, limitations, and applications.      |

#### Course Outcomes

|                             |                                                                                                                                                                                                |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                                                                                |
| CO1                         | <i>explain</i> the fundamentals, classifications, advantages, and applications of different AM processes.                                                                                      |
| CO2                         | <i>describe</i> and <i>compare</i> various liquid-based AM systems (SLA) by analyzing their working principles and process parameters.                                                         |
| CO3                         | <i>analyze</i> solid-based AM systems (LOM, FDM) by evaluating their process sequences, machine specifications, applications, and performance characteristics.                                 |
| CO4                         | <i>evaluate</i> powder-based AM technologies (SLS, 3DP, EBM) by examining process mechanisms and material behavior.                                                                            |
| CO5                         | <i>select</i> suitable materials for different AM processes by examining their properties such as dimensional accuracy, stability, surface finish, machinability and environmental resistance. |

## Course Contents

| Module             | Unit                                        | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                 | Hours     |
|--------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | <b>Prerequisites</b>                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |
|                    | Engineering Graphics                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |
| <b>1.0</b>         | <b>Additive Manufacturing</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>05</b> |
|                    | 1.1                                         | Introduction to AM, Classification of AM Processes, Advantages & Disadvantages, AM Applications; in Design, Concept Models, Form & Fit Checking, Functional testing and CAD data verification.                                                                                                                                                                                                                                                    |           |
| <b>2.0</b>         | <b>Liquid-based Systems</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>05</b> |
|                    | 2.1                                         | Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies.                                                                                                                                                                                                          |           |
| <b>3.0</b>         | <b>Solid-based Systems</b>                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>05</b> |
|                    | 3.1                                         | Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies.                                                                                                                                          |           |
| <b>4.0</b>         | <b>Powder-Based Systems</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>05</b> |
|                    | 4.1                                         | Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three-dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies. Electron Beam Melting (EBM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. |           |
| <b>5</b>           | <b>Materials for Additive Manufacturing</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>06</b> |
|                    | 5.1                                         | Types of material: polymers, metals, ceramics and composites, liquid-based materials, photo polymer development, solid-based materials, powder-based materials. Material properties: Colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, and operational properties.                                                                                                                                |           |
| <b>Total Hours</b> |                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Additive Manufacturing, I Ed., Dr R. B. Chaudary, Khanna Publishers, 2022.
2. Rapid Prototyping: Principles and Applications, II Ed., Chua Chee Kai, Kah Fai Leong, Tata McGraw-Hill, 2018.

**Reference Books**

1. Additive Manufacturing: Principles, Technologies and Applications, I Ed., C.P. Paul, A.N. Jinoop, McGraw-Hill India, 2021.
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, Springer, 2020.

**Web Resources**

1. SWAYAM course on Fundamentals of Additive Manufacturing Technologies, Dr. Sajan Kapil, IIT Guwahati  
[https://onlinecourses.nptel.ac.in/noc25\\_me151/preview](https://onlinecourses.nptel.ac.in/noc25_me151/preview)

### 3.8.4 Introduction to Robotics (ME4MM\_CX2)

#### Teaching Scheme

| Course Code | Course Name              | Contact Hours | Credits |
|-------------|--------------------------|---------------|---------|
| ME4MM_CX2   | Introduction to Robotics | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                       |
|--------|----------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> the history, evolution, and fundamental concepts of robotics.                                                |
| 2      | To <i>teach</i> about the types, working principles, roles and applications of sensors, actuators and end effectors in robotics. |
| 3      | To <i>explore</i> the classification of robots based on various criteria.                                                        |
| 4      | To <i>discuss</i> the ethical, social, and safety implications of robotics.                                                      |

#### Course Outcomes

|                              |                                                                                           |
|------------------------------|-------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                           |
| CO1                          | <i>explain</i> the history, evolution, and basic concepts of robotics.                    |
| CO2                          | <i>identify</i> different sensors and actuators and their integration in robotic systems. |
| CO3                          | <i>identify</i> appropriate end effectors for specific applications.                      |
| CO4                          | <i>classify</i> and <i>relate</i> between robots based on various criteria.               |
| CO5                          | <i>discuss</i> the ethical, social, and safety implications of robotics.                  |

#### Course Contents

| Module | Unit                                    | Detailed Contents                                                                                                                                                                                                                   | Hours |
|--------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1.0    | Prerequisites                           |                                                                                                                                                                                                                                     | 05    |
|        | Physics of Motion, Coordinate geometry. |                                                                                                                                                                                                                                     |       |
|        | History and Concepts in Robotics        |                                                                                                                                                                                                                                     |       |
|        | 1.1                                     | Introduction to Robotics: Definition of robotics, Historical milestones in robotics, Asimov’s laws of robotics, Basic types of robots (stationary, mobile, swarm), Overview of robot components, Block diagram of a robotic system. |       |
|        | 1.2                                     | Study Areas in Robotics: Basic concepts of motion (position, velocity, and acceleration), Forward and inverse kinematics, Robot dynamics, Motion planning, Motion and force control,                                                |       |

|            |                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                          |           |
|------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            |                                                      | Perception and enabling technologies.                                                                                                                                                                                                                                                                                                                                                                                    |           |
|            | 1.3                                                  | Robot Applications: Applications of robots in industry and society, Famous robots (Stanford robot, Canada arm, ASIMO, Boston Dynamics robots, Mars rovers, etc.).                                                                                                                                                                                                                                                        |           |
| <b>2.0</b> | <b>Sensors and Actuators</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>05</b> |
|            | 2.1                                                  | Introduction to Sensors: Types of sensors (proximity, vision, force, temperature, etc.), Working of sensors (ultrasonic, infrared, accelerometer, etc.), Role of sensors in robot perception and decision-making.                                                                                                                                                                                                        |           |
|            | 2.2                                                  | Introduction to Actuators: Types of actuators (electric motors, hydraulic, pneumatic, piezoelectric), Working of actuators (DC motors, stepper motors, servo motors), Role of actuators in robot movement and manipulation.                                                                                                                                                                                              |           |
|            | 2.3                                                  | Sensor-Actuator Integration: How sensors and actuators work together in a robotic system, Interfacing with microcontrollers, Study of line-following and obstacle-avoidance robots.                                                                                                                                                                                                                                      |           |
| <b>3.0</b> | <b>Robot End Effectors</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>05</b> |
|            | 3.1                                                  | Introduction to End Effectors: Definition and role of end effectors in robotics, Major classes of end effectors (mechanical and non-mechanical).                                                                                                                                                                                                                                                                         |           |
|            | 3.2                                                  | End effectors Applications: Grippers (two-finger, multi-finger, parallel, magnetic), Tools (suction cups, welding guns, fastening tools, glue nozzles, etc.), Advanced end effectors, compliant end effectors, and end effectors for soft robotics. Factors to consider during end effector design and selection (payload, precision, application), Case studies (Robotic hands, surgical tools, and adaptive grippers). |           |
| <b>4.0</b> | <b>Robot Classification</b>                          |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>05</b> |
|            | 4.1                                                  | Classification based on Mobility: Fixed robots (industrial arms), Mobile robots (wheeled, legged, flying, underwater).                                                                                                                                                                                                                                                                                                   |           |
|            | 4.2                                                  | Classification based on Control: Autonomous and teleoperated robots.                                                                                                                                                                                                                                                                                                                                                     |           |
| <b>5.0</b> | <b>Ethical and Safety Considerations in Robotics</b> |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>06</b> |
|            | 5.1                                                  | Ethical Issues in Robotics: Ethical dilemmas, job displacement, and privacy concerns, Positive and negative impacts on society.                                                                                                                                                                                                                                                                                          |           |
|            | 5.2                                                  | Safety Standards in Robotics: Safety protocols for industrial and service robots, Risk assessment and hazard mitigation, Designing robots for safe and effective interaction with humans.                                                                                                                                                                                                                                |           |
|            | 5.3                                                  | Case Studies: Self-driving car accidents, robotic surgery errors, Collaborative robots (cobots) and social robots.                                                                                                                                                                                                                                                                                                       |           |
|            | <b>Total Hours</b>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Robotics and Control, I Ed., R. K. Mittal, I. J. Nagrath, McGraw Hill Education, 2017.

2. Industrial Robotics-Technology, Programming and Applications, II Ed., Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, McGraw Hill Education, 2014.
3. Robotics, I Ed., Chikesh Ranjan, Kaushik Kumar, S. Chand, 2024.

### **Reference Books**

1. Robotics Modelling, Planning and Control, I Ed., Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Springer, 2009.
2. Robotics, Vision and Control - Fundamental Algorithms in Python, III Ed., Peter Corke, Springer, 2023.
3. Introduction to Robotics, II Ed., S. K. Saha, McGraw Hill Education, 2014.

### **Web Resources**

1. SWAYAM course on Experimental Robotics, Dr. Dilip Kumar Pratihari, IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc24\\_ge31/preview](https://onlinecourses.nptel.ac.in/noc24_ge31/preview)
2. NPTEL Course, Robotics, Prof. Dk Pratihari, IIT Kharagpur  
<https://nptel.ac.in/courses/112105249>
3. NPTEL course on Introduction to Robotics, Dr. Krishna Vasudevan, Dr. T Asokan, Dr. Balaraman Ravindran, IIT Madras  
<https://nptel.ac.in/courses/107106090>

## 3.9 Open Elective Courses

### 3.9.1 IPR and Patenting (IL4OE\_CX1)

#### Teaching Scheme

| Course Code | Course Name       | Contact Hours | Credits |
|-------------|-------------------|---------------|---------|
| IL4OE_CX1   | IPR and Patenting | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                        |
|--------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>familiarize</i> the learners with the concept of intellectual property and the need to protect it.                          |
| 2      | To <i>explain</i> the process of patent filing and related issues to the learners.                                                |
| 3      | To <i>teach</i> the learners the processes, laws and practical issues related to copyrights and trademarks.                       |
| 4      | To <i>teach</i> the learners the processes, laws and practical issues related to industrial designs and geographical indications. |
| 5      | To <i>teach</i> the learners the processes, laws and practical issues related to trade secrets and traditional knowledge.         |

#### Course Outcomes

|                             |                                                                                                                     |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                     |
| CO1                         | <i>understand</i> the concepts of intellectual property rights.                                                     |
| CO2                         | <i>understand</i> the process of patent filing and analyze the related issues.                                      |
| CO3                         | <i>analyze</i> the processes, laws and practical issues related to copyrights and trademarks.                       |
| CO4                         | <i>analyze</i> the processes, laws and practical issues related to industrial designs and geographical indications. |
| CO5                         | <i>analyze</i> the processes, laws and practical issues related to trade secrets and traditional knowledge.         |

#### Course Contents

| Module     | Unit                                                | Detailed Contents | Hours     |
|------------|-----------------------------------------------------|-------------------|-----------|
|            | <b>Prerequisites: Nil</b>                           |                   |           |
| <b>1.0</b> | <b>Introduction to Intellectual Property Rights</b> |                   | <b>05</b> |

|            |                                                        |                                                                                                                                                                                                                                                                                                                                              |           |
|------------|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | 1.1                                                    | Intellectual property: Definition, Intellectual property versus physical property, Origin of IP, Role of IP in economic and cultural development.                                                                                                                                                                                            |           |
|            | 1.2                                                    | Categories of Intellectual Property: Patent, Copyrights, Trademarks, industrial Designs, Geographical Indications,                                                                                                                                                                                                                           |           |
|            | 1.3                                                    | IP Governance: What is IP Governance?, Organizations involved in IP governance in India and abroad – DPIIT, TIFAC, NRDC, CIPAM, WIPO and their functions.                                                                                                                                                                                    |           |
| <b>2.0</b> | <b>Fundamentals of Patent</b>                          |                                                                                                                                                                                                                                                                                                                                              | <b>05</b> |
|            | 2.1                                                    | Understanding patents: Conditions for granting of patent, non-patentable inventions, process versus product patents, Types of patent applications.                                                                                                                                                                                           |           |
|            | 2.2                                                    | Processes: Granting of a patent, filing an e-patent, Precautions to be taken while filing a patent.                                                                                                                                                                                                                                          |           |
|            | 2.3                                                    | Temporal and spatial aspect, Opposition to grant of patent, Rights of patentee.                                                                                                                                                                                                                                                              |           |
| <b>3.0</b> | <b>Copyrights and Trademarks</b>                       |                                                                                                                                                                                                                                                                                                                                              | <b>05</b> |
|            | 3.1                                                    | Copyright: Definition and classes of copyrights, Publication of copyright, The rights of the copyright owner, Terms of copyright, Registration of copyright.                                                                                                                                                                                 |           |
|            | 3.2                                                    | Laws: Copyright infringement, The copyright (Amendment) act, 2012, The Information Technology Act, 2000.                                                                                                                                                                                                                                     |           |
|            | 3.3                                                    | Trademarks: Definition, Classification of trademark, Developing a trademark, Conditions for trademark registrations, Infringement and remedies for trademark registration.                                                                                                                                                                   |           |
| <b>4.0</b> | <b>Industrial Designs and Geographical Indications</b> |                                                                                                                                                                                                                                                                                                                                              | <b>06</b> |
|            | 4.1                                                    | Industrial Designs: Definition, Registration of designs, Copyright in registered designs, conditions for registered designs, Procedure for registration of industrial designs, Terms of industrial design, Infringement of industrial design and their remedies, Integrated Circuits (IC) layout design, grant of registration of IC design. |           |
|            | 4.2                                                    | Geographical indications: Concept, Procedure and duration of registration.                                                                                                                                                                                                                                                                   |           |
|            | 4.3                                                    | Geographical indications: Registration process, examination of application, acceptance of application, opposition to registration of GI, Infringement of GI and remedies.                                                                                                                                                                    |           |
| <b>5.0</b> | <b>Trade Secrets and Traditional knowledge</b>         |                                                                                                                                                                                                                                                                                                                                              | <b>05</b> |
|            | 5.1                                                    | Criteria for trade secret, registration and protection time of trade secrets, rights associated with trade secrets, enforcement of trade secrets.                                                                                                                                                                                            |           |
|            | 5.2                                                    | Application for trade secrets, precautions to be taken by the organizations.                                                                                                                                                                                                                                                                 |           |
|            | 5.3                                                    | Traditional knowledge: Significance, agreement and protection.                                                                                                                                                                                                                                                                               |           |
|            | <b>Total Hours</b>                                     |                                                                                                                                                                                                                                                                                                                                              | <b>26</b> |

## **Suggested Learning Resources**

### **Textbooks**

1. Intellectual Property Rights, I Ed., Neeraj Pandey, Khusdeep Dharni, Prentice Hall India, 2014.
2. Intellectual Property Rights: Texts and Cases, I Ed., R. Radhakrishnan, S. Balasubramanian, Excel Books, 2008.

### **Reference Books**

1. Fundamentals of Intellectual Property for Engineers, I Ed., Kompal Bansal, Parikshit Bansal, BS Publications, 2014.

### **Web Resources**

1. Intellectual Property: A Primer for Academia, Rupinder Tewari, Mamta Bharadwai, Publication Bureau, Panjab University, 2021.  
<https://tinyurl.com/mvsvvafj>
2. NPTEL course on Intellectual Property Rights and Competition Law, Prof. K.D. Raju, Prof. Niharika Sahoo Bhattacharya, IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc24\\_mgl25/preview](https://onlinecourses.nptel.ac.in/noc24_mgl25/preview)

### 3.9.2 Cyber Security and Laws (IL4OE\_CX2)

#### Teaching Scheme

| Course Code | Course Name             | Contact Hours | Credits |
|-------------|-------------------------|---------------|---------|
| IL4OE_CX2   | Cyber Security and Laws | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                          |
|--------|-----------------------------------------------------------------------------------------------------|
| 1      | To <i>understand</i> and <i>identify</i> different types cybercrime and cyber law.                  |
| 2      | To <i>recognize</i> Indian IT Act 2008 and its latest amendments.                                   |
| 3      | To <i>understand</i> the types of attacks and how to tackle the amount of risk involved.            |
| 4      | To <i>discuss</i> the role of industry standards and legal requirements with respect to compliance. |
| 5      | To <i>create</i> awareness about Incident Management and its life cycle.                            |

#### Course Outcomes

|                              |                                                                       |
|------------------------------|-----------------------------------------------------------------------|
| The student will be able to: |                                                                       |
| CO1                          | <i>understand</i> fundamental cyber threats and security principles.  |
| CO2                          | <i>apply</i> cryptography techniques to secure digital assets.        |
| CO3                          | <i>analyze</i> cybercrimes and perform basic forensic investigations. |
| CO4                          | <i>explain</i> key cyber laws and compliance frameworks.              |
| CO5                          | <i>explore</i> cybersecurity applications in IoT, AI, and Blockchain. |

#### Course Contents

| Module | Unit                                  | Detailed Contents                                                                                                                                                                                | Hours |
|--------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
|        | <b>Prerequisites:</b>                 |                                                                                                                                                                                                  |       |
|        | Basic Computer Science and Networking |                                                                                                                                                                                                  |       |
| 1.0    | <b>Introduction to Cyber Security</b> |                                                                                                                                                                                                  | 06    |
|        | 1.1                                   | Fundamentals of cyber security: Definition, Need and Importance, Evolution of Cyber Security, CIA Triad (Confidentiality, Integrity, Availability), Cyber Threats, Vulnerabilities, and Attacks. |       |
|        | 1.2                                   | Types of cyber-attack: Malware (Viruses, Worms, Trojans, Ransomware), Phishing and Social Engineering Attacks, Denial of Service (DoS) and Distributed DoS (DDoS), SQL Injection, Man-           |       |

|            |                                                  |                                                                                                                                                                                                           |           |
|------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            |                                                  | in-the-Middle (MITM) Attacks.                                                                                                                                                                             |           |
|            | 1.3                                              | Cybersecurity Challenges & Trends: Zero-Day Attacks, Cloud Security Risks, AI in Cybersecurity.                                                                                                           |           |
| <b>2.0</b> | <b>Cyber Security Mechanisms</b>                 |                                                                                                                                                                                                           | <b>06</b> |
|            | 2.1                                              | Cyber Defense Strategies: Encryption Techniques & Cryptography Basics, Firewalls, Intrusion Detection & Prevention Systems (IDS/IPS), Endpoint Security & Antivirus Software.                             |           |
|            | 2.2                                              | Authentication & Access Control: Multi-Factor Authentication (MFA), Role-Based Access Control (RBAC), Digital Signatures & Certificates.                                                                  |           |
|            | 2.3                                              | Cyber Security Frameworks & Standards: NIST Cybersecurity Framework, ISO 27001 Standard, GDPR, HIPAA, and Compliance Requirements.                                                                        |           |
| <b>3.0</b> | <b>Ethical Hacking &amp; Cyber Forensics</b>     |                                                                                                                                                                                                           | <b>05</b> |
|            | 3.1                                              | Ethical Hacking & Penetration Testing: Phases of Ethical Hacking, Common Hacking Techniques, Vulnerability Assessment & Exploitation.                                                                     |           |
|            | 3.2                                              | Cyber Forensics & Incident Response: Digital Evidence Collection & Chain of Custody, Incident Handling & Recovery Strategies, Case Studies on Real-World Cybercrime Investigations.                       |           |
| <b>4.0</b> | <b>Cyber Laws &amp; Legal Framework</b>          |                                                                                                                                                                                                           | <b>05</b> |
|            | 4.1                                              | Overview of Cyber Laws: Importance of Cyber Laws, Cyber Crimes and Legal Challenges, International Perspectives on Cyber Laws.                                                                            |           |
|            | 4.2                                              | IT Act, 2000 & Amendments: Key Provisions of the Information Technology (IT) Act, 2000, Important Sections Related to Cybercrime & Data Protection, Recent Amendments & Relevance in Today's Digital Era. |           |
|            | 4.3                                              | Global Cybersecurity Regulations & Compliance: General Data Protection Regulation (GDPR), California Consumer Privacy Act (CCPA), International Cyber Treaties & Agreements.                              |           |
| <b>5.0</b> | <b>Case Studies &amp; Practical Applications</b> |                                                                                                                                                                                                           | <b>04</b> |
|            | 5.1                                              | Real-World Cybercrime Case Studies: Famous Cyber Attacks & Data Breaches, Lessons Learned from High-Profile Security Incidents.                                                                           |           |
|            | 5.2                                              | Cybersecurity in Business & Government: Corporate Cybersecurity Strategies, Role of Governments in Cybersecurity Policies.                                                                                |           |
|            | 5.3                                              | Future Trends in Cybersecurity & Law: Cyber Warfare & Nation-State Attacks, Artificial Intelligence in Cybersecurity Law Enforcement, Future of Data Privacy & Ethical Challenges.                        |           |
|            | <b>Total Hours</b>                               |                                                                                                                                                                                                           | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Cyber Security, I Ed., Nina Godbole, Sunit Belapure, Wiley India, 2011.
2. The Indian Cyber Law, I Ed., Suresh T. Vishwanathan, Bharat Law House, 2004.

3. The Information Technology Act, 2000 (Bare Act), I Ed., Professional Book Publishers, 2000.
4. Cyber Law & Cyber Crimes, I Ed., Advocate Prashant Mali, Snow White Publications, 2012.
5. Information Systems Security, I Ed., Nina Godbole, Wiley India, 2012.
6. Cyber Security & Global Information Assurance, I Ed., Kenneth J. Knapp, Information Science Publishing, 2009.
7. Cryptography and Network Security, VII Ed., William Stallings, Pearson Education, 2017.

### **Reference Books**

1. IT Systems Management: Designing, Implementing and Managing World - Class Infrastructures, II Ed., Rich-Schiesser, Prentice Hall, 2010.
2. COBIT 2019 Framework: Introduction and Methodology, I Ed., Dr. David Lanter, ISACA, 2019.
3. Open Source Security Testing Methodology Manual (OSSTMM) v3, III Ed., Pete Herzog, 2010.
4. Guide for Conducting Risk Assessments, NIST Special Publication, National Institute of Standards and Technology (NIST), 2012.

### **Web Resources**

1. NPTEL Course on Introduction to Information Security – I, Prof. V. Kamakoti, IIT Madras  
<https://archive.nptel.ac.in/courses/106/106/106106129/>
2. Ultimate IT Security website  
<https://www.ultimatewindowssecurity.com/securitylog/book/Default.aspx>
3. American Library Association - Chapter 14: Standards, Guidelines, and Frameworks  
<http://www.ala.org/acrl/resources/policies/chapter14>
4. Advisera - ISO 27001  
<https://advisera.com/27001academy/what-is-iso-27001/>  
<https://nvlpubs.nist.gov/nistpubs/legacy/sp/nistspecialpublication800-30r1.pdf>  
<http://www.diva-portal.org/smash/get/diva2:1117263/FULLTEXT01.pdf>

### 3.9.3 Psychology (IL4OE\_CX3)

#### Teaching Scheme

| Course Code | Course Name | Contact Hours | Credits |
|-------------|-------------|---------------|---------|
| IL4OE_CX3   | Psychology  | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                          |
|--------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <i>define</i> key concepts of psychology, including its definitions, history, and major milestones.                                 |
| 2      | <i>understand</i> the various methods used in psychology and the differences between sensory mechanisms and perception theories.    |
| 3      | <i>apply</i> learning theories such as classical conditioning, operant conditioning, and social learning to real-life situations.   |
| 4      | <i>analyze</i> the different perspectives on personality, comparing theories from different schools of thought.                     |
| 5      | <i>evaluate</i> and <i>assess</i> the effectiveness of different memory theories and the techniques for improving memory retention. |

#### Course Outcomes

|                             |                                                                                                                                                                                 |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                                                                 |
| CO1                         | <i>describe</i> and <i>explain</i> the various schools of thought in psychology and the core principles behind sensation, perception, and learning.                             |
| CO2                         | <i>demonstrate</i> a clear understanding of the major theories of learning and memory, including classical conditioning, operant conditioning, and cognitive learning theories. |
| CO3                         | <i>apply</i> psychological theories of personality, memory, and learning to real-world scenarios, demonstrating practical understanding                                         |
| CO4                         | <i>analyze</i> and <i>compare</i> the effectiveness of different psychological approaches to personality assessment, as well as the role of culture in perception.              |
| CO5                         | <i>create</i> a comprehensive evaluation of personality theories and suggest how modern psychological perspectives can be integrated into personality assessments.              |

#### Course Contents

| Module     | Unit                              | Detailed Contents                                                                                                                                                                                             | Hours     |
|------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites: Nil</b>         |                                                                                                                                                                                                               |           |
| <b>1.0</b> | <b>Introduction to Psychology</b> |                                                                                                                                                                                                               | <b>05</b> |
|            | 1.1                               | Definition of Psychology, Psychology as a science, Major Milestones in Psychology, Methods in psychology.                                                                                                     |           |
|            | 1.2                               | Different schools of thought of Psychology, and modern perspectives of psychology, Scope and branches of psychology.                                                                                          |           |
| <b>2.0</b> | <b>Sensation and Perception</b>   |                                                                                                                                                                                                               | <b>06</b> |
|            | 2.1                               | Sensory Mechanisms, General Properties of Senses.                                                                                                                                                             |           |
|            | 2.2                               | External Factors in Perception: Theory of Signal Detection, Gestalt Principles, Form Perception, Role of culture in perception.                                                                               |           |
| <b>3.0</b> | <b>Learning</b>                   |                                                                                                                                                                                                               | <b>05</b> |
|            | 3.1                               | Definition of learning, Basic concepts of learning.                                                                                                                                                           |           |
|            | 3.2                               | Theories of learning: Classical conditioning, Operant conditioning, Cognitive Learning, Social Learning.                                                                                                      |           |
| <b>4.0</b> | <b>Memory</b>                     |                                                                                                                                                                                                               | <b>05</b> |
|            | 4.1                               | Meaning and nature of memory, Theories of memory: Information processing theories-sensory register, Short term memory, Storage and Retention.                                                                 |           |
|            | 4.2                               | Long term memory- organizations, semantic and episodic memory, encoding and storing long term memories, Forgetting- Motivated forgetting, Interference, Decay through disuse, Techniques of improving memory. |           |
| <b>5.0</b> | <b>Personality</b>                |                                                                                                                                                                                                               | <b>05</b> |
|            | 5.1                               | Various perspectives of Personality, Neo Freudian and Behaviourist Perspective, Humanistic Perspective.                                                                                                       |           |
|            | 5.2                               | Indian Perspective of Personality and assessment of Personality, Psychometric tests of Personality Assessment.                                                                                                |           |
|            | <b>Total Hours</b>                |                                                                                                                                                                                                               | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Introduction to Psychology, VII Ed., Morgan, C.T., King, R.A., Weisz, J.R., Amp; Schopler, J., Singapore: McGraw- Hill, 2007.
2. Psychology, V Ed., D.G. Myers, Worth Publishers-New York, 2004.
3. Psychology, V Ed., R.A. Baron, Prentice Hall, India, 2002.
4. Introduction To Psychology, VIII Ed. J. Kalat, Wordsworth Pub. Co., 2007.
5. Introduction To Psychology, XIV Ed., E.R. Hilgard, R. L. Atkinson, Wordsworth Pub. Co., 2013.

### Reference Books

1. Understanding Psychology, VI Ed., R.S. Feldman, Tata McGraw Hill, New Delhi, 2006.
2. Psychology In Context, III Ed., S.M. Kosslyn, R.S. Rosenberg, Pearson Education Ltd., 2006.

**Web Resources**

1. NPTEL course on Introduction to Psychology, Dr. Braj Bhushan, IIT Kanpur  
<https://archive.nptel.ac.in/courses/109/104/109104105/>

### 3.9.4 Personal Finance, Investments and Taxation (IL4OE\_CX4)

#### Teaching Scheme

| Course Code | Course Name                                | Contact Hours | Credits |
|-------------|--------------------------------------------|---------------|---------|
| IL4OE_CX4   | Personal Finance, Investments and Taxation | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                            |
|--------|-----------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> personal finance, budgeting, debt management, savings, and insurance.                             |
| 2      | To <i>bring out</i> awareness of investment opportunities and <i>illustrate</i> the importance of wealth creation.    |
| 3      | To <i>acquaint</i> with alternative investments and long-term retirement planning.                                    |
| 4      | To <i>explain</i> Indian tax system, income tax structure, tax implications of investments and tax-saving strategies. |
| 5      | To <i>train</i> on comprehensive financial planning and tax filing/compliance.                                        |

#### Course Outcomes

|                             |                                                                                                                                      |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                      |
| CO1                         | <i>set</i> financial goals, track income and expenses, manage debt, and select appropriate insurance and savings plans.              |
| CO2                         | <i>analyze</i> and <i>invest</i> in equities, fixed-income products, and use online platforms for investments.                       |
| CO3                         | <i>diversify</i> with alternative investments, and plan for retirement using various instruments.                                    |
| CO4                         | <i>understand</i> the taxation system, calculate taxes based on income, and use tax-efficient strategies for minimizing liabilities. |
| CO5                         | <i>create</i> a financial plan and file taxes compliantly.                                                                           |

#### Course Contents

| Module     | Unit                                   | Detailed Contents                                                                                                                                                          | Hours     |
|------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites: Nil</b>              |                                                                                                                                                                            |           |
| <b>1.0</b> | <b>Foundations of Personal Finance</b> |                                                                                                                                                                            | <b>04</b> |
|            | 1.1                                    | Introduction to Personal Finance- Setting financial goals and priorities, Budgeting, Tracking income and expenses, Importance of emergency funds and financial discipline. |           |

|            |                                                         |                                                                                                                                                                                                                                                                                                                                              |           |
|------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | 1.2                                                     | Managing Debt and Credit- Types of debt, understanding credit scores, Debt repayment strategies and managing EMIs, Credit card management and Personal loans.                                                                                                                                                                                |           |
|            | 1.3                                                     | Savings and Insurance Planning- Saving instruments: Fixed Deposits (FD), Recurring Deposits (RD), Public Provident Fund (PPF), Understanding insurance products: Life insurance, health insurance, and general insurance, Risk management strategies: Health, life, and property insurance.                                                  |           |
| <b>2.0</b> | <b>Investment Basics and Opportunities</b>              |                                                                                                                                                                                                                                                                                                                                              | <b>05</b> |
|            | 2.1                                                     | Introduction to Investments and Wealth Creation- Different investment instruments: Stocks, mutual funds, fixed-income, real estate, etc., Regulatory bodies and market overview: SEBI, RBI, NSE, BSE, Asset allocation and diversification strategies                                                                                        |           |
|            | 2.2                                                     | Equity and Stock Market Investments- Overview of the Indian stock market (NSE, BSE, Sensex, Nifty), Understanding stocks, IPOs, mutual funds, and ETFs, Stock market analysis, How to invest in stocks using online trading platforms (Zerodha, Groww, etc.), Risks of investing in stock market.                                            |           |
|            | 2.3                                                     | Fixed-Income Investments- Understanding bonds and fixed-income securities (Government bonds, corporate bonds, etc.), role of CRISIL and ICRA bond ratings, tax treatment of fixed deposits and interest income.                                                                                                                              |           |
| <b>3.0</b> | <b>Alternative Investments, and Retirement Planning</b> |                                                                                                                                                                                                                                                                                                                                              | <b>05</b> |
|            | 3.1                                                     | Alternative Investments- Investment in commodities: Gold, silver, and other precious metals, cryptocurrency and digital assets.                                                                                                                                                                                                              |           |
|            | 3.2                                                     | Retirement Planning- Understanding retirement planning and tax-saving options: National Pension Scheme (NPS), EPF, and PPF, creating a retirement corpus: The role of compounding.                                                                                                                                                           |           |
| <b>4.0</b> | <b>Taxation</b>                                         |                                                                                                                                                                                                                                                                                                                                              | <b>06</b> |
|            | 4.1                                                     | Introduction to the Indian Taxation System- Overview of the Indian taxation system: Direct vs. Indirect taxes, Income tax laws and the Income Tax Act, 1961, Types of taxes: Income tax, Goods and Services Tax (GST). Income tax structure for individuals (tax slabs, exemptions, deductions).                                             |           |
|            | 4.2                                                     | Taxation of Investments and Savings- Taxation of interest income from fixed deposits, PPF, and other savings instruments, understanding capital gains tax: Short-term vs. long-term capital gains tax, Taxation of dividend income, rental income, and mutual funds, TDS (Tax Deducted at Source) in India and its relevance to investments. |           |
|            | 4.3                                                     | Advanced Tax Planning Strategies- Tax-saving instruments under Section 80C (ELSS, PPF, NPS, etc.), Tax deductions under Section 80D, 80G, and other sections, Tax planning for salaried and self-employed individuals, Tax planning for NRIs (Non-                                                                                           |           |

|            |                                          |                                                                                                                                                                                                                                                                                                                              |           |
|------------|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            |                                          | Resident Indians).                                                                                                                                                                                                                                                                                                           |           |
| <b>5.0</b> | <b>Financial Planning and Compliance</b> |                                                                                                                                                                                                                                                                                                                              | <b>06</b> |
|            | 5.1                                      | Comprehensive Financial Planning in India- Developing a financial plan: Setting goals, budgeting, investing and risk management, Integrating tax planning, retirement planning and insurance into financial planning.                                                                                                        |           |
|            | 5.2                                      | Tax filing, Compliance, and Investment strategies- Filing income tax returns (ITR forms, filing process, deadlines, understanding Form 16, Form 26AS, and their role in tax filing, using tax software and online portals for e-filing (e.g., NSDL, Income Tax Portal), Strategies for maximizing tax-efficient investments. |           |
|            | <b>Total Hours</b>                       |                                                                                                                                                                                                                                                                                                                              | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Let's Talk Money, II Ed., Monika Halan, HarperCollins India, 2023.
2. Retire Rich: Invest Wisely to A Secure Future, I Ed., P.V. Subramanyam, CNBC TV18, 2013.
3. Taxation of Individuals, Dr. Girish Ahuja, Ravi Gupta, Commercial Law Publishers, 2024.
4. Income Tax: Law and Practice, 65th Ed., Dr. H.C. Mehrotra, Dr. S.P. Goyal, Sahitya Bhawan Publications, 2024.
5. How to Save Taxes through Tax Planning, Amit Tiwari, Bharat Law House, 2024.

### Reference Books

1. The Little Book of Common-Sense Investing, II Ed., John C. Bogle, John Wiley & Sons, 2017.
2. The Intelligent Investor, III Ed., Benjamin Graham, Harper Business, 2024.

### Web Resources

1. Million Dollar Life Lessons- T. Harv Eker  
<https://www.harveker.com/>
2. Employee Provident Fund Organization portal  
[https://www.epfindia.gov.in/site\\_en/index.php](https://www.epfindia.gov.in/site_en/index.php)
3. Income Tax Department e-filing portal  
<https://eportal.incometax.gov.in/iec/foervices/#/login>
4. National Pension Scheme portal  
<https://enps.nsdl.com/eNPS/NationalPensionSystem.html>
5. National Stock Exchange portal  
<https://www.nseindia.com/>
6. Bombay Stock Exchange portal  
<https://www.bseindia.com/>

### 3.9.5 Adolescent Health and Wellbeing (IL4OE\_CX5)

#### Teaching Scheme

| Course Code | Course Name                     | Contact Hours | Credits |
|-------------|---------------------------------|---------------|---------|
| IL4OE_CX5   | Adolescent Health and Wellbeing | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                                            |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>provide</i> students with a fundamental understanding of nutrition, its role in health, and the importance of meal planning.                    |
| 2      | To <i>educate</i> students on the nutritional requirements and challenges specific to adolescence, including physiological and psychological aspects. |
| 3      | To <i>equip</i> students with knowledge about behavior modification, weight management, and national initiatives supporting adolescent well-being.    |

#### Course Outcomes

|                             |                                                                                                                 |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                 |
| CO1                         | <i>develop</i> nutritionally balanced meal plans considering macronutrient and micronutrient requirements.      |
| CO2                         | <i>analyze</i> the impact of macronutrients and micronutrients on adolescent growth and health.                 |
| CO3                         | <i>evaluate</i> the physiological, psychological, and nutritional needs of adolescents.                         |
| CO4                         | <i>apply</i> dietary counseling strategies to address adolescent nutritional challenges.                        |
| CO5                         | <i>implement</i> behavior modification techniques for weight management and holistic well-being in adolescents. |

#### Course Contents

| Module   | Unit                               | Detailed Contents                                                                                                         | Hours     |
|----------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Prerequisites: Nil</b>          |                                                                                                                           |           |
| <b>1</b> | <b>Basic Concepts in Nutrition</b> |                                                                                                                           | <b>05</b> |
|          | 1.1                                | Food, Nutrition and Health                                                                                                |           |
|          | 1.2                                | Macronutrients- 1, Macronutrients- 2, Carbohydrates and Water, Vitamin                                                    |           |
|          | 1.3                                | Principles of Meal Planning, Meal planning for adults, Food Preservation and Other methods of maximization of Nutritional |           |

|          |                                                                         |                                                                                                                      |           |
|----------|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------|
|          |                                                                         | Benefit                                                                                                              |           |
| <b>2</b> | <b>Foundation of Nutrition and Wellbeing in Adolescence</b>             |                                                                                                                      | <b>06</b> |
|          | 2.1                                                                     | Adolescent Health Statistics, Introduction to Nutrition and Dietetics                                                |           |
|          | 2.2                                                                     | Role of Macronutrients, Role of Micronutrients                                                                       |           |
|          | 2.3                                                                     | Basics of Adolescent Mental Health                                                                                   |           |
| <b>3</b> | <b>Special Requirements during Adolescence</b>                          |                                                                                                                      | <b>05</b> |
|          | 3.1                                                                     | Physiological and Psychological changes during Adolescence                                                           |           |
|          | 3.2                                                                     | Special nutritional requirements during Adolescence, Malnutrition during Adolescence and their effects in later life |           |
|          | 3.3                                                                     | Adolescent Immunization, High risk behaviors in Adolescents                                                          |           |
| <b>4</b> | <b>A Comprehensive Guide for Nutritional Support during Adolescence</b> |                                                                                                                      | <b>05</b> |
|          | 4.1                                                                     | Nutrition Care Process<br>Dietary Counselling and Nutritional planning                                               |           |
|          | 4.2                                                                     | Common Micronutrient Deficiency in Adolescents<br>Eating-disorders in Adolescents                                    |           |
|          | 4.3                                                                     | National Initiatives related to Adolescents                                                                          |           |
| <b>5</b> | <b>Behavior Modification for Weight Management and Wellbeing</b>        |                                                                                                                      | <b>05</b> |
|          | 5.1                                                                     | Behavior modification for Weight management                                                                          |           |
|          | 5.2                                                                     | Adolescents and Physical Activity                                                                                    |           |
|          | 5.3                                                                     | Combating Special Situations                                                                                         |           |
|          | <b>Total Hours</b>                                                      |                                                                                                                      | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Dietary Guidelines for Indians. A manual by National Institute of Nutrition, ICMR.
2. Guidelines for Parents: Nutrition for Adolescents by IAP (Indian Academy of Paediatrics).
3. Implementing Adolescent Nutrition Guidelines by UNICEF.

### Reference Books

1. Guideline: Implementing effective actions for improving adolescent nutrition by WHO.
2. National Health Programs of India, National Policies and legislations related to health by J. Kishore.
3. Fitness Protocols and Guidelines for 5-18 Years by Ministry of Youth Affairs & Sports.
4. Adolescence in India: Issues, Challenges and Possibilities by Swati Patra.

### Web Resources

1. NPTEL course  
[https://onlinecourses.nptel.ac.in/noc24\\_ge61/preview](https://onlinecourses.nptel.ac.in/noc24_ge61/preview)

### 3.9.6 Essentials of Management (IL4OE\_CX6)

#### Teaching Scheme

| Course Code | Course Name              | Contact Hours | Credits |
|-------------|--------------------------|---------------|---------|
| IL4OE_CX6   | Essentials of Management | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                                                        |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>equip</i> students with a comprehensive understanding of core management concepts, theories, and functions (planning, organizing, leading, and controlling) |
| 2      | To <i>encourage</i> students to think critically and analytically about decision-making processes in an organizational context.                                   |
| 3      | To <i>promote</i> leadership development and team collaboration                                                                                                   |
| 4      | To <i>prepare</i> students to apply management skills in technical roles and interdisciplinary projects.                                                          |
| 5      | To <i>help</i> students understand the importance of ethical decision-making while managing projects and teams.                                                   |

#### Course Outcomes

|                             |                                                                                                                            |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                            |
| CO1                         | <i>demonstrate</i> an understanding of core management concepts.                                                           |
| CO2                         | <i>use</i> analytical tools for strategic planning and decision-making.                                                    |
| CO3                         | <i>demonstrate</i> leadership skills, effectively manage teams, and communicate effectively in a professional environment. |
| CO4                         | <i>apply</i> management principles in engineering contexts.                                                                |
| CO5                         | <i>recognize</i> the importance of ethical decision-making and propose practical solutions to organizational challenges.   |

#### Course Contents

| Module | Unit                                                    | Detailed Contents                                                                                                                              | Hours |
|--------|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------|
|        | Prerequisites: Nil                                      |                                                                                                                                                |       |
| 1.0    | Fundamentals of Management and Organizational Structure |                                                                                                                                                | 05    |
|        | 1.1                                                     | Introduction to Management:<br>Definition, Nature, and Scope of Management, Levels and Functions of Management (Planning, Organizing, Leading, |       |

|                    |                                                    |                                                                                                                                                                                                                            |           |
|--------------------|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    |                                                    | Controlling), Evolution of Management Thought (Classical, Behavioral, Modern Theories)                                                                                                                                     |           |
| <b>2.0</b>         | <b>Planning, Decision-Making, and Strategy</b>     |                                                                                                                                                                                                                            | <b>05</b> |
|                    | 2.1                                                | Principles of Planning: Types of Planning (Strategic, Tactical, Operational), Planning Tools: SWOT Analysis, PESTLE Analysis, Management by Objectives (MBO).                                                              |           |
|                    | 2.2                                                | Decision-Making in Management: Types of Decisions (Programmed vs. Non-Programmed), Decision-Making Models and Techniques (Rational Model, Bounded Rationality, Heuristics), Risk and Uncertainty in Decision-Making.       |           |
| <b>3.0</b>         | <b>Leadership, Motivation, and Team Management</b> |                                                                                                                                                                                                                            | <b>06</b> |
|                    | 3.1                                                | Leadership in Management: Leadership Theories (Trait, Behavioral, Contingency), Styles of Leadership (Autocratic, Democratic, Laissez-Faire), Role of Engineers as Leaders in Organizations.                               |           |
|                    | 3.2                                                | Motivation Theories and Practices: Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, McGregor's Theory X & Y, Motivational Tools and Techniques in the Workplace Empowerment and Employee Engagement.             |           |
|                    | 3.3                                                | Team Management and Communication: Building and Managing Effective Teams, Communication Process, Barriers, and Channels in Management, Conflict Resolution and Negotiation Skills.                                         |           |
| <b>4.</b>          | <b>Financial and Operations Management</b>         |                                                                                                                                                                                                                            | <b>05</b> |
|                    | 4.1                                                | Basics of Financial Management: Understanding Financial Statements (Balance Sheet, Income Statement), Budgeting, Costing, and Break-Even Analysis, Basics of Capital Investment Decisions (NPV, IRR)                       |           |
|                    | 4.2                                                | Operations and Project Management: Introduction to Operations Management in Engineering, Project Management Tools (Gantt Charts, PERT, CPM), Resource Allocation and Time Management.                                      |           |
| <b>5.0</b>         | <b>Ethics and Sustainability in Management</b>     |                                                                                                                                                                                                                            | <b>05</b> |
|                    | 5.1                                                | Business Ethics and Corporate Governance: Ethical Issues in Management and Engineering, Corporate Social Responsibility (CSR) and Sustainability Practices, Legal and Regulatory Frameworks for Ethical Business Practices |           |
|                    | 5.2                                                | Globalization and Contemporary Issues in Management: Global Business Environment and Cross-Cultural Management, The Role of Technology in Modern Management, Sustainable Development Goals (SDGs) and Management's Role    |           |
| <b>Total Hours</b> |                                                    |                                                                                                                                                                                                                            | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Principles and Practice of Management, L. M. Prasad, S. Chand and Sons; 11th Standard

Edition, 2024.

2. Business Organization and Management, C. B. Gupta, S. Chand and Sons, 2017.
3. Essentials of Management, Harold Koontz and Heinz Weihrich, McGraw Hill Education, 11th Edition, 2020

### **Reference Books**

1. Human Management, Stephen P. Robbins, Pearson Education; 14th edition, 2019.

### **Web Resources**

1. Principles of Management, by Prof. Susmita Mukhopadhyay, Prof. S. Srinivasan, IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc21\\_mg88/preview](https://onlinecourses.nptel.ac.in/noc21_mg88/preview)

### 3.9.7 Foreign Language – German (IL4OE\_CX7)

#### Teaching Scheme

| Course Code | Course Name               | Contact Hours | Credits |
|-------------|---------------------------|---------------|---------|
| IL4OE_CX7   | Foreign Language – German | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                      |
|--------|---------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> German language in a holistic manner.                                                                       |
| 2      | To <i>develop</i> essential communication skills for greetings, introductions, and common conversational scenarios.             |
| 3      | To <i>enhance</i> reading, comprehension, and writing abilities using different types of German texts.                          |
| 4      | To <i>gain</i> insights into German culture, family structures, work culture, and digital communication.                        |
| 5      | To <i>acquire</i> corporate communication skills such as writing emails, technical reports, and making presentations in German. |

#### Course Outcomes

|                             |                                                                                                                                                                     |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                                                     |
| CO1                         | <i>demonstrate</i> understanding of basic German grammar, pronunciation, and expressions for effective communication.                                               |
| CO2                         | <i>engage</i> in basic German conversations using greetings, self-introductions, numbers, dates, and everyday expressions.                                          |
| CO3                         | <i>develop</i> reading, comprehension, and writing skills by interpreting German texts such as dialogs, monologs, and biodata.                                      |
| CO4                         | <i>demonstrate</i> understanding of key aspects of German culture, family structures, work culture, and digital communication in a professional and social context. |
| CO5                         | <i>apply</i> corporate communication skills by drafting emails, technical reports, and delivering presentations in German.                                          |

#### Course Contents

| Module | Unit                      | Detailed Contents | Hours |
|--------|---------------------------|-------------------|-------|
|        | <b>Prerequisites: Nil</b> |                   |       |

|                    |                                                                |                                                                                             |           |
|--------------------|----------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------|
| <b>1.0</b>         | <b>Introduction to German Language</b>                         |                                                                                             | <b>05</b> |
|                    | 1.1                                                            | Basic grammar.                                                                              |           |
|                    | 1.2                                                            | Pronunciation and basic expressions.                                                        |           |
| <b>2.0</b>         | <b>Communication</b>                                           |                                                                                             | <b>05</b> |
|                    | 2.1                                                            | Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates. |           |
| <b>3.0</b>         | <b>Text Interpretation and Composition</b>                     |                                                                                             | <b>04</b> |
|                    | 3.1                                                            | Reading, Comprehension, and writing - (Type of Text).                                       |           |
|                    | 3.2                                                            | Dialogs, Monologs, Biodata.                                                                 |           |
| <b>4.0</b>         | <b>German Society, Work Culture, and Digital Communication</b> |                                                                                             | <b>07</b> |
|                    | 4.1                                                            | Family Structures, Culture.                                                                 |           |
|                    | 4.2                                                            | Computer and Multimedia.                                                                    |           |
|                    | 4.3                                                            | Work culture.                                                                               |           |
| <b>5.0</b>         | <b>Corporate Communication</b>                                 |                                                                                             | <b>04</b> |
|                    | 5.1                                                            | Emails, Technical Reports, Making presentations.                                            |           |
| <b>Total Hours</b> |                                                                |                                                                                             | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. German Conversation Demystified, I Ed., Ed Swick, Tata McGraw Hill Education, 2009.
2. German for Beginners, II Ed., Angela Wilkes, Usborne Publishing Ltd., 2001.

### Reference Books

1. German Conversational Course - Level 1, I Ed., Pimsleur, Simon & Schuster Audio, 2005.
2. German Made Easy Level 1: An Easy Step-By-Step Approach to Learn German for Beginners, I Ed., Lingo Mastery, 2022.

### Web Resources

1. NPTEL Course on German-I, Prof. Miling Brahme, IIT Madras  
[https://onlinecourses.nptel.ac.in/noc21\\_hs30/preview](https://onlinecourses.nptel.ac.in/noc21_hs30/preview)

### 3.9.8 Foreign Language – French (IL4OE\_CX8)

#### Teaching Scheme

| Course Code | Course Name               | Contact Hours | Credits |
|-------------|---------------------------|---------------|---------|
| IL4OE_CX8   | Foreign Language – French | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 15    | Continuous | 15    | 1               | 45    | 2               | 75          |

#### Course Objectives

| S. No. | Objectives                                                                                                                      |
|--------|---------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> French in a holistic manner.                                                                                |
| 2      | To <i>develop</i> essential communication skills for greetings, introductions, and common conversational scenarios.             |
| 3      | To <i>enhance</i> reading, comprehension, and writing abilities using different types of French texts.                          |
| 4      | To <i>gain</i> insights into French culture, family structures, work culture, and digital communication.                        |
| 5      | To <i>acquire</i> corporate communication skills such as writing emails, technical reports, and making presentations in French. |

#### Course Outcomes

|                             |                                                                                                                                                                                                    |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                                                                                                    |
| CO1                         | <i>understand</i> basic grammar rules and pronunciation, enabling them to use fundamental expressions correctly                                                                                    |
| CO2                         | <i>introduce</i> themselves, <i>engage</i> in simple conversations, and use numbers, dates, and greetings appropriately.                                                                           |
| CO3                         | <i>develop</i> French reading and writing skills, including comprehension of different text types such as dialogues, monologues, and biodata.                                                      |
| CO4                         | <i>gain insights</i> into French family structures, cultural aspects, and work environments while developing digital communication skills.                                                         |
| CO5                         | <i>compose</i> professional emails, draft technical reports, and deliver structured presentations in French, <i>demonstrating</i> appropriate linguistic accuracy and formal communication skills. |

## Course Contents

| Module     | Unit                                                           | Detailed Contents                                                                          | Hours     |
|------------|----------------------------------------------------------------|--------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites: Nil</b>                                      |                                                                                            |           |
| <b>1.0</b> | <b>Introduction to French Language</b>                         |                                                                                            | <b>06</b> |
|            | 1.1                                                            | Basic grammar.                                                                             |           |
|            | 1.2                                                            | Pronunciation and basic expressions.                                                       |           |
| <b>2.0</b> | <b>Communication</b>                                           |                                                                                            | <b>06</b> |
|            | 2.1                                                            | Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates |           |
| <b>3.0</b> | <b>Text Interpretation and Composition</b>                     |                                                                                            | <b>04</b> |
|            | 3.1                                                            | Reading, Comprehension and writing - (Type of Text)                                        |           |
|            | 3.2                                                            | Dialogs, Monologs, Biodata                                                                 |           |
| <b>4.0</b> | <b>French Society, Work Culture, and Digital Communication</b> |                                                                                            | <b>06</b> |
|            | 4.1                                                            | Family Structures, Culture                                                                 |           |
|            | 4.2                                                            | Computer and Multimedia                                                                    |           |
|            | 4.3                                                            | Work culture                                                                               |           |
| <b>5.0</b> | <b>Corporate Communication</b>                                 |                                                                                            | <b>04</b> |
|            | 5.1                                                            | Emails, Technical Reports, Making presentations                                            |           |
|            | <b>Total Hours</b>                                             |                                                                                            | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. French Conversational Course - Level 1, I Ed., Pimsleur, Simon & Schuster Audio, 2005.
2. Easy French Step-by-Step, I Ed., Myrna Bell-Rochester, Mc-Graw Hill Publications, 2008.

### Reference Books

1. French Made Simple, II Ed., Pamela Rose Haze, Crown publishing Group, 2006.
2. French For Dummies, II Ed., Dodi-Katrin Schmidt, Michelle M. Williams, Dominique Wenzel, Wiley, 2011.

### Web Resources

1. NPTEL Course on Foundations of French, Ramya Jagannathan, IIM Bangalore  
[https://onlinecourses.swayam2.ac.in/imb25\\_mg88/preview](https://onlinecourses.swayam2.ac.in/imb25_mg88/preview)

### 3.10 Professional Communication and Soft Skills (ILSHM\_CR1)

#### Teaching Scheme

| Course Code | Course Name                                | Contact Hours | Credits |
|-------------|--------------------------------------------|---------------|---------|
| ILSHM_CR1   | Professional Communication and Soft Skills | 01            | 01      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 25    | Continuous | -     | -               | -     | -               | 25          |

#### Course Objectives

| S. No. | Objectives                                                                                                                                               |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>equip</i> students with the skills required for verbal aptitude tests and competitive exams.                                                       |
| 2      | To <i>learn</i> advanced technical writing, focusing on clear, concise and well-structured reports.                                                      |
| 3      | To <i>develop</i> key employability skills necessary for securing a job and excelling in professional environments.                                      |
| 4      | To <i>enhance</i> the ability to <i>design</i> and <i>deliver</i> professional presentations with a focus on clarity, engagement and impactful delivery. |
| 5      | To <i>introduce</i> students to AI tools and ethical approach that can enhance their technical and professional skills.                                  |

#### Course Outcomes

|                             |                                                                                                                            |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                                            |
| CO1                         | <i>develop</i> and <i>implement</i> preparation strategy for competitive exams.                                            |
| CO2                         | <i>write</i> a well-structured technical report with proper citations and data presentation.                               |
| CO3                         | <i>prepare</i> for and <i>participate</i> in interviews, group discussions, and conflict resolution exercises.             |
| CO4                         | <i>design</i> and <i>deliver</i> a professional presentation using advanced tools.                                         |
| CO5                         | <i>apply</i> AI tools to enhance their research, writing, and data analysis skills, and demonstrate practical application. |

#### Course Contents

| Module | Unit                                                                      | Detailed Contents | Hours |
|--------|---------------------------------------------------------------------------|-------------------|-------|
|        | Prerequisites: Nil                                                        |                   |       |
|        | Basic knowledge of communication skills and minimal language proficiency. |                   |       |
| 1.0    | Aptitude Tests and Competitive Exams                                      |                   | 03    |

|                    |                                                       |                                                                                                                                                                                                                                                   |           |
|--------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 1.1                                                   | Logical Reasoning: Puzzles, Analogies and Verbal Reasoning: Reading Comprehension, Sentence Completion.                                                                                                                                           |           |
|                    | 1.2                                                   | GRE, TOEFL, IELTS and GATE, Exam pattern and syllabus breakdown.                                                                                                                                                                                  |           |
|                    | 1.3                                                   | Time management strategies for exam preparation.                                                                                                                                                                                                  |           |
| <b>2.0</b>         | <b>Advanced Technical Writing and Reports</b>         |                                                                                                                                                                                                                                                   | <b>03</b> |
|                    | 2.1                                                   | Structure of technical documents: Executive summaries, introduction, methodology, findings, conclusions, and recommendations. Language and tone for technical communication.                                                                      |           |
|                    | 2.2                                                   | Use of graphs, tables and data visualization.                                                                                                                                                                                                     |           |
|                    | 2.3                                                   | Research-based writing and citations (using LaTeX).                                                                                                                                                                                               |           |
| <b>3.0</b>         | <b>Employability Skills</b>                           |                                                                                                                                                                                                                                                   | <b>03</b> |
|                    | 3.1                                                   | Types of Interviews: Telephonic, face-to-face and video. STAR method for answering behavioral questions. Preparing for interviews: Resume writing, platforms for checking resume efficiency, company and profile research, documents and conduct. |           |
|                    | 3.2                                                   | Group discussions. Leadership, listening skills and body language. Structuring arguments and building consensus.                                                                                                                                  |           |
|                    | 3.3                                                   | Emotional intelligence, conflict resolution and building professional relationships.                                                                                                                                                              |           |
| <b>4.0</b>         | <b>Advanced Presentation Skills</b>                   |                                                                                                                                                                                                                                                   | <b>02</b> |
|                    | 4.1                                                   | Structuring a presentation: Introduction, body and conclusion.                                                                                                                                                                                    |           |
|                    | 4.2                                                   | Visual design: Effective use of slides, SmartArt, charts and animation. Presentations using Canva, Prezi and other creative tools.                                                                                                                |           |
|                    | 4.3                                                   | Voice modulation, body language and eye contact. Handling audience questions and managing feedback.                                                                                                                                               |           |
| <b>5.0</b>         | <b>Use of AI Tools Supporting Professional Growth</b> |                                                                                                                                                                                                                                                   | <b>02</b> |
|                    | 5.1                                                   | AI-powered research assistants and writing tools (e.g., ChatGPT, Grammarly etc.).                                                                                                                                                                 |           |
|                    | 5.2                                                   | Using AI for plagiarism detection and content generation.                                                                                                                                                                                         |           |
|                    | 5.3                                                   | Tools for automated data analysis (e.g., Tableau, Power BI, Python-based AI tools).                                                                                                                                                               |           |
| <b>Total Hours</b> |                                                       |                                                                                                                                                                                                                                                   | <b>13</b> |

## Suggested Learning Resources

### Textbooks

1. Soft Skills, IV Ed., Dr. K. Alex, S. Chand Publishing, 2021.
2. Business Communication, XII Ed., Leslikar, Flatley, Rentz and Pande, Cengage Learning, 2021.

### Reference Books

1. The IUP Journal of Soft Skills, IUP Publications.
2. Managing Soft Skills for Personality Development, I Ed., B. N. Ghosh, IUP Publications, 2023.
3. Soft Skills and Employability Skills, I Ed., Sabina Pillai, Agna Fernandez, IUP Publications, 2023.

### **Web Resources**

1. Business Communication  
[http://www.ndl.gov.in/he\\_document/swayam\\_ugc\\_moocs/swayam\\_ugc\\_moocs/IN\\_\\_S\\_U\\_M\\_1\\_U\\_C\\_17\\_B\\_C\\_133\\_134](http://www.ndl.gov.in/he_document/swayam_ugc_moocs/swayam_ugc_moocs/IN__S_U_M_1_U_C_17_B_C_133_134)
2. English for Competitive Exams  
[http://www.ndl.gov.in/he\\_document/dishtvo/dishtavo/D\\_D\\_I\\_S\\_F\\_H\\_T\\_A\\_V\\_O\\_B\\_O\\_A\\_E\\_F\\_C\\_E\\_E\\_1573464798?e=0|Competitive%20exams|||](http://www.ndl.gov.in/he_document/dishtvo/dishtavo/D_D_I_S_F_H_T_A_V_O_B_O_A_E_F_C_E_E_1573464798?e=0|Competitive%20exams|||)
3. Advanced Presentation Skills  
[http://www.ndl.gov.in/he\\_document/openstax\\_cnx/openstax/IN\\_O\\_1\\_W\\_S\\_a\\_S\\_1006\\_C\\_07\\_A\\_P\\_S\\_2725\\_2726](http://www.ndl.gov.in/he_document/openstax_cnx/openstax/IN_O_1_W_S_a_S_1006_C_07_A_P_S_2725_2726)
4. Latex Documents  
[https://www.ndl.gov.in/he\\_search?key=Latex%20documents](https://www.ndl.gov.in/he_search?key=Latex%20documents)

### 3.11 Professional Communication and Soft Skills Lab (ILSHM\_LR1)

#### Teaching Scheme

| Course Code | Course Name                                    | Contact Hours | Credits |
|-------------|------------------------------------------------|---------------|---------|
| ILSHM_LR1   | Professional Communication and Soft Skills Lab | 02            | 01      |

#### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | -   | -   | -   | 25          |

#### Course Objectives

| S. No. | Objectives                                                                          |
|--------|-------------------------------------------------------------------------------------|
| 1      | To <i>practice</i> solving quantitative and logical reasoning problems efficiently. |
| 2      | To <i>write</i> clear and well-formatted technical reports with proper citations.   |
| 3      | To <i>develop</i> skills in resume writing, group discussions, and mock interviews. |
| 4      | To <i>deliver</i> clear and engaging presentations on technical topics.             |
| 5      | To <i>use</i> AI tools for data analysis, visualization, and resume improvement.    |

#### Course Outcomes

|                             |                                                                                                              |
|-----------------------------|--------------------------------------------------------------------------------------------------------------|
| The student will be able to |                                                                                                              |
| CO1                         | <i>solve</i> aptitude and reasoning problems accurately within set time limits.                              |
| CO2                         | <i>create</i> structured technical reports on engineering topics with correct citations and formatting.      |
| CO3                         | <i>draft</i> a professional resume, participate in group discussions, and <i>perform</i> in mock interviews. |
| CO4                         | <i>present</i> technical topics confidently using visual aids and effective communication.                   |
| CO5                         | <i>apply</i> AI tools for automated data analysis, visualization, and resume optimization.                   |

#### Course Contents

| S. No. | Suggestive List of Activities                                                                                                           |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Time bound practice session of quantitative and logical reasoning problems.                                                             |
| 2      | Write a technical report on a specific engineering topic with proper citations and formatting.                                          |
| 3      | Participate in a mock group discussion, demonstrating leadership, communication, and problem-solving skills.                            |
| 4      | Appear for a mock interview showcasing the techniques learnt.                                                                           |
| 5      | Deliver a live presentation on the topic chosen/ technical report prepared.                                                             |
| 6      | Draft an effective resume, check the efficiency percentage of the resume and showcase the report along with analysis of how to improve. |
| 7      | Workshop/ Hands on session on tools for automated data analysis                                                                         |

|    |                                                                                                              |
|----|--------------------------------------------------------------------------------------------------------------|
| 8  | Report of the above workshop/hands on session along with plagiarism check analysis of the same.              |
| 9  | Role play focusing on conflict resolution and maintaining professional conduct and challenging scenario.     |
| 10 | Create a data visualization report using the tool learnt in the workshop incorporating AI assisted insights. |

**Note:** Lab course shall consist minimum of 05 activities covering the syllabus of corresponding theory course but not limited to the suggested list.

## Suggested Learning Resources

### Textbooks

1. Soft Skills, IV Ed., Dr. K. Alex, S. Chand Publishing, 2021.
2. Business Communication, XII Ed., Leslikar, Flatley, Rentz and Pande, Cengage Learning, 2021.

### Reference Books

1. The IUP Journal of Soft Skills, IUP Publications.
2. Managing Soft Skills for Personality Development, I Ed., B. N. Ghosh, IUP Publications, 2023.
3. Soft Skills and Employability Skills, I Ed., Sabina Pillai, Agna Fernandez, IUP Publications, 2023.

### Web Resources

1. Business Communication  
[http://www.ndl.gov.in/he\\_document/swayam\\_ugc\\_moocs/swayam\\_ugc\\_moocs/IN\\_\\_S\\_U\\_M\\_1\\_U\\_C\\_17\\_B\\_C\\_133\\_134](http://www.ndl.gov.in/he_document/swayam_ugc_moocs/swayam_ugc_moocs/IN__S_U_M_1_U_C_17_B_C_133_134)
2. English for Competitive Exams  
[http://www.ndl.gov.in/he\\_document/dishtvo/dishtavo/D\\_D\\_I\\_S\\_F\\_H\\_T\\_A\\_V\\_O\\_B\\_O\\_A\\_E\\_F\\_C\\_E\\_E\\_1573464798?e=0|Competitive%20exams||](http://www.ndl.gov.in/he_document/dishtvo/dishtavo/D_D_I_S_F_H_T_A_V_O_B_O_A_E_F_C_E_E_1573464798?e=0|Competitive%20exams||)
3. Advanced Presentation Skills  
[http://www.ndl.gov.in/he\\_document/openstax\\_cnx/openstax/IN\\_\\_O\\_1\\_W\\_S\\_a\\_S\\_1006\\_C\\_07\\_A\\_P\\_S\\_2725\\_2726](http://www.ndl.gov.in/he_document/openstax_cnx/openstax/IN__O_1_W_S_a_S_1006_C_07_A_P_S_2725_2726)
4. Latex Documents  
[https://www.ndl.gov.in/he\\_search?key=Latex%20documents](https://www.ndl.gov.in/he_search?key=Latex%20documents)

### 3.12 Human Values and Ethics (ILSHM\_CR2)

#### Teaching Scheme

| Course Code | Course Name             | Contact Hours | Credits |
|-------------|-------------------------|---------------|---------|
| ILSHM_CR2   | Human Values and Ethics | 02            | 02      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 50    | Continuous | -     | -               | -     | -               | 50          |

#### Course Objectives

| S. No. | Objectives                                                                                                                              |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>introduce</i> and <i>define</i> core universal human values and aid understanding of their role in individual and social harmony. |
| 2      | To <i>explore</i> the principles of trust, respect, and justice in relationships.                                                       |
| 3      | To <i>understand</i> the interconnectedness of humans and nature and the importance of developing sustainable practices.                |
| 4      | To <i>learn</i> about ethical decision-making frameworks in professional settings.                                                      |
| 5      | To <i>integrate</i> intellectual, emotional, physical, and spiritual growth into personal development.                                  |

#### Course Outcomes

|                              |                                                                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                               |
| CO1                          | <i>identify</i> and <i>explain</i> the core universal values.                                                                                 |
| CO2                          | <i>demonstrate</i> the ability to resolve a real-life familial and societal conflict by applying principles of trust, respect and justice.    |
| CO3                          | <i>conduct</i> an environmental audit of a local project or practice and <i>propose</i> sustainable changes.                                  |
| CO4                          | <i>evaluate</i> an ethical dilemma in a professional context and <i>present</i> a solution based on ethical decision-making frameworks.       |
| CO5                          | <i>create</i> and <i>implement</i> a personal development plan that integrates intellectual, emotional, physical, and spiritual growth goals. |

#### Course Contents

| Module     | Unit                                                | Detailed Contents                                           | Hours     |
|------------|-----------------------------------------------------|-------------------------------------------------------------|-----------|
|            | <b>Prerequisites: Nil</b>                           |                                                             |           |
| <b>1.0</b> | <b>Introduction to Universal Human Values (UHV)</b> |                                                             | <b>05</b> |
|            | 1.1                                                 | Concept and importance of human values.                     |           |
|            | 1.2                                                 | Harmony in the individual (Understanding Self: I and Body). |           |

|            |                                                      |                                                                                                     |           |
|------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------|
|            | 1.3                                                  | Perspective on human values: Right understanding, relationships and physical facility.              |           |
| <b>2.0</b> | <b>Harmony in Family and Society</b>                 |                                                                                                     | <b>05</b> |
|            | 2.1                                                  | Understanding relationships: Trust and respect.                                                     |           |
|            | 2.2                                                  | Family as a basic unit of society.                                                                  |           |
|            | 2.3                                                  | Case studies on ethical issues in family and social settings.                                       |           |
| <b>3.0</b> | <b>Harmony with Nature and Sustainability</b>        |                                                                                                     | <b>05</b> |
|            | 3.1                                                  | Interconnectedness of humans and nature.                                                            |           |
|            | 3.2                                                  | Insights on living in harmony with nature.                                                          |           |
|            | 3.3                                                  | Professional practices, environmental responsibility and sustainability.                            |           |
| <b>4.0</b> | <b>Ethics in Professional Life</b>                   |                                                                                                     | <b>06</b> |
|            | 4.1                                                  | Defining professional ethics: Integrity, accountability and transparency.                           |           |
|            | 4.2                                                  | Ethical decision-making models.                                                                     |           |
|            | 4.3                                                  | Code of ethics for engineers. Dealing with workplace challenges: Bias, corruption, and competition. |           |
| <b>5.0</b> | <b>Holistic Development through Universal Values</b> |                                                                                                     | <b>05</b> |
|            | 5.1                                                  | Integrating intellectual, emotional, physical, and spiritual growth.                                |           |
|            | 5.2                                                  | The role of meditation and reflection in personal development.                                      |           |
|            | 5.3                                                  | Professional excellence with ethical foundations.                                                   |           |
|            | <b>Total Hours</b>                                   |                                                                                                     | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. A Foundation Course on Human Values and Professional Ethics, III Ed., R. R. Gaur, R. Asthana, G. P. Bagaria, PHI, 2023.

### Reference Books

1. Human Values and Professional Ethics, III Ed., R.S. Naagarazan, New Age International Publishers, 2023.
2. Ethics in Engineering, IV Ed., Mike W. Martin, Roland Schinzinger, McGraw Hill Education, 2020.
3. Harmony with Nature: An Anthology, II Ed., A. K. Sharma, Vikas Publishing House, 2021.

### Web Resources

1. Coursera course on The Science of Well-Being, Yale University  
<https://www.coursera.org/lecture/the-science-of-well-being/start-a-new-journey-swBKu>
2. NPTEL course on Introduction to Human Values and Professional Ethics,  
[https://archive.nptel.ac.in/content/storage2/courses/109104068/lecture36/36\\_2.html](https://archive.nptel.ac.in/content/storage2/courses/109104068/lecture36/36_2.html)
3. AICTE aided materials on UHV  
<https://fdp-si.aicte-india.org/SIPTeachMaterialM1.php>
4. Free courses on Sustainability by Harvard University

<https://pll.harvard.edu/climate-sustainability>

## 4 Exit Courses

### 4.1 Embedded System Design (EC4EX\_CR1)

#### Teaching Scheme

| Course Code | Course Name            | Contact Hours | Credits |
|-------------|------------------------|---------------|---------|
| EC4EX_CR1   | Embedded System Design | 03            | 03      |

#### Examination and Evaluation Scheme

| ISE   |            |       |                 | ESE   |                 | Total Marks |
|-------|------------|-------|-----------------|-------|-----------------|-------------|
| CA    |            | MSE   |                 |       |                 |             |
| Marks | Duration   | Marks | Duration (Hrs.) | Marks | Duration (Hrs.) |             |
| 20    | Continuous | 20    | 1               | 60    | 2.5             | 100         |

#### Course Objectives

| S. No. | Objectives                                                                                                                     |
|--------|--------------------------------------------------------------------------------------------------------------------------------|
| 1      | To <i>study</i> the concepts and basic of digital signal system and architecture of a microprocessor.                          |
| 2      | To <i>study</i> basics of embedded system and <i>select</i> the relevant microcontrollers for various industrial applications. |
| 3      | To <i>use</i> 'Embedded C' programming language to develop embedded system.                                                    |
| 4      | To <i>study</i> the communication standards & protocols of embedded systems.                                                   |
| 5      | To <i>study</i> fundamental concepts of Internet of Things (IOT).                                                              |

#### Course Outcomes

|                              |                                                                                                                              |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                              |
| CO1                          | <i>explain</i> the basic concepts of digital signal system and <i>develop</i> assembly language programs for microprocessor. |
| CO2                          | <i>select</i> the appropriate microcontroller and <i>develop</i> assembly language programming skills for microcontroller.   |
| CO3                          | <i>develop</i> 'Embedded C' programs and <i>interface</i> various input/output devices to develop embedded system.           |
| CO4                          | <i>interpret</i> the communication standards and protocols of embedded systems.                                              |
| CO5                          | <i>understand</i> the various concepts, terminologies and architecture of IoT systems.                                       |

#### Course Contents

| Module | Unit                                                                                                                                              | Detailed Contents | Hours |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------|
|        | Prerequisites: Nil                                                                                                                                |                   |       |
|        | Introduction to digital signals, Introduction to number systems: Base or radix of number systems, binary, octal, decimal and hexadecimal numbers. |                   |       |

|            |                                                |                                                                                                                                                                                                                                                                           |           |
|------------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>1.0</b> | <b>Introduction to Microprocessor</b>          |                                                                                                                                                                                                                                                                           | <b>07</b> |
|            | 1.1                                            | Microprocessor based system: CPU, I/O Devices, Clock, Memory, Concept of Address, Data and Control Bus.                                                                                                                                                                   |           |
|            | 1.2                                            | 8086 microprocessor Architecture, Pin description, Memory Segmentation, Pipelining.                                                                                                                                                                                       |           |
|            | 1.3                                            | Instruction Set and Assembler Directives, Assembly language programming.                                                                                                                                                                                                  |           |
| <b>2.0</b> | <b>Introduction to Embedded System</b>         |                                                                                                                                                                                                                                                                           | <b>08</b> |
|            | 2.1                                            | Block diagram of embedded system with hardware components, Harvard and Von-Neumann architecture, RISC and CISC processors. Classification of Embedded system: small scale, medium scale, sophisticated, stand alone, reactive/real time.                                  |           |
|            | 2.2                                            | Features of 89C51, PIC, AVR & ARM microcontrollers with their applications, Differences between a Microprocessor and Microcontroller.                                                                                                                                     |           |
|            | 2.3                                            | Architecture of 8051 microcontroller, memory organization, Instruction set of 8051 microcontroller, Programs related to: arithmetic, logical, Branch and delay.                                                                                                           |           |
| <b>3.0</b> | <b>Programming using Embedded C</b>            |                                                                                                                                                                                                                                                                           | <b>08</b> |
|            | 3.1                                            | Programming with “Embedded C”: Arithmetic & logical operations, Data transfer with memory and port.                                                                                                                                                                       |           |
|            | 3.2                                            | Timer/counter program using ‘Embedded C’ for given microcontroller.                                                                                                                                                                                                       |           |
|            | 3.3                                            | Interfacing of various Input/Output devices and special devices to microcontroller - Input devices: Matrix keyboard, Output devices: LED, LCD, 7-segment display, Special devices: Motor, ADC/DAC, Temperature sensor (LM35).                                             |           |
| <b>4.0</b> | <b>Communication standards &amp; protocols</b> |                                                                                                                                                                                                                                                                           | <b>08</b> |
|            | 4.1                                            | Modes of data communication: Serial/ Parallel, Synchronous/ Asynchronous. Serial Communication standards: RS232.                                                                                                                                                          |           |
|            | 4.2                                            | Communication protocols - Serial communication protocols: I <sup>2</sup> C, CAN, USB, Serial peripheral interface (SPI), Synchronous serial protocol (SSP), Parallel communication protocols: PCI, PCI-X, Features of advanced serial protocols: IrDA, Bluetooth, Zigbee. |           |
|            | 4.3                                            | Features and functions of RTOS.                                                                                                                                                                                                                                           |           |
| <b>5.0</b> | <b>Fundamentals of IOT</b>                     |                                                                                                                                                                                                                                                                           | <b>08</b> |
|            | 5.1                                            | Introduction, definitions and characteristics of IoT, IoT architecture. Sensors Networks: Definition, Types of sensors, Types of actuators, Examples and working.                                                                                                         |           |
|            | 5.2                                            | IoT Development Boards: Arduino IDE and Board Types, RaspberryPi Development Kit.                                                                                                                                                                                         |           |

|  |     |                                                                                                        |           |
|--|-----|--------------------------------------------------------------------------------------------------------|-----------|
|  | 5.3 | Introduction to Arduino platform and programming, Simple applications using Arduino development board. |           |
|  |     | <b>Total Hours</b>                                                                                     | <b>39</b> |

## Suggested Learning Resources

### Textbooks

1. Modern Digital Electronics, V Ed., R. P. Jain, Tata McGraw Hill Education, 2010.
2. Microprocessor and Interfacing, II Ed., Douglas Hall, Tata McGraw Hill, 2014.
3. The 8051 Microcontroller & Embedded Systems III Ed., M. A. Mazidi, J. G. Mazidi, R. D. Mckinlay, Pearson Publications, 2018.
4. The 8051 Microcontroller & Embedded System using Assembly & 'C', III Ed., C. Kenneth J. Ayala and D. V. Gadre, Cengage Learning, 2018.
5. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, II Ed., Joseph Yiu, Newnes, 2013.

### Reference Books

1. Digital Principles and Applications, VIII Ed., Donald P. Leach, Albert Paul Malvino, Gautam Saha, McGraw Hill, 2015.
2. 8086 Microprocessor Programming and Interfacing the PC, V Ed., Kenneth Ayala, Cengage Learning, 2010.
3. Microcontrollers: Architecture, Programming, Interfacing and System Design, III Ed., Raj Kamal, Pearson Education, 2017.
4. ARM Architecture", Reference Manual, II Ed., David Seal, Addison Wesley, 2001.
5. Introduction to IOT, I Ed., Sudip Misra, Anandarup Mukherjee, Arijit Roy, Pearson, 2019.

### Web Resources

1. NPTEL course on Microprocessors and Microcontrollers, Prof. Santanu Chattopadhyay, IIT Kharagpur.  
[https://archive.nptel.ac.in/content/syllabus\\_pdf/108105102.pdf](https://archive.nptel.ac.in/content/syllabus_pdf/108105102.pdf)
2. 8086 Assembly Language Programming  
<https://youtube.com/playlist?list=PLIGqj2KrYnpSAqx7fcnq4AJJIJ5rjG9CT&feature=shared>
3. NPTEL course on Real-time Systems, Prof. Rajib Mall, Prof. Durga Prasad Mohapatra, IIT Kharagpur.  
[https://archive.nptel.ac.in/content/syllabus\\_pdf/106105229.pdf](https://archive.nptel.ac.in/content/syllabus_pdf/106105229.pdf)
4. Arduino website  
<https://www.arduino.cc>

## 4.2 Embedded System Design Lab (EC4EX\_LR1)

### Teaching Scheme

| Course Code | Course Name                | Contact Hours | Credits |
|-------------|----------------------------|---------------|---------|
| EC4EX_LR1   | Embedded System Design Lab | 02            | 01      |

### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 25  | 25  | -   | -   | 50          |

### Course Objectives

| S. No. | Objectives                                                                                                    |
|--------|---------------------------------------------------------------------------------------------------------------|
| 1      | To <i>write</i> assembly language programs for microprocessors and microcontrollers for various applications. |
| 2      | To <i>write</i> microcontroller programs using embedded 'C' language for various applications.                |
| 3      | To <i>know</i> the importance of different peripheral devices and their interfacing to 8051.                  |
| 4      | To <i>explain</i> microcontroller used in different application.                                              |
| 5      | To <i>study</i> applications to interface various sensors & actuators with Arduino board.                     |

### Course Outcomes

|                              |                                                                             |
|------------------------------|-----------------------------------------------------------------------------|
| The student will be able to: |                                                                             |
| CO1                          | <i>develop</i> programming skills for microprocessors and microcontrollers. |
| CO2                          | <i>develop</i> programming skills using embedded 'C' platform.              |
| CO3                          | <i>interface</i> various devices with Microcontroller systems.              |
| CO4                          | <i>design</i> a microcontroller-based system.                               |
| CO5                          | <i>develop</i> various applications using Arduino board.                    |

### Course Contents

| S. No. | Suggested List of Experiments                                                                             |
|--------|-----------------------------------------------------------------------------------------------------------|
| 1      | Write an assembly language program to add/subtract two 8-bit/16-bit numbers using 8086 microprocessor.    |
| 2      | Write an assembly language program to add two BCD numbers using 8086 microprocessor.                      |
| 3      | Write an assembly language program to multiply/divide two 8-bit/16-bit numbers using 8086 microprocessor. |
| 4      | Write assembly language program to perform block transfer using 8086 microprocessor.                      |
| 5      | Write an assembly language program to find sum of series of 5 numbers using 8086 microprocessor.          |

|    |                                                                                                                                                 |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 6  | Develop and Test the 'C' program to perform data transfer from source to destination (Use internal data memory locations).                      |
| 7  | Develop and test the 'C' program to turn on LED (S) with key (S) press.                                                                         |
| 8  | Interface 89C51 microcontroller and write the 'C' program to display numbers from 0 to 9 on 7-segment display with specified delay.             |
| 9  | Interface 89C51 and write C program to generate square and sawtooth waveforms using given 8 bit DAC.                                            |
| 10 | Develop an ALP to generate pulse and square wave by using Timer delay using 8051 microcontroller.                                               |
| 11 | Interface 89C51 microcontroller and write C program to rotate stepper motor with different speeds in clockwise and counter clockwise direction. |
| 12 | Interface 89C51 and write C program to observe the real time status of the triangular waveform generated using DAC (Use IDE tool Keil).         |
| 13 | Develop an application for simple LED ON/OFF with a push button using Arduino UNO development board.                                            |
| 14 | Develop an application to interface the Arduino board with Ultrasonic sensor to measure distance.                                               |
| 15 | Develop an application to interface Arduino board with DC motor to run the motor.                                                               |

Note: Lab course shall consist of minimum 10 experiments covering all the topics but not limited to the suggested list.

## Suggested Learning Resources

### Textbooks

1. Microprocessor and Interfacing, II Ed., Douglas Hall, Tata McGraw Hill, 2014.
2. The 8051 Microcontroller & Embedded Systems III Ed., M. A. Mazidi, J. G. Mazidi, R. D. Mckinlay, Pearson Publications, 2018.
3. The 8051 Microcontroller & Embedded System using Assembly & 'C', III Ed., C. Kenneth J. Ayala and D. V. Gadre, Cengage Learning, 2018.

### Reference Books

1. 8086 Microprocessor Programming and Interfacing the PC, V Ed., Kenneth Ayala, Cengage Learning, 2010.
2. Microcontrollers: Architecture, Programming, Interfacing and System Design, III Ed., Raj Kamal, Pearson Education, 2017.
3. Arduino: The complete guide to Arduino for beginners including projects tips tricks and programming! By James Arthur.

### Web Resources

1. 8086 Assembly Language Programming  
<https://youtube.com/playlist?list=PLlGqj2KrYnpSAqx7fcnq4AJJIJ5rjG9CT&feature=shared>
2. 8086 Assembly language programming  
<https://youtube.com/playlist?list=PLlGqj2KrYnpSAqx7fcnq4AJJIJ5rjG9CT&feature=shared>
3. Interfacing of 7 segment display with microcontroller 8051  
<https://www.youtube.com/watch?v=LUtx6ukDmSc&pp=ygUGIzgwNTE3>

4. Interfacing of LCD display with microcontroller 8051  
<https://www.youtube.com/watch?v=ktUbTEglyPI>
5. Interfacing of keyboard with 8051 microcontroller  
<https://www.youtube.com/watch?v=2SUhAtDvMxE&pp=ygUcI2ludGVyZmFjaW5na2V5Ym9hcmR3aXRoODA1MQ%3D%3D>
6. Interfacing of stepper motor with 8051 microcontroller  
<https://www.youtube.com/watch?v=Xj8QoHL2lPE>
7. Simple LED ON/OFF with a push button using Arduino UNO development board.  
<https://youtu.be/ZoaUlquC6x8>
8. Interface the Arduino board with Ultrasonic sensor to measure distance.  
[https://youtu.be/\\_JZhDCFo3lY](https://youtu.be/_JZhDCFo3lY)
9. Interface Arduino board with DC motor to run the motor  
[https://youtu.be/XrJ\\_zLWFGFw](https://youtu.be/XrJ_zLWFGFw)
10. Arduino website  
<https://www.arduino.cc>

### 4.3 Internship (EC4EX\_PR1)

#### Teaching Scheme

| Course Code | Course Name | Contact Hours | Credits |
|-------------|-------------|---------------|---------|
| EC4EX_PR1   | Internship  | 08            | 04      |

#### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 50  | -   | -   | 100 | 150         |

#### Course Objectives

| S. No. | Objectives                                                                                                  |
|--------|-------------------------------------------------------------------------------------------------------------|
| 1      | To <i>gain</i> hands-on experience in a professional work environment and understand the industry dynamics. |
| 2      | To <i>apply</i> theoretical knowledge gained to real-world projects in the industry.                        |
| 3      | To <i>acquire</i> a deeper understanding of workplace culture and ethics.                                   |
| 4      | To <i>improve</i> communication, teamwork, and interpersonal skills.                                        |

#### Course Outcomes

|                              |                                                                                       |
|------------------------------|---------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                       |
| CO1                          | <i>apply</i> academic knowledge in practical settings.                                |
| CO2                          | <i>develop</i> specific technical skills.                                             |
| CO3                          | <i>achieve</i> a better understanding of career paths within the chosen field.        |
| CO4                          | <i>develop</i> personal attributes like accountability, work ethic, and adaptability. |

#### Guidelines

##### A. Process of internship identification for exit program

- The student shall approach industry for internship opportunities. The industry and the role/profile need to be approved by HoD/Dean Academics. The student may also take guidance from TPO/ IIC/IIC for identification of a suitable opportunity.
- The internship taken up by the student should result in either being converted to job or job-ready for a similar role.

##### B. Continuous Monitoring and Assessment

- A mentor is to be appointed at the department level to guide the student.
- The mentor should assess the progress of the students on a weekly basis and record their observations in the logbook. Preferably, the mentors should interact with the industry mentor and may also visit the company to assess his/her progress.
- Mentors need to visit the industry minimum once in a semester if required.
- ISE mark to be given based on continuous evaluation and recommendation from industry mentor.

##### C. End Semester Examination

- A report to be prepared and submitted by the student.

- A presentation summarizing the work done in the industry needs to be done. The external examiner should preferably be from the industry.

Mark distribution for internship for exit program after second year of Engineering

| <b>Assessment Tool</b> | <b>Components</b>                              | <b>Marks</b> |
|------------------------|------------------------------------------------|--------------|
| <b>CA</b>              | Logbook                                        | 25           |
|                        | Approval presentation and mid sem presentation | 25           |
|                        | <b>TOTAL</b>                                   | <b>50</b>    |
| <b>ESE</b>             | Report                                         | 50           |
|                        | Final Presentation                             | 50           |
|                        | <b>Total</b>                                   | <b>100</b>   |

## 4.4 Project - IoT based Application (EC4EX\_PR2)

### Teaching Scheme

| Course Code | Course Name                     | Contact Hours | Credits |
|-------------|---------------------------------|---------------|---------|
| EC4EX_PR2   | Project - IoT based Application | 08            | 04      |

### Examination and Evaluation Scheme

| Evaluation | ISE | ESE |     |     | Total Marks |
|------------|-----|-----|-----|-----|-------------|
|            | CA  | PE  | OrE | PrE |             |
| Marks      | 50  | -   | -   | 100 | 150         |

### Course Objectives

| S. No. | Objectives                                                                                          |
|--------|-----------------------------------------------------------------------------------------------------|
| 1      | To <i>acquaint</i> with the process of identifying the issues and formulating a problem statement.  |
| 2      | To <i>explore</i> the various approaches to solve the problem.                                      |
| 3      | To <i>identify</i> the resources for implementation of the project.                                 |
| 4      | To <i>design, implement and test</i> the intended solution.                                         |
| 5      | To <i>inculcate</i> the process of self-learning and <i>develop</i> effective communication skills. |

### Course Outcomes

|                             |                                                           |
|-----------------------------|-----------------------------------------------------------|
| The student will be able to |                                                           |
| CO1                         | <i>carry out</i> literature review and identify problems. |
| CO2                         | <i>apply</i> knowledge and skill to solve the problem.    |
| CO3                         | <i>design, implement and test</i> a working prototype.    |
| CO4                         | <i>document and demonstrate</i> the work carried out.     |
| CO5                         | <i>build</i> self-learning capabilities.                  |

### Guidelines

#### A. Process of project identification and implementation for exit program

- Students shall carry out a survey and identify needs, which shall be converted into problem statement for project in consultation with the faculty mentor.
- Students shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled.
- A log book is to be prepared to record weekly work progress.

#### B. Continuous Monitoring and Assessment

- A mentor is to be appointed at the department level to guide the student.

- The mentor should assess the progress of the students on a weekly basis and record their observations in the logbook.

### C. End Semester Examination

- A report is to be prepared and submitted by the student.
- Project shall be assessed through a presentation and demonstration of working model to a panel of Internal and External Examiners preferably from industry.

Mark distribution for project for exit program after second year of Engineering

| Assessment Tool | Components                                     | Marks      |
|-----------------|------------------------------------------------|------------|
| CA              | Logbook                                        | 25         |
|                 | Approval presentation and mid sem presentation | 25         |
|                 | <b>TOTAL</b>                                   | <b>50</b>  |
| ESE             | Report                                         | 50         |
|                 | Final Presentation                             | 50         |
|                 | <b>Total</b>                                   | <b>100</b> |