

# **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 Telecommunication Engineering**

### **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 Telecommunication Engineering typically focuses on expanding foundational knowledge while introducing more advanced topics in electronics and communication. 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 electronic and digital circuits, programming, embedded system, signal processing, communication, and Field, wave and electromagnetics. 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>AIML</b>   | Artificial Intelligence and Machine Learning Engineering  |
| <b>CA</b>     | Continuous Assessment                                     |
| <b>CC</b>     | Co-curricular Courses                                     |
| <b>CMPN</b>   | Computer Engineering                                      |
| <b>ECS</b>    | Electronics and Computer Science                          |
| <b>EEM</b>    | Entrepreneurship/Economics/Management                     |
| <b>ELEC</b>   | Electrical Engineering                                    |
| <b>ELC</b>    | Experiential Learning Courses                             |
| <b>ESC</b>    | Engineering Science Courses                               |
| <b>ESE</b>    | End Semester Examination                                  |
| <b>EXTC</b>   | Electronics and Telecommunication Engineering             |
| <b>FBT</b>    | First Year B.Tech.                                        |
| <b>FP</b>     | Field Projects                                            |
| <b>INFT</b>   | Information Technology                                    |
| <b>ISE</b>    | In Semester Evaluation                                    |
| <b>MDC</b>    | Multidisciplinary Courses                                 |
| <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>OE</b>     | Generic/ Open Electives (other than a particular program) |
| <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 Engg. / Tech. Degree

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

## 1.3 Total Credits and Marks of B.E. in EXTC with Multidisciplinary Minor ##:

Table 1.3: Total credits and marks of four-year EXTC degree program

| S.No. | Academic Year                   | Total Credits | Total Marks |
|-------|---------------------------------|---------------|-------------|
| 1     | First Year                      | 43            | 1450        |
| 2     | Second Year                     | 44            | 1450        |
| 3     | Third Year (Tentative)          | 41            | 1400        |
| 4     | Final Year (Tentative)          | 41            | 1200        |
|       | <b>Total Credits of Program</b> | <b>169</b>    | <b>5500</b> |

## 1.4 Semester-wise Credit Distribution Structure

Table 1.4 Credit distribution of verticals as per NEP-2020 in Second Year of B.Tech. in EXTC

| S. No.              | Course Type | Course Code | Courses                                   | Credits | Total |
|---------------------|-------------|-------------|-------------------------------------------|---------|-------|
| <b>Semester-III</b> |             |             |                                           |         |       |
| 1                   | <b>PC</b>   | ET3PC_CR1   | Mathematics for Communication Engineering | 3       | 16    |
| 2                   |             | ET3PC_CR2   | Analog and Digital Communication          | 3       |       |
| 3                   |             | ET3PC_LR2   | Analog and Digital Communication Lab      | 1       |       |
| 4                   |             | ET3PC_CR3   | Digital Logic Design                      | 2       |       |
| 5                   |             | ET3PC_LR3   | Digital Logic Design Lab                  | 1       |       |
| 6                   |             | ET3PC_CR4   | Electronics Devices and Circuits          | 3       |       |

|                    |            |           |                                                  |           |    |
|--------------------|------------|-----------|--------------------------------------------------|-----------|----|
| 7                  |            | ET3PC_LR4 | Electronics Devices and Circuits Lab             | 1         |    |
| 8                  |            | ET3PC_CR5 | Signals and Control Systems                      | 2         |    |
| 9                  | <b>HM</b>  | IL3HM_CR1 | Innovation, Business Models and Entrepreneurship | 2         | 2  |
| 10                 | <b>EL</b>  | ILSEL_PR1 | Field project                                    | 2         | 2  |
| 11                 | <b>HM</b>  | ILSHM_CR3 | Environment & Technology                         | 2         | 2  |
|                    |            |           | <b>Total</b>                                     | <b>22</b> |    |
| <b>Semester-IV</b> |            |           |                                                  |           |    |
| 1                  | <b>PCC</b> | ET4PC_CR1 | Optimization Techniques and Algorithms           | 3         | 10 |
| 2                  |            | ET4PC_CR2 | Linear Integrated Circuits                       | 3         |    |
| 3                  |            | ET4PC_LR2 | Linear Integrated Circuits Lab                   | 1         |    |
| 4                  |            | ET4PC_CR3 | Microcontroller and Applications                 | 2         |    |
| 5                  |            | ET4PC_LR3 | Microcontroller and Applications Lab             | 1         |    |
| 6                  | <b>VC</b>  | ET4VS_LR1 | Object Oriented Programming using JAVA           | 2         | 2  |
| 7                  | <b>HM</b>  | IL4HM_CR1 | Business Forecasting                             | 2         | 2  |
| 8                  | <b>MM</b>  | -         | MM-I*                                            | 2         | 2  |
| 9                  | <b>OE</b>  | -         | OE-I \$                                          | 2         | 2  |
| 10                 | <b>AC</b>  | ILSHM_CR1 | Professional Communication and Soft Skills       | 1         | 1  |
| 11                 |            | ILSHM_LR1 | Professional Communication and Soft Skills Lab   | 1         | 1  |
| 12                 | <b>VC</b>  | ILSHM_CR2 | Human Values and Ethics                          | 2         | 2  |
|                    |            |           | <b>Total</b>                                     | <b>22</b> |    |

C-Course, L-Laboratory

## 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

| Sr. No.      | Course Code | Course                                         | Contact Hours |               |              |       | Credits Assigned |               |              |       |
|--------------|-------------|------------------------------------------------|---------------|---------------|--------------|-------|------------------|---------------|--------------|-------|
|              |             |                                                | Theory (Th)   | Practical (P) | Tutorial (T) | Total | Theory (Th)      | Practical (P) | Tutorial (T) | Total |
| Semester III |             |                                                |               |               |              |       |                  |               |              |       |
| 1            | ET3PC_CR1   | Mathematics for Communication Engineering      | 3             | -             | -            | 3     | 3                | -             | -            | 3     |
| 2            | ET3PC_CR2   | Analog and Digital Communication               | 3             | -             | -            | 3     | 3                | -             | -            | 3     |
| 3            | ET3PC_LR2   | Analog and Digital Communication Lab           | -             | 2             | -            | 2     | -                | 1             | -            | 1     |
| 4            | ET3PC_CR3   | Digital Logic Design                           | 2             | -             | -            | 2     | 2                | -             | -            | 2     |
| 5            | ET3PC_LR3   | Digital Logic Design Lab                       | -             | 2             | -            | 2     | -                | 1             | -            | 1     |
| 6            | ET3PC_CR4   | Electronics Devices Circuits                   | 3             |               | -            | 3     | 3                | -             | -            | 3     |
| 7            | ET3PC_LR4   | Electronics Devices Circuits Lab               | -             | 2             | -            | 2     | -                | 1             | -            | 1     |
| 8            | ET3PC_CR5   | Signals and Control Systems                    | 2             | -             | -            | 2     | 2                | -             | -            | 2     |
| 9            | IL3HM_CR1   | Innovation, Business Models & Entrepreneurship | 2             | -             | -            | 2     | 2                | -             | -            | 2     |
| 10           | ILSEL_PR1   | Field project                                  | -             | 4             | -            | 4     | -                | 2             | -            | 2     |
| 11           | ILSHM_CR3   | Environment & Technology                       | 2             | -             | -            | 2     | 2                | -             | -            | 2     |

|                    |           | <b>TOTAL</b>                                   | <b>16</b> | <b>10</b> | <b>1</b> | <b>27</b> | <b>17</b> | <b>5</b> | <b>-</b> | <b>22</b> |
|--------------------|-----------|------------------------------------------------|-----------|-----------|----------|-----------|-----------|----------|----------|-----------|
| <b>Semester IV</b> |           |                                                |           |           |          |           |           |          |          |           |
| 1                  | ET4PC_CR1 | Optimization Techniques and Algorithms         | 3         | -         | -        | 3         | 3         | -        | -        | 3         |
| 2                  | ET4PC_CR2 | Linear Integrated Circuits                     | 3         | -         | -        | 3         | 3         | -        | -        | 3         |
| 3                  | ET4PC_LR2 | Linear Integrated Circuits Lab                 | -         | 2         | -        | 2         | -         | 1        | -        | 1         |
| 4                  | ET4PC_CR3 | Microcontroller and Applications               | 2         | -         | -        | 2         | 2         | -        | -        | 2         |
| 5                  | ET4PC_LR3 | Microcontroller and Applications Lab           | -         | 2         | -        | 2         | -         | 1        | -        | 1         |
| 6                  | ET4VS_LR1 | Object Oriented Programming using JAVA         | -         | 4         | -        | 4         | -         | 2        | -        | 2         |
| 7                  | IL4HM_CR1 | Business Forecasting                           | 2         | -         | -        | 2         | 2         | -        | -        | 2         |
| 8                  | -         | MM-I*                                          | 2         | -         | -        | 2         | 2         | -        | -        | 2         |
| 9                  | -         | OE-I §                                         | 2         | -         | -        | 2         | 2         | -        | -        | 2         |
| 10                 | ILSHM_CR1 | Professional Communication and Soft Skills     | 1         | -         | -        | 1         | 1         | -        | -        | 1         |
| 11                 | ILSHM_LR1 | Professional Communication and Soft Skills Lab | -         | 2         | -        | 2         | -         | 1        | -        | 1         |
| 12                 | ILSHM_CR2 | Human Values and Ethics                        | 2         | -         | -        | 2         | 2         | -        | -        | 2         |
|                    |           | <b>Total</b>                                   | <b>16</b> | <b>10</b> | <b>1</b> | <b>27</b> | <b>16</b> | <b>5</b> | <b>1</b> | <b>22</b> |

\* Refer Table No. 1.5.2

§ Refer Table No. 1.5.3

### 1.5.2 Multi-Disciplinary Minor Courses Offered in EXTC Program

Table 1.5.2: Semester wise credit distribution of Multi-Disciplinary Minor courses (MM)

| S. No. | Minor Title                   | Sem IV<br>(2 credits)                  | Sem V<br>(4 credits)                        | Sem VI<br>(4 credits)                    | Sem VII<br>(4 credits)                       |
|--------|-------------------------------|----------------------------------------|---------------------------------------------|------------------------------------------|----------------------------------------------|
| 1      | <b>Computer Science</b>       | Data Structures                        | Database Management Systems                 | Advanced Web Technologies                | Advanced Computing Applications              |
|        | <b>Course Codes:</b>          | <b>CE4MM_CX1</b>                       | <b>CE5MM_CX1</b>                            | <b>CE6MM_CX1</b>                         | <b>CE7MM_CX1</b>                             |
| 2      | <b>Business Intelligence</b>  | Database Management Systems            | Advanced Database Management Systems        | Data Warehousing and Mining              | Business Intelligence                        |
|        | <b>Course Codes:</b>          | <b>IT4MM_CX1</b>                       | <b>IT5MM_CX1</b>                            | <b>IT6MM_CX1</b>                         | <b>IT7MM_CX1</b>                             |
| 3      | <b>Electric Vehicles (EV)</b> | Introduction to Electric Vehicle       | EV Converters & Drives                      | Energy Storage & Charging Infrastructure | Auxiliary Systems & Advancement in EV System |
|        | <b>Course Codes</b>           | <b>EE4MM_CX1</b>                       | <b>EE5MM_CX1</b>                            | <b>EE6MM_CX1</b>                         | <b>EE7MM_CX1</b>                             |
| 4      | <b>Additive Manufacturing</b> | Introduction to Additive Manufacturing | Introduction to Computer-Aided-Design (CAD) | Applications of Additive Manufacturing   | 3D Printing for Medical Tech                 |
|        | <b>Course Codes</b>           | <b>ME4MM_CX1</b>                       | <b>ME5MM_CX1</b>                            | <b>ME6MM_CX1</b>                         | <b>ME7MM_CX1</b>                             |
| 5      | <b>Robotics</b>               | Introduction to Robotics               | Robot Kinematics and Dynamics               | Path planning and Control in Robotics    | Industrial and Service Robots                |
|        | <b>Course Codes</b>           | <b>ME4MM_CX2</b>                       | <b>ME5MM_CX2</b>                            | <b>ME6MM_CX2</b>                         | <b>ME7MM_CX2</b>                             |
| 6      | <b>Data Science</b>           | Data Analytics Foundations             | Data Mining and Predictive Analytics        | Time Series Forecasting                  | Applied and Scaled data Science              |

|   | Course Codes:                   | AI4MM_CX1                                 | AI5MM_CX1                                             | AI6MM_CX1                  | AI7MM_CX1                 |
|---|---------------------------------|-------------------------------------------|-------------------------------------------------------|----------------------------|---------------------------|
| 7 | <b>Internet of Things (IoT)</b> | Introduction to IoT and Core Technologies | IoT Data Management, Cloud Integration, and Analytics | IoT System Design Security | Advanced IoT Applications |
|   | Course Code                     | EC4MM_CX1                                 | EC5MM_CX1                                             | EC6MM_CX1                  | EC7MM_CX1                 |

**Note:** Student will choose any one MM stream during four-year degree program.

### 1.5.3 Open Elective-1 Courses Offered in Semester-IV

Table 1.5.3: List of Open Elective-1 Courses with credits

| Course Code | List of OE-1 Courses                       |
|-------------|--------------------------------------------|
| IL4OE_CX1   | IPR and Patenting                          |
| IL4OE_CX2   | Cybersecurity and Laws                     |
| IL4OE_CX3   | Psychology                                 |
| IL4OE_CX4   | Personal Finance, Taxation and Investments |
| 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: Marks distribution of courses

| S.No.               | Course Code | Course                                           | ISE        | MSE       | ESE        | PE         | Total      |
|---------------------|-------------|--------------------------------------------------|------------|-----------|------------|------------|------------|
| <b>Semester III</b> |             |                                                  |            |           |            |            |            |
| 1                   | ET3PC_CR1   | Mathematics for Communication Engineering        | 15         | 15        | 45         | -          | 75         |
| 2                   | ET3PC_CR2   | Analog and Digital Communication                 | 20         | 20        | 60         | -          | 100        |
| 3                   | ET3PC_LR2   | Analog and Digital Communication Lab             | 25         | -         | -          | 25         | 50         |
| 4                   | ET3PC_CR3   | Digital Logic Design                             | 15         | 15        | 45         | -          | 75         |
| 5                   | ET3PC_LR3   | Digital Logic Design Lab                         | 25         | -         | -          | 25         | 50         |
| 6                   | ET3PC_CR4   | Electronics Devices Circuits                     | 20         | 20        | 60         | -          | 100        |
| 7                   | ET3PC_LR4   | Electronics Devices Circuits Lab                 | 25         | -         | -          | 25         | 50         |
| 8                   | ET3PC_CR5   | Signals and Control Systems                      | 15         | 15        | 45         | -          | 75         |
| 9                   | IL3HM_CR1   | Innovation, Business Models and Entrepreneurship | 50         | -         | -          | -          | 50         |
| 10                  | ILSEL_PR1   | Field Project                                    | 25         | -         | -          | 25         | 50         |
| 11                  | ILSHM_CR3   | Environment & Technology                         | 50         | -         | -          | -          | 50         |
| <b>Total</b>        |             |                                                  | <b>185</b> | <b>85</b> | <b>255</b> | <b>100</b> | <b>725</b> |
| <b>Semester IV</b>  |             |                                                  |            |           |            |            |            |
| 1                   | ET4PC_CR1   | Optimization Techniques and Algorithms           | 20         | 20        | 60         | -          | 100        |
| 2                   | ET4PC_CR2   | Linear Integrated Circuits                       | 20         | 20        | 60         | -          | 100        |
| 3                   | ET4PC_LR2   | Linear Integrated Circuits Lab                   | 25         | -         | -          | 25         | 50         |
| 4                   | ET4PC_CR3   | Microcontroller and Applications                 | 15         | 15        | 45         | -          | 75         |

|              |           |                                                |            |           |            |           |            |
|--------------|-----------|------------------------------------------------|------------|-----------|------------|-----------|------------|
| 5            | ET4PC_LR3 | Microcontroller and Applications Lab           | 25         | -         | -          | 25        | 50         |
| 6            | ET4VS_LR1 | Object Oriented Programming using JAVA         | 50         |           |            | 25        | 75         |
| 7            | IL4HM_CR1 | Business Forecasting                           | 50         |           |            |           | 50         |
| 8            | -         | MDM-I*                                         | 15         | 15        | 45         | -         | 75         |
| 9            | -         | OE-I §                                         | 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>335</b> | <b>85</b> | <b>255</b> | <b>75</b> | <b>750</b> |

\* Refer Table No. 1.5.2

§ Refer Table No. 1.5.3

### Evaluation Pattern:

#### Note:

Evaluations consists 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> </ul> | 25/50 <sup>&amp;</sup> |

|                  |     |                   |                        |
|------------------|-----|-------------------|------------------------|
|                  |     | • Attendance: 20% |                        |
| ESE <sup>§</sup> | PrE | 100%              | 25/50 <sup>&amp;</sup> |

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

@ 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 (Th)   | Practical (P) | Tutorial (T) | Total | Theory (Th)      | Practical (P) | Tutorial (T) | Total |
| 1      | ETSEX_CR1   | Embedded System     | 3             | -             | -            | 3     | 3                | -             | -            | 3     |
| 2      | ETSEX_LR1   | Embedded System Lab | -             | 2             | -            | 2     | -                | 1             | -            | 1     |
| 3      | ETSEX_LR2   | Internship          | -             | 8             | -            | 8     | -                | 4             | -            | 4     |
|        | OR          |                     |               |               |              |       |                  |               |              |       |
|        | ETSEX_LR3   | Project             | -             | 8             | -            | 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 | Practicals |             |
| 1      | ETSEX_CR1   | Embedded System     | 20  | 20  | 60     | -          | 100         |
| 2      | ETSEX_LR1   | Embedded System Lab | 25  | -   | -      | 25         | 50          |
| 3      | ETSEX_LR2   | Internship          | 50  | -   | -      | 100        | 150         |
| OR     |             |                     |     |     |        |            |             |
| 4      | ETSEX_LR3   | Project             | 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 Mathematics for Communication Engineering (ET3PC\_CR1)

#### Teaching Scheme

| Course Code | Course Name                               | Contact Hours | Credits |
|-------------|-------------------------------------------|---------------|---------|
| ET3PC_CR1   | Mathematics for Communication Engineering | 03            | 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      | Develop a strong understanding of vector analysis along with their practical applications in various coordinate systems.               |
| 2      | Learn dimensionality reduction techniques to efficiently reduce the complexity of data while preserving its essential characteristics. |
| 3      | Gain a thorough understanding of random processes and analyze real-world data.                                                         |
| 4      | Understand the principles and applications of estimation techniques                                                                    |

#### Course Outcomes

|                              |                                                                                                                        |
|------------------------------|------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                        |
| CO1                          | Demonstrate an understanding of fundamental vector operations for Cartesian and cylindrical coordinate systems.        |
| CO2                          | Analyze various dimensionality reduction techniques for improved visualization and feature extraction.                 |
| CO3                          | Analyze random processes, understanding their stationarity (SSS and WSS), ergodicity, and their power spectral density |
| CO4                          | Evaluate the properties of statistical estimators                                                                      |
| CO5                          | Construct and interpret confidence intervals for population parameters                                                 |

#### Course Contents

| Module | Unit                          | Detailed Contents                                                                      | Hours |
|--------|-------------------------------|----------------------------------------------------------------------------------------|-------|
|        | Prerequisite                  |                                                                                        |       |
|        |                               |                                                                                        |       |
|        |                               |                                                                                        |       |
| 1      | Vectors and Coordinate system |                                                                                        | 06    |
|        | 1.1                           | Fundamental of vectors, Vector Multiplication, Cartesian system & Projection of Vector |       |

|                    |                                       |                                                                                                                                                      |           |
|--------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 1.2                                   | Gradient, Divergence and Curl, Gauss Divergence Theorem, Stokes Theorem, Cylindrical Coordinate System                                               |           |
| <b>2</b>           | <b>Dimensionality Reduction</b>       |                                                                                                                                                      | <b>06</b> |
|                    | 2.1                                   | Principal Component Analysis (PCA), Locally Linear Embedding (LLE), t-stochastic Neighbour Embedding (t-SNE)                                         |           |
|                    | 2.2                                   | Fisher Discriminant Analysis (FDA), Singular Value Decomposition (SVD)                                                                               |           |
| <b>3</b>           | <b>Introduction to Random process</b> |                                                                                                                                                      | <b>04</b> |
|                    | 3.1                                   | Random process: Discrete time processes, Probabilistic structure of a random process; mean, autocorrelation and autocovariance functions.            |           |
|                    | 3.2                                   | Random process: Continuous time processes, Probabilistic structure of a random process; mean, autocorrelation and autocovariance functions.          |           |
| <b>4</b>           | <b>Analysis of Random process</b>     |                                                                                                                                                      | <b>04</b> |
|                    | 4.1                                   | Strict-sense stationary (SSS) and Wide-sense stationary (WSS) processes                                                                              |           |
|                    | 4.2                                   | Autocorrelation function of a real WSS process and its properties, cross-correlation function, Ergodicity and its importance, Power Spectral Density |           |
| <b>5</b>           | <b>Estimation</b>                     |                                                                                                                                                      | <b>06</b> |
|                    | 5.1                                   | Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation                                                     |           |
|                    | 5.2                                   | confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions.               |           |
| <b>Total Hours</b> |                                       |                                                                                                                                                      | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Advanced Engineering Mathematics, 10th ed., E. Kreyszig, 2011.
2. A First Course in Probability, 10th ed., S. Ross, Boston, MA, USA: Pearson, 2018.
3. Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers, 3rd ed., R. D. Yates and D. J. Goodman, Hoboken, NJ, USA: Wiley, 2014.
4. Introduction to the Practice of Statistics, 9th ed., D. S. Moore, G. P. McCabe, and B. A. Craig, New York, NY, USA: W. H. Freeman, 2020.

### Reference Books

1. Introduction to Applied Mathematics., G. Strang, Wellesley, MA, USA: Wellesley-Cambridge Press, 1986.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd ed., T. Hastie, R. Tibshirani, and J. Friedman, New York, NY, USA: Springer, 2009.

### Web Resources

1. MIT OpenCourseWare on Multivariable Calculus  
<https://ocw.mit.edu/courses/mathematics/18-02sc-multivariable-calculus-fall-2010/>
2. NPTEL Course on Probability and Statistics, Dr. S. Dharmaraja, IIT Delhi  
<https://nptel.ac.in/courses/111/102/111102111/>

## 2.2 Analog and Digital Communication (ET3PC\_CR2)

### Teaching Scheme

| Course Code | Course Name                      | Contact Hours | Credits |
|-------------|----------------------------------|---------------|---------|
| ET3PC_CR2   | Analog and Digital Communication | 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 illustrate the fundamentals of basic communication system.                                             |
| 2      | To understand the various theorems applied in communication systems for the stability of its performance. |
| 3      | To understand Analog and Digital modulation and demodulation techniques.                                  |
| 4      | To understand the methods of error correction and detection in a communication system.                    |

### Course Outcomes

|                              |                                                                                                                                                     |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                                     |
| CO1                          | Understand the entities of analog communication systems.                                                                                            |
| CO2                          | Understand the concepts of radio receiver for analog communication systems.                                                                         |
| CO3                          | Understand Pulse and baseband transmission methods along with Nyquist criterion for the design of a communication system.                           |
| CO4                          | Illustrate various digital modulation and demodulation methods.                                                                                     |
| CO5                          | Understand the concepts of information theory for efficient source coding and the methods of error control coding in digital communication systems. |

### Course Contents

| Module   | Unit                                | Detailed Contents                                                                                              | Hours     |
|----------|-------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Prerequisites</b>                |                                                                                                                |           |
|          |                                     |                                                                                                                |           |
| <b>1</b> | <b>Analog Modulation Techniques</b> |                                                                                                                | <b>09</b> |
|          | 1.1                                 | Basic blocks of Communication System. Analog Modulation - Principles of Amplitude Modulation, DSBSC, SSB-SC.   |           |
|          | 1.2                                 | Angle Modulation - Frequency and Phase Modulation. Transmission Bandwidth of FM signals, Methods of generation |           |
|          | 1.3                                 | <b>Transmitters:</b> Classification of Transmitters, AM Transmitters, FM Transmitters.                         |           |

|                    |                                                    |                                                                                                                                                                                     |           |
|--------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>2</b>           | <b>Radio Receivers</b>                             |                                                                                                                                                                                     | <b>06</b> |
|                    | 2.1                                                | Receiver Types - Tuned radio frequency receiver, Superhetrodyne receiver                                                                                                            |           |
|                    | 2.2                                                | RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, Image frequency, AGC, Amplitude limiting, FM Receiver, Comparison of AM and FM Receivers. |           |
| <b>3</b>           | <b>Pulse Modulation and Baseband Transmission</b>  |                                                                                                                                                                                     | <b>06</b> |
|                    | 3.1                                                | Analog Pulse Modulation PAM and PWM.                                                                                                                                                |           |
|                    | 3.2                                                | Digital Modulation: Pulse Code Modulation(PCM) and Delta modulation and its Generation and Reconstruction, Quantization Noise, Companding and Aliasing                              |           |
|                    | 3.3                                                | Representation of Baseband signal, ISI, Eye Diagram.                                                                                                                                |           |
| <b>4</b>           | <b>Digital Modulation Techniques</b>               |                                                                                                                                                                                     | <b>09</b> |
|                    | 4.1                                                | ASK- Modulator, Coherent ASK Detector, FSK- Modulator, Non-Coherent FSK Detector, BPSK- Modulator, concept of M-ary, Coherent BPSK Detection. Principles of QPSK, QAM and MSK.      |           |
|                    | 4.2                                                | Optimal Reception of Digital Signal: A Baseband Signal Receiver, Optimum Receiver, Coherent Reception                                                                               |           |
| <b>5</b>           | <b>Information Theory and Error Control Coding</b> |                                                                                                                                                                                     | <b>09</b> |
|                    | 5.1                                                | Entropy, Source coding theorem, Channel capacity Theorem, Huffman encoding, Shannon Fano coding                                                                                     |           |
|                    | 5.2                                                | Error control coding techniques – Linear block codes- Encoder and decoder. Cyclic codes – Encoder, Syndrome Calculator, Convolution codes.                                          |           |
| <b>Total Hours</b> |                                                    |                                                                                                                                                                                     | <b>39</b> |

## Suggested Learning Resources

### Textbooks

1. Electronics Communication System, 4<sup>th</sup> Edition, Kennedy and Davis, Tata McGraw Hill.
2. Modern Digital and Analog Communication system, 4<sup>th</sup> Edition, B.P. Lathi, Zhi Ding, Oxford University Press.
3. Electronics Communication Systems, 5<sup>th</sup> Edition, Wayne Tomasi, Pearson education.
4. Principles of Communication Systems, 3<sup>rd</sup> Edition, H. Taub, D. Schilling, and G. Saha, Tata Mc- Graw Hill, New Delhi, 2012.
5. Digital Communications, 4<sup>th</sup> Edition, Haykin Simon-, John Wiley and Sons, New Delhi, 2014.
6. Digital Communications, 4<sup>th</sup> Edition, John G. Proakis, McGraw-Hill.

### Reference Books

1. Taub's Principles of Communication systems , 3<sup>rd</sup> Edition, Taub, Schilling and Saha, Tata McGraw Hill.
2. Communication Systems: Analog and Digital, 3<sup>rd</sup> Edition, P. Sing and S.D. Sapre, Tata McGraw Hill.
3. Analog and Digital Communication, 1<sup>st</sup> Edition, T L Singal, Tata Mc-Graw Hill, New Delhi, 2012.

## 2.3 Analog and Digital Communication Lab (ET3PC\_LR2)

### Teaching Scheme

| Course Code | Course Name                          | Contact Hours | Credits |
|-------------|--------------------------------------|---------------|---------|
| ET3PC_LR2   | Analog and Digital Communication 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 implement analog communication system.                                                                 |
| 2      | To understand the various theorems applied in communication systems for the stability of its performance. |
| 3      | To implement various analog and Digital modulation and demodulation techniques.                           |
| 4      | To explore the various methods of error correction and detection in a communication system.               |

### Course Outcomes

|                              |                                                                                                                                                    |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                                    |
| CO1                          | Implement, analyse the analog modulation and demodulation techniques                                                                               |
| CO2                          | Understand and implement the radio receiver for analog communication systems.                                                                      |
| CO3                          | Implement, analyse the baseband and pulse transmission methods and its reconstruction with knowledge of nyquist criterion.                         |
| CO4                          | Analyse, Implement the various digital modulation methods.                                                                                         |
| CO5                          | Implement the concepts of information theory for efficient source coding and the methods of error control coding in digital communication systems. |

### Suggested List of Experiments

| S. No | Suggestive List of Experiments                                                                                                                                                                                    |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.    | To study Amplitude Modulation and demodulation (using diode detector)<br>a) Generate AM waveforms and calculate the modulation Index<br>b) Plot trapezoidal pattern for the AM waveforms and verify the MI in (a) |
| 2.    | Simulation of AM using MATLAB/SCILAB                                                                                                                                                                              |
| 3.    | Simulation of FM using MATLAB/SCILAB                                                                                                                                                                              |
| 4.    | To Generate PAM signals and verify the sampling theorem                                                                                                                                                           |
| 5.    | Implementation of Information Theory Concepts                                                                                                                                                                     |
| 6.    | Implementation of Linear Block Codes                                                                                                                                                                              |
| 7.    | Implementation of Cyclic Redundancy Check (CRC) Codes                                                                                                                                                             |
| 8.    | Implementation of Line Coding Techniques                                                                                                                                                                          |
| 9.    | Implementation of Digital Modulation Techniques                                                                                                                                                                   |
| 10.   | Course based Project: Design of any analog/ communication system block                                                                                                                                            |

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. Electronics Communication System, 4<sup>th</sup> Edition, Kennedy and Davis, Tata McGraw Hill.
2. Modern Digital and Analog Communication system, 4<sup>th</sup> Edition, B.P. Lathi, Zhi Ding, Oxford University Press.
3. Electronics Communication Systems, 5<sup>th</sup> Edition, Wayne Tomasi, Pearson education.
4. Principles of Communication Systems, 3<sup>rd</sup> Edition, H. Taub, D. Schilling, and G. Saha, Tata Mc- Graw Hill, New Delhi, 2012.
5. Digital Communications, 4<sup>th</sup> Edition, Haykin Simon-, John Wiley and Sons, New Delhi, 2014.
6. Digital Communications, 4<sup>th</sup> Edition, John G. Proakis, McGraw-Hill.

### **Reference Books**

1. Taub's Principles of Communication systems , 3<sup>rd</sup> Edition, Taub, Schilling and Saha, Tata McGraw Hill.
2. Communication Systems: Analog and Digital, 3<sup>rd</sup> Edition, P. Sing and S.D. Sapre, Tata McGraw Hill.
3. Analog and Digital Communication, 1<sup>st</sup> Edition, T L Singal, Tata Mc-Graw Hill, New Delhi, 2012.

## 2.4 Digital Logic Design (ET3PC\_CR3)

### Teaching Scheme

| Course Code | Course Name          | Contact Hours | Credits |
|-------------|----------------------|---------------|---------|
| ET3PC_CR3   | Digital Logic 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 develop an understanding of code conversions and explore various logic families (TTL and CMOS) used in digital electronic circuits.                       |
| 2      | To analyze digital logic processes and to implement logical operations using various combinational logic circuits.                                           |
| 3      | To analyze digital logic processes and to implement logical operations using various sequential logic circuits.                                              |
| 4      | To explore the characteristics and classification of programmable devices (PLD) and also implement combinational and sequential circuits using VHDL/Verilog. |

### Course Outcomes

|                              |                                                                                                                            |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                            |
| CO1                          | Develop digital logic skills, perform code conversions, and analyze logic families (TTL and CMOS).                         |
| CO2                          | Analyze, design and implement combinational logic circuits.                                                                |
| CO3                          | Analyze, design and implement sequential logic circuits.                                                                   |
| CO4                          | Design and implement basic digital counters.                                                                               |
| CO5                          | Classify various types of PLDs, and simulate and implement basic combinational and sequential circuits using VHDL/Verilog. |

### Course Contents

| Module | Unit                                                                     | Detailed Contents                                                                                    | Hours |
|--------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------|
|        | <b>Prerequisite</b>                                                      |                                                                                                      |       |
|        | Basic Electrical Engineering – Module 5: Fundamentals of Digital Systems |                                                                                                      |       |
| 1      | <b>Codes and Logic Families</b>                                          |                                                                                                      | 04    |
|        | 1.1                                                                      | Binary, Gray, and BCD Codes, Code Conversion                                                         |       |
|        | 1.2                                                                      | Introduction to Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics |       |
| 2      | <b>Combinational Logic Circuits</b>                                      |                                                                                                      | 10    |
|        | 2.1                                                                      | SOP and POS representation, K-Map and Quine-McClusky method for                                      |       |

|                    |                                                            |                                                                                                                                                                                                                                |           |
|--------------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    |                                                            | minimization of logic expressions                                                                                                                                                                                              |           |
|                    | 2.2                                                        | Binary Adder/Subtractor, BCD Adder.                                                                                                                                                                                            |           |
|                    | 2.3                                                        | Magnitude Comparator, Multiplexer, Demultiplexer, Encoder, Decoder, Parity Generator/Checker, Boolean function implementation using Multiplexer, Demultiplexer, and basic gates, Applications of combinational logic circuits. |           |
| <b>3</b>           | <b>Sequential Logic Circuits – Flip flops</b>              |                                                                                                                                                                                                                                | <b>04</b> |
|                    | 3.1                                                        | Flip flops: RS, JK, Master slave flip flops; Toggle & Delay flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal Shift Register                                  |           |
| <b>4</b>           | <b>Sequential Logic Circuits – Counters</b>                |                                                                                                                                                                                                                                | <b>04</b> |
|                    | 4.1                                                        | Asynchronous and Synchronous counters, Up/Down counter, MOD-N Counter, BCD Counter, Ring counter, Johnson counter, Applications of sequential logic circuits.                                                                  |           |
| <b>5</b>           | <b>Programmable logic devices and Introduction to VHDL</b> |                                                                                                                                                                                                                                | <b>04</b> |
|                    | 5.1                                                        | Programmable Logic Devices (PLD), Programmable Read Only Memories (PROMs), Programmable Logic Array (PLA), Programmable Array Logic (PAL), Applications of PLDs.                                                               |           |
|                    | 5.2                                                        | Basics of VHDL/Verilog Programming, Design of combinational and sequential circuits using VHDL/Verilog: adder, subtractor, multiplexer, flip flop and counters.                                                                |           |
| <b>Total Hours</b> |                                                            |                                                                                                                                                                                                                                | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Digital Design Principles and Practices, 5<sup>th</sup> Edition, John F. Warkerly, Pearson Education, (2018).
2. Digital Design, 5<sup>th</sup> Edition, Morris Mano, Michael D. Ciletti, Pearson Education (2013).
3. Modern Digital Electronics, 4<sup>th</sup> Edition, R. P. Jain, Tata McGraw Hill Education (2010).
4. Fundamentals of Digital Circuits, 4<sup>th</sup> Edition, A. Anand Kumar, PHI (2016).
5. Digital Electronics and Design with VHDL, 1<sup>st</sup> Edition, Volnei A. Pedroni, Morgan Kaufmann Publisher (2008).
6. A Verilog HDL Primer , 3<sup>rd</sup> Edition, J. Bhasker, Star Galaxy Press (1997).

### Reference Books

1. Digital Fundamentals, 11<sup>th</sup> Edition, Thomas L. Floyd, Pearson Prentice Hall (2015).
2. Digital Electronics Principles and Applications, 1<sup>st</sup> Edition, Mandal, McGraw Hill Education (2010).
3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss “”, Ninth Edition, PHI (2009).
4. Digital Principles and Applications, 8<sup>th</sup> Edition, Donald P. Leach / Albert Paul Malvino/Gautam Saha, The McGraw Hill (2015).
5. Fundamentals of Digital Logic Design with VHDL, 2<sup>nd</sup> Edition, Stephen Brown & Zvonko Vranesic, TMH (2009).
6. Fundamentals of Digital Logic with Verilog Design, 3<sup>rd</sup> Edition, Stephen Brown & Zvonko Vranesic, MGH (2014).

## Web Resources

1. NPTEL Course on Digital Circuits, Prof. Santanu Chattopadhyay, IIT Kharagpur  
[https://swayam.gov.in/nd1\\_noc20\\_ee70/preview](https://swayam.gov.in/nd1_noc20_ee70/preview)

## 2.5 Digital Logic Design Lab (ET3PC\_LR3)

### Teaching Scheme

| Course Code | Course Name              | Contact Hours | Credits |
|-------------|--------------------------|---------------|---------|
| ET3PC_LR3   | Digital Logic 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 develop an understanding of code conversion and practical skills in performing code conversions using standard digital IC's. |
| 2      | To equip students with the ability to design, analyze, simulate using EDA tools and implement combinational logic circuits.     |
| 3      | To equip students with the ability to design, analyze, simulate using EDA tools and implement sequential logic circuits.        |
| 4      | To explore simulation software for VHDL/Verilog programming.                                                                    |

### Course Outcomes

|                              |                                                                                        |
|------------------------------|----------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                        |
| CO1                          | Perform code conversions and implement them using digital ICs.                         |
| CO2                          | Design, simulate, and implement combinational logic circuits using digital ICs.        |
| CO3                          | Design, simulate, and implement sequential logic circuits. using digital ICs.          |
| CO4                          | Design, construct, and test basic digital counters using digital ICs.                  |
| CO5                          | Simulate and implement basic combinational and sequential circuits using VHDL/Verilog. |

### Suggested List of Experiments

| S. No. | Suggestive List of Experiments                                                        |
|--------|---------------------------------------------------------------------------------------|
| 1      | Design, Implement and verify code converters.                                         |
| 2      | Simplification of Boolean functions and their implementation using Digital ICs.       |
| 3      | Design, implement and verify Binary Adder/subtractor.                                 |
| 4      | Design, implement and verify BCD Adder.                                               |
| 5      | Design, implement and verify Magnitude Comparator.                                    |
| 6      | Design, implement and verify Multiplexer.                                             |
| 7      | Design, implement and verify De-Multiplexer.                                          |
| 8      | Implementation of Boolean Expression using Multiplexer/Demultiplexer and logic gates. |
| 9      | Design, implement and verify Encoder.                                                 |

|    |                                                                 |
|----|-----------------------------------------------------------------|
| 10 | Design, implement and verify Decoder.                           |
| 11 | Implement and verify Parity generator/checker.                  |
| 12 | Verify the truth table of different types of Flip Flops.        |
| 13 | Design, implement and verify Flip Flop conversion.              |
| 14 | Implement and verify Shift registers.                           |
| 15 | Design, implement and verify Asynchronous/Synchronous Counters. |
| 16 | Verify Counter IC operation.                                    |
| 17 | VHDL code for Combinational Circuits                            |
| 18 | VHDL code for Sequential circuits.                              |

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, 5<sup>th</sup> Edition, John F. Warkerly, Pearson Education, (2018).
2. Digital Design, 5<sup>th</sup> Edition, Morris Mano, Michael D. Ciletti, Pearson Education (2013).
3. Modern Digital Electronics, 4<sup>th</sup> Edition, R. P. Jain, Tata McGraw Hill Education (2010).
4. Fundamentals of Digital Circuits, 4<sup>th</sup> Edition, A. Anand Kumar, PHI (2016).
5. Digital Electronics and Design with VHDL, 1<sup>st</sup> Edition, Volnei A. Pedroni, Morgan Kaufmann Publisher (2008).
6. A Verilog HDL Primer, 3<sup>rd</sup> Edition, J. Bhasker, Star Galaxy Press (1997).

### Reference Books

1. Digital Fundamentals, 11<sup>th</sup> Edition, Thomas L. Floyd, Pearson Prentice Hall (2015).
2. Digital Electronics Principles and Applications, 1<sup>st</sup> Edition, Mandal, McGraw Hill Education (2010).
3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss “”, Ninth Edition, PHI (2009).
4. Digital Principles and Applications, 8<sup>th</sup> Edition, Donald P. Leach / Albert Paul Malvino/Gautam Saha, The McGraw Hill (2015).
5. Fundamentals of Digital Logic Design with VHDL, 2<sup>nd</sup> Edition, Stephen Brown & Zvonko Vranesic, TMH (2009).
6. Fundamentals of Digital Logic with Verilog Design, 3<sup>rd</sup> Edition, Stephen Brown & Zvonko Vranesic, MGH (2014).

### Web Resources

1. NPTEL Course on Digital Circuits, Prof. Santanu Chattopadhyay, IIT Kharagpur  
[https://swayam.gov.in/nd1\\_noc20\\_ee70/preview](https://swayam.gov.in/nd1_noc20_ee70/preview)

## 2.6 Electronic Devices and Circuits (ET3PC\_CR4)

## Teaching Scheme

| Course Code | Course Name                     | Contact Hours | Credits |
|-------------|---------------------------------|---------------|---------|
| ET3PC_CR4   | 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 explain functionality of different electronic devices.                                                                          |
| 2      | To perform DC and AC analysis of small signal amplifier circuits.                                                                  |
| 3      | To analyze frequency response of small signal amplifiers.                                                                          |
| 4      | To explain large signal amplifiers and compare them with small signal amplifiers and classify feedback amplifiers and oscillators. |

## Course Outcomes

|                              |                                                                          |
|------------------------------|--------------------------------------------------------------------------|
| The student will be able to: |                                                                          |
| CO1                          | comprehend the construction, working and characteristics of transistors. |
| CO2                          | evaluate DC parameters of the amplifier.                                 |
| CO3                          | evaluate AC parameters and frequency response of the amplifier.          |
| CO4                          | comprehend and classify the large signal amplifiers.                     |
| CO5                          | comprehend and classify Feedback amplifiers and Oscillators.             |

## Course Contents

| Module | Unit                                                                                             | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                             | Hours |
|--------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
|        | <b>Prerequisite</b>                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                               |       |
|        | Basic Circuit components, Ohm's law, Kirchhoff's laws, Superposition theorem, PN junction diode. |                                                                                                                                                                                                                                                                                                                                                                                                               |       |
| 1      | <b>Introduction of Semiconductor Transistors</b>                                                 |                                                                                                                                                                                                                                                                                                                                                                                                               | 10    |
|        | 1.1                                                                                              | Fundamentals of BJT: Construction, current components and equations, CB, CE and CC configuration, input and output characteristics of CE and various region of operation, Early effect, FET construction- JFET: Construction, transfer and drain characteristics of CS configuration, Enhancement and Depletion MOSFET, drain and transfer Characteristics of CS MOSFET amplifier, Application of BJT and FET |       |
|        | <b>Biassing Circuits</b>                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                               |       |
|        | 1.2                                                                                              | Concept of DC load line, Q point, Bias Stabilization and Thermal Runaway, analysis & design of biasing circuits for BJT, JFET and MOSFET amplifiers                                                                                                                                                                                                                                                           |       |

|                    |                                                      |                                                                                                                                      |           |
|--------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>2</b>           | <b>Small Signal Amplifiers</b>                       |                                                                                                                                      | <b>09</b> |
|                    | 2.1                                                  | Small signal mid frequency analysis of CE amplifier using hybrid pi model. Small signal mid frequency analysis of CS JFET amplifiers |           |
|                    | 2.2                                                  | Introduction to multistage amplifier, BJT Differential amplifier, BJT Current mirror and Buffer circuits                             |           |
| <b>3</b>           | <b>Frequency Response of Small Signal Amplifiers</b> |                                                                                                                                      | <b>06</b> |
|                    | 3.1                                                  | Concept of Miller effect and Miller capacitance, High and Low frequency analysis of CE BJT amplifiers.                               |           |
|                    | 3.2                                                  | High and Low frequency analysis of CS MOSFET amplifiers.                                                                             |           |
| <b>4</b>           | <b>Large Signal Amplifiers</b>                       |                                                                                                                                      | <b>06</b> |
|                    | 4.1                                                  | Difference between small signal & large signal amplifiers.                                                                           |           |
|                    | 4.2                                                  | Classification and working of Power amplifiers (Class A, Class B and Class AB amplifiers)                                            |           |
| <b>5</b>           | <b>Feedback amplifiers and Oscillators</b>           |                                                                                                                                      | <b>08</b> |
|                    | 5.1                                                  | Concept of negative and positive feedback, classification of negative feedbacks.                                                     |           |
|                    | 5.2                                                  | Barkhausen criteria for oscillation, Low and High frequency oscillators (RC Phase shift, Wein bridge, Hartley and Colpitts).         |           |
| <b>Total Hours</b> |                                                      |                                                                                                                                      | <b>39</b> |

## Suggested Learning Resources

### Textbooks

1. Electronic Circuit Analysis and Design, 2<sup>nd</sup> Edition, D. A. Neamen, Tata McGraw Hill.
2. Electronic Devices and Circuits Theory, 11th Edition, Boylestad and Nashelesky, Pearson Education.
3. Electronic Devices And Circuit, 6<sup>th</sup> Edition, T. F. Bogart, Merrill.
4. Electronic Devices and Circuits, R. S. Dudhe and M. Farhan, Synergy Knowledgeware.

### Reference Books

1. Electronic Devices and Circuits, A. K. Maini, Wiley.
2. Electronic Devices and Circuits, 3<sup>rd</sup> Edition, J. Millman, Christos C Halkias, and Satyabratajit, Millman's, McGrawHill.
3. Electronic Devices, 9<sup>th</sup> Edition, T. L. Floyd, Prentice Hall, 2012.
4. Electronic Devices and Circuits, 3<sup>rd</sup> Edition, S. Salivahanan, N. Suresh Kumar, Tata McGraw Hill.
5. Electronic devices and circuits, Bell, David A., Prentice-Hall of India, 1999.
6. Microelectronics Circuits Analysis and Design, 2<sup>nd</sup> Edition, Muhammad H. Rashid, Cengage Learning.

### Web Resources

1. NPTEL course on Analog Electronic Circuits, Prof. Pradip Mandal, IIT Kharagpur  
<https://archive.nptel.ac.in/courses/108/105/108105158/>

## 2.7 Electronic Device Circuits Lab (ET3PC\_LR4)

### Teaching Scheme

| Course Code | Course Name                    | Contact Hours | Credits |
|-------------|--------------------------------|---------------|---------|
| ET3PC_LR4   | Electronic Device 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 make students familiar with equipment and measuring instruments used to perform Electronics Devices and Circuits laboratory work.                                |
| 2      | To provide hands on experience to develop laboratory setup for performing given experimental using various equipment, electronic devices and measuring instruments. |
| 3      | To develop an ability among students to gather appropriate data and analyze the same to relate theory with practical.                                               |
| 4      | To develop troubleshooting abilities among students.                                                                                                                |

### Course Outcomes

|                              |                                                                                     |
|------------------------------|-------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                     |
| CO1                          | Comprehend the construction, working and characteristics of diode and transistors.  |
| CO2                          | Evaluate the Q point of biasing circuits and analyze the bias stability             |
| CO3                          | Evaluate the AC parameters of the amplifiers and understand the frequency response. |
| CO4                          | Analyze the large signal amplifiers.                                                |
| CO5                          | Analyze the effect of negative and positive feedback using amplifiers and Filters.  |

### Suggested List of Experiments

| S. No. | Suggestive List of Experiments                                                                  |
|--------|-------------------------------------------------------------------------------------------------|
| 1      | To introduce electronics components and devices in the laboratory.                              |
| 2      | To plot the characteristics of BJT and graphically determine h-parameters.                      |
| 3      | To measure the Q point of given Biasing Circuits.                                               |
| 4      | To find out the $R_{in}$ , $R_o$ , $A_v$ of CE Amplifier and verify with the theoretical value. |
| 5      | To determine output impedance $R_o$ and voltage gain $A_v$ of the CS-MOSFET Amplifier.          |
| 6      | To sketch and Analyze frequency response of single stage CE Amplifier.                          |
| 7      | To sketch and Analyze frequency response of single stage CS Amplifier.                          |

|    |                                                                          |
|----|--------------------------------------------------------------------------|
| 8  | To study the crossover distortion in class B power amplifiers.           |
| 9  | To study the impact of negative feedback on amplifier.                   |
| 10 | To analyze R-C Phase Shift Oscillator using Bipolar Junction Transistor. |

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, 2<sup>nd</sup> Edition, D. A. Neamen, Tata McGraw Hill.
2. Electronic Devices and Circuits Theory, 11<sup>th</sup> Edition, Boylestad and Nashelesky, Pearson Education.
3. Electronic Devices And Circuit, 6<sup>th</sup> Edition, T. F. Bogart, Merrill.
4. Electronic Devices and Circuits, R. S. Dudhe and M. Farhan, Synergy Knowledgeware.

### Reference Books

1. Electronic Devices and Circuits, A. K. Maini, Wiley.
2. Electronic Devices and Circuits, 3<sup>rd</sup> Edition, J. Millman, Christos C Halkias, and Satyabratajit, Millman's, McGrawHill.
3. Electronic Devices, 9<sup>th</sup> Edition, T. L. Floyd, Prentice Hall, 2012.
4. Electronic Devices and Circuits, 3<sup>rd</sup> Edition, S. Salivahanan, N. Suresh Kumar, Tata McGraw Hill.
5. Electronic devices and circuits, Bell, David A., Prentice-Hall of India, 1999.
6. Microelectronics Circuits Analysis and Design, 2<sup>nd</sup> Edition, Muhammad H. Rashid, Cengage Learning.

### Web Resources

1. NPTEL course on Analog Electronic Circuits, Prof. Pradip Mandal, IIT Kharagpur  
<https://archive.nptel.ac.in/courses/108/105/108105158/>

## 2.8 Signals and Control Systems (ET3PC\_CR5)

### Teaching Scheme

| Course Code | Course Name                 | Contact Hours | Credits |
|-------------|-----------------------------|---------------|---------|
| ET3PC_CR5   | Signals and Control 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 introduce students to the idea of signal and system analysis and characterization in time and frequency domain.                                                  |
| 2      | To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems. |
| 3      | To provide fundamental concepts of control system such as mathematical modeling, time response and Frequency response.                                              |
| 4      | To develop concepts of stability and its assessment criteria.                                                                                                       |

### Course Outcomes

|     |                                                                                                                  |
|-----|------------------------------------------------------------------------------------------------------------------|
| CO1 | Classify and Analyze different types of signals and systems                                                      |
| CO2 | Analyze continuous time LTI signals and systems in transform domain                                              |
| CO3 | Determine the models of physical systems in forms suitable for use in the analysis and design of control systems |
| CO4 | Obtain the transfer functions for a given Control system.                                                        |
| CO5 | Understand the analysis of systems in time domain and frequency domain.                                          |

### Course Contents

| Module   | Unit                                                    | Detailed Contents                                                                                                                                                                                                                                                 | Hours     |
|----------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Prerequisites</b>                                    |                                                                                                                                                                                                                                                                   |           |
|          | Basic Electrical Engineering, Engineering Mathematics   |                                                                                                                                                                                                                                                                   |           |
| <b>1</b> | <b>Classification Of Signals And Systems</b>            |                                                                                                                                                                                                                                                                   | <b>05</b> |
|          | 1.1                                                     | Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - |           |
|          | 1.2                                                     | Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable. Convolution and Correlation                                                                                    |           |
| <b>2</b> | <b>Analysis Of Continuous And Discrete Time Signals</b> |                                                                                                                                                                                                                                                                   | <b>06</b> |

|                    |                                                         |                                                                                                                                                                  |           |
|--------------------|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 2.1                                                     | Fourier series for periodic signals – Fourier Transform – properties- Laplace Transforms and Properties.                                                         |           |
|                    | 2.2                                                     | Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT – Z Transform & Properties                                        |           |
| <b>3</b>           | <b>Systems Components, Representation And Stability</b> |                                                                                                                                                                  | <b>05</b> |
|                    | 3.1                                                     | Control System: Terminology and Basic Structure-Feed forward and Feedback control theory Electrical and Mechanical Transfer Function Models-Block diagram Models |           |
|                    | 3.2                                                     | Signal flow graphs models-DC and AC servo Systems-Synchronous - Multivariable control system                                                                     |           |
| <b>4</b>           | <b>Stability Of The Systems</b>                         |                                                                                                                                                                  | <b>05</b> |
|                    | 4.1                                                     | Concept of stability-Bounded – Input Bounded – Output stability-Routh stability criterion-Relative Stability                                                     |           |
|                    | 4.2                                                     | Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion                                                                               |           |
| <b>5</b>           | <b>Frequency Response And System Analysis</b>           |                                                                                                                                                                  | <b>05</b> |
|                    | 5.1                                                     | Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system                                  |           |
|                    | 5.2                                                     | Bode Plot – Polar Plot- Nyquist plots-Design of compensators using Bode Plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation   |           |
| <b>Total Hours</b> |                                                         |                                                                                                                                                                  | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Signals and Systems, 3<sup>rd</sup> Edition, Nagoor Kani, Tata McGraw Hill, 2011.
2. Signals and Systems, 4<sup>th</sup> Edition, Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Pearson Education, 2009.
3. Signals and Systems, 2<sup>nd</sup> Edition, Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Prentice-Hall of India, 2002.
4. Signals and Systems, 2<sup>nd</sup> Edition, Simon Haykin and Barry Van Veen, John Wiley and Sons, 2004.
5. Control System Engineering, Nagrath, M.Gopal, Tata McGrawHill.
6. Modern Control Engineering, 3<sup>rd</sup> Edition, K.Ogata, Pearson Education.

### Reference Books

1. Signals and Systems, 3<sup>rd</sup> Edition, Hwei. P Hsu, Tata McGraw Hill, 2010
2. Signals and Systems, 2<sup>nd</sup> Edition, Simon Haykin and Barry Van Veen, John Wiley and Sons, 2004.
3. Signals and Systems, 1<sup>st</sup> Edition, V. Krishnaveni and A. Rajeshwari, Wiley-India, 2012.
4. Fundamentals of Signals and systems, special Indian Economy edition, Michael J Roberts, Tata McGraw Hill, , 2009.
5. Automatic Control Systems, 7<sup>th</sup> Edition, Benjamin C.Kuo, Pearson education.
6. Control Systems Principles and Design, 7<sup>th</sup> Edition, Madan Gopal, Tata McGraw hill,1997.
7. Control System Engineering, 3<sup>rd</sup> Edition, Normon, John Wiley & sons.

### **Web Resources**

1. NPTEL Course on Control Systems, Prof. C. S. Shankar Ram, IIT Madras  
[https://swayam.gov.in/nd1\\_noc20\\_ee90/preview](https://swayam.gov.in/nd1_noc20_ee90/preview)
2. NPTEL Course on Principles of Signals & Systems, Prof. Aditya K. Jagannatham, IIT Kanpur  
[https://swayam.gov.in/nd1\\_noc20\\_ee15/preview](https://swayam.gov.in/nd1_noc20_ee15/preview)
3. Signals and Systems Laboratory: Virtual Laboratory <http://ssl-iitg.vlabs.ac.in/>

## 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 introduce key innovation concepts, understand types of innovation, and explore the importance of creativity in business.             |
| 2      | To learn about the challenges and steps in managing innovation and understand divergent/convergent thinking and design thinking.        |
| 3      | To explore experimentation in innovation, foster idea champions, and understand co-creation and prototyping in product development.     |
| 4      | To understand business models, entrepreneurship, and strategies like Blue Ocean Strategy, and learn to address business model failures. |
| 5      | To learn about technological innovation management, sustainability in entrepreneurship, and the role of intellectual property (IPR).    |

### Course Outcomes

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

### Course Contents

| Module | Unit                                     | Detailed Contents | Hours |
|--------|------------------------------------------|-------------------|-------|
|        | Prerequisites                            |                   |       |
| 1      | Foundations of Innovation and Creativity |                   | 07    |

|                    |                                                                            |                                                                                                                                                                                                                                                                                                                                                                |           |
|--------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 1.1                                                                        | Analyzing the Current Business Scenario, Innovation and Creativity: An Introduction, Innovation in the Current Environment, Types of Innovation, School of Innovation.                                                                                                                                                                                         |           |
| <b>2</b>           | <b>Innovation Management and Design Thinking</b>                           |                                                                                                                                                                                                                                                                                                                                                                | <b>05</b> |
|                    | 2.1                                                                        | Challenges of Innovation, Steps of Innovation Management, Idea Management System, Divergent vs. Convergent Thinking, Design Thinking and Entrepreneurship.                                                                                                                                                                                                     |           |
| <b>3</b>           | <b>Experimentation, Co-Creation, and Prototyping</b>                       |                                                                                                                                                                                                                                                                                                                                                                | <b>05</b> |
|                    | 3.1                                                                        | Experimentation in Innovation Management, Idea Championship, Participation for Innovation, Co-Creation for Innovation, Prototyping to Incubation.                                                                                                                                                                                                              |           |
| <b>4</b>           | <b>Business Models, Entrepreneurship, and Strategies</b>                   |                                                                                                                                                                                                                                                                                                                                                                | <b>05</b> |
|                    | 4.1                                                                        | 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</b>           | <b>Technological Innovation, Sustainability, and Intellectual Property</b> |                                                                                                                                                                                                                                                                                                                                                                | <b>04</b> |
|                    | 5.1                                                                        | 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 identify real-world problems in society through observations and interaction with the community. |
| 2      | To propose technology-based solutions to societal issues.                                           |
| 3      | To provide exposure to interdisciplinary problem-solving and promote teamwork.                      |
| 4      | To enhance communication skills.                                                                    |

### Course Outcomes

|                              |                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                               |
| CO1                          | Interact with society at large and identify socio-economic issues prevalent in the society.   |
| CO2                          | Relate theoretical knowledge for generation of technological solutions to real-life problems. |
| CO3                          | Collaborate and contribute effectively in a team based activity.                              |
| CO4                          | Present their solutions in technical reports, presentations, and demonstrations.              |
| CO5                          | Recognise 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.

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

## 2.11 Environment & Technology (ILSHM\_CR3)

### Teaching Scheme

| Course Code | Course Name              | Contact Hours | Credits |
|-------------|--------------------------|---------------|---------|
| ILSHM_CR3   | 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 understand the interconnections between environmental science and technological advancements.                                                                                   |
| 2      | To investigate the role of sustainable technologies in mitigating environmental issues.                                                                                            |
| 3      | To study the concepts of renewable energy, waste management, pollution control, and conservation technologies, analyze and interpret environmental data using computational tools. |

### Course Outcomes

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

### Course Contents

| Module   | Unit                                                           | Detailed Contents | Hours     |
|----------|----------------------------------------------------------------|-------------------|-----------|
|          | <b>Prerequisites:</b>                                          |                   |           |
|          | Introductory courses in environmental Science and mathematics. |                   |           |
| <b>1</b> | <b>Introduction to Environment and Technology</b>              |                   | <b>04</b> |

|          |                                                                                                                                                                                                                                                                                                                                                                            |           |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | Environmental science & engineering and its significance, Definition and scope of technology in environmental context, Technological innovations in environmental protection and sustainability, History of environmental concerns and technological responses.                                                                                                            |           |
| <b>2</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>06</b> |
| <b>3</b> | <b>Solid Waste Management and Pollution Control Technologies</b><br>Solid waste management technologies: recycling, composting, and waste-to-energy, Electronic waste and hazardous waste management technologies, Role of information technology in waste management systems.                                                                                             | <b>06</b> |
| <b>4</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</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

### **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 Techniques and Algorithms (ET4PC\_CR1)

##### Teaching Scheme

| Course Code | Course Name                            | Contact Hours | Credits |
|-------------|----------------------------------------|---------------|---------|
| ET4PC_CR1   | Optimization Techniques and Algorithms | 03            | 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      | Understand the fundamentals of optimization and its engineering applications                                                      |
| 2      | Explore graphical approaches to solve optimization problems and determining optimal solutions for different constraint scenarios. |
| 3      | Learn linear programming (LP) techniques and their application to optimum design                                                  |
| 4      | Investigate advanced optimization algorithms and apply them to constrained and unconstrained problems                             |

##### Course Outcomes

|                              |                                                                                                                                                        |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                                        |
| CO1                          | Classify optimization problems and apply basic calculus concepts to formulate and solve real-world optimization problems.                              |
| CO2                          | Use graphical methods to solve optimization problems with constraints and accurately identify the optimal solution for different types of constraints. |
| CO3                          | Apply linear programming models and the simplex algorithm to solve optimization problems                                                               |
| CO4                          | Implement advanced optimization algorithms to solve both constrained and unconstrained optimization problems.                                          |

##### Course Contents

| Module   | Unit                                          | Detailed Contents                                                                                              | Hours     |
|----------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Pre-requisite</b>                          |                                                                                                                |           |
|          | .                                             |                                                                                                                |           |
| <b>1</b> | <b>Module1: Introduction to Optimization:</b> |                                                                                                                | <b>06</b> |
|          | 1.1                                           | Engineering application of Optimization – Statement of an Optimization problem – Optimal Problem formulation – |           |

|                    |                                                       |                                                                                                                                                                                                                           |           |
|--------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 1.2                                                   | Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria – Review of basic calculus concepts – Global optimality                                      |           |
| <b>2</b>           | <b>Graphical Approaches for Optimization Problems</b> |                                                                                                                                                                                                                           | <b>05</b> |
|                    | 2.1                                                   | Brief introduction of graphical approaches for Optimization, Plotting the Constraint Function, Plotting of Objective Function                                                                                             |           |
|                    | 2.2                                                   | Identification of Optimal Solution, Influence of Inequality and Equality Constraints.                                                                                                                                     |           |
| <b>3</b>           | <b>Linear programming methods for optimum design</b>  |                                                                                                                                                                                                                           | <b>06</b> |
|                    | 3.1                                                   | Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models, Graphical method for two variable optimization problem                                                          |           |
|                    | 3.2                                                   | Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems.                                                                        |           |
| <b>4</b>           | <b>Optimization algorithms</b>                        |                                                                                                                                                                                                                           | <b>06</b> |
|                    | 4.1                                                   | Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy’s steepest descent method, Newton’s method, Conjugate gradient method.                                            |           |
|                    | 4.2                                                   | Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method – Engineering applications of constrained and unconstrained algorithms.       |           |
| <b>5</b>           | <b>Modern methods of Optimization</b>                 |                                                                                                                                                                                                                           | <b>03</b> |
|                    | 5.1                                                   | Genetic Algorithms – Simulated Annealing – Ant colony optimization – Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications. Use of Matlab/Python to solve optimization problems. |           |
| <b>Total Hours</b> |                                                       |                                                                                                                                                                                                                           | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Engineering Optimization, Theory and Practice , 4<sup>th</sup> Edition, Rao S. S. , New Age International Publishers , 2012
2. Linear programming, G. Hadley, Narosa Publishing House, New Delhi, 2002.

### Reference Books

1. Optimization for Engineering Design Algorithms and Examples, Deb K., PHI, 2000
2. Introduction to Optimization Design, Arora J., Elsevier Academic Press, New Delhi, 2004
3. Manufacturing Optimization through Intelligent Techniques, Saravanan R., Taylor & Francis (CRC Press), 2006

## 3.2 Linear Integrated Circuits (ET4PC\_CR2)

## Teaching Scheme

| Course Code | Course Name                | Contact Hours | Credits |
|-------------|----------------------------|---------------|---------|
| ET4 PC_CR2  | Linear Integrated 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

|                              |                                                                                                                                |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                |
| CO1                          | Introduce the fundamental, characteristics, and configurations of operational amplifiers.                                      |
| CO2                          | Develop the ability to analyze and design linear and non-linear application using Op-amp.                                      |
| CO3                          | Familiarize student with the design and implementation of waveform generator and voltage regulators using integrated circuits. |
| CO4                          | Provide an understanding of the operation and applications of specialized ICs such as IC 555, 565, 566                         |

## Course Outcomes

|                              |                                                                                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                 |
| CO1                          | Outline, identify and classify all types of linear integrated circuits.                                                         |
| CO2                          | Understand and analyze the linear applications of Op-amp.                                                                       |
| CO3                          | Understand and analyze the non-linear applications of Op-amp.                                                                   |
| CO4                          | Illustrate the working principles of waveform generator, oscillator and specialized ICs such as voltage regulator, VCO and PCL. |
| CO5                          | Explain, analyze and Design different multivibrators using IC 555 and general purpose Op-amp.                                   |

## Course Contents

| Module   | Unit                                                                                | Detailed Contents                                                                                                                             | Hours     |
|----------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Pre-requisite</b>                                                                |                                                                                                                                               |           |
|          | Basic Electrical Engineering (FE-ESE-BEE),<br>Electronic Device Circuit (ET3PC_CR4) |                                                                                                                                               |           |
| <b>1</b> | <b>Introduction to Operational Amplifier</b>                                        |                                                                                                                                               | <b>07</b> |
|          | 1.1                                                                                 | Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.                                                                       |           |
|          | 1.2                                                                                 | Configurations of Op-Amp: Open loop and closed loop configurations of Op-amp, Inverting and Non-inverting configuration of Op-amp and buffer. |           |
|          | 1.3                                                                                 | Summing amplifier, Scaling amplifier, averaging, Difference amplifiers and Instrumentation amplifier using Op-amp.                            |           |
| <b>2</b> | <b>Linear Applications of Operational Amplifier</b>                                 |                                                                                                                                               | <b>07</b> |
|          | 2.1                                                                                 | Voltage to Current (V to I) and Current to Voltage (I to V) converter.                                                                        |           |

|                    |                                                         |                                                                                                                                                             |           |
|--------------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 2.2                                                     | Op-amp Integrator & Differentiator (ideal & practical).                                                                                                     |           |
| <b>3</b>           | <b>Non-Linear Applications of Operational Amplifier</b> |                                                                                                                                                             | <b>08</b> |
|                    | 3.1                                                     | Comparators: Inverting comparator, non-inverting comparator, zero crossing detector (ZCD) , window detector.                                                |           |
|                    | 3.2                                                     | Regenerative Comparator or Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.                                                      |           |
| <b>4</b>           | <b>Waveform Generators and Special Function ICs</b>     |                                                                                                                                                             | <b>08</b> |
|                    | 4.1                                                     | IC Voltage regulators – Three terminal fixed (IC 78XX, 79XX) and adjustable voltage regulators – IC 723 general purpose regulator (LVLC and HVHC regulator) |           |
|                    | 4.2                                                     | Special purpose IC: IC-566 voltage-controlled oscillator IC, 565-phaselocked loop                                                                           |           |
| <b>5</b>           | <b>Timer IC 555 and it's applications</b>               |                                                                                                                                                             | <b>08</b> |
|                    | 5.1                                                     | Functional block diagram and working of IC 555                                                                                                              |           |
|                    | 5.2                                                     | Design of Astable and Monostable multivibrator using IC 555                                                                                                 |           |
|                    | 5.3                                                     | Applications of Astable and Monostable                                                                                                                      |           |
| <b>Total Hours</b> |                                                         |                                                                                                                                                             | <b>39</b> |

## Suggested Learning Resources

### Textbooks

1. Ramakant A. Gayakwad, “*Op-Amps and Linear Integrated Circuits*”, Pearson Prentice Hall, 4<sup>th</sup> Edition.
2. D. Roy Choudhury and S. B. Jain, “*Linear Integrated Circuits*”, New Age International Publishers, 4<sup>th</sup> Edition.

### Reference Books

1. K. R. Botkar, “*Integrated Circuits*”, Khanna Publishers (2004)
2. Sergio Franco, “*Design with operational amplifiers and analog integrated circuits*”, Tata McGraw Hill, 3<sup>rd</sup> Edition.
3. David A. Bell, “*Operation Amplifiers and Linear Integrated Circuits*”, Oxford University Press, Indian Edition.
4. R. F. Coughlin and F. F. Driscoll, “*Operation Amplifiers and Linear Integrated Circuits*”, Prentice Hall, 6<sup>th</sup> Edition.
5. J. Millman, Christos C. Halkias and Satyabrata Jit “*Millman's Electronic Devices and Circuits*”, McGraw Hill 3<sup>rd</sup> Edition.

### Web Resources

1. NPTEL course on ICs MOSFETs Op-Amps & Their Applications, Prof. Hardik Jeetendra Pandya, IISc Bangalore [https://swayam.gov.in/nd1\\_noc20\\_ee13/preview](https://swayam.gov.in/nd1_noc20_ee13/preview)

## 3.3 Linear Integrated Circuits Lab (ET4PC\_LR2)

### Teaching Scheme

| Course Code | Course Name                    | Contact Hours | Credits |
|-------------|--------------------------------|---------------|---------|
| ET4PC_LR2   | Linear Integrated 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      | Understanding Basic op-amp characteristics and parameters.                                |
| 2      | Develop skills in constructing and testing analog circuits using IC 741, 555, 565         |
| 3      | Designing Linear and non-linear circuits using op-amp                                     |
| 4      | Familiarize students with simulation tools (Multisim, LTSpice) for analog circuit design. |
| 5      | Apply theoretical concepts to practical analog system design problems.                    |

## Course Outcomes

|                              |                                                                                                                                     |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                     |
| CO1                          | Demonstrate understanding of Op-amp fundamentals and related IC parameters through experiments.                                     |
| CO2                          | Design and realize linear circuits such as amplifiers, integrators, differentiators using Op-amp.                                   |
| CO3                          | Construct and test nono-linear circuits such as comparators, Schmitt triggers and ZCD.                                              |
| CO4                          | Implement practical application using voltage regulator (IC 723, 78xx, 79xx)                                                        |
| CO5                          | Use simulation tools to design, test and verify the performance of analog circuits and compare result with hardware implementation. |

## Course Contents

| Sr.No. | Title                                                                                                  |
|--------|--------------------------------------------------------------------------------------------------------|
| 1.     | Basic Closed Loop Configuration of Operational Amplifier (Opamp) Inverting and Non-inverting amplifier |
| 2.     | Basic Closed Loop Configuration of Operational Amplifier as inverting adder and subtractor             |
| 3.     | Study of Integrator using Op-Amp IC 741                                                                |
| 4.     | Study of Differentiator using Op-Amp IC 741                                                            |
| 5.     | Study of Second-order LPF Active Butterworth Filter using Op-Amp                                       |
| 6.     | Study of Second-order HPF Active Butterworth Filter using Op-Amp                                       |
| 7.     | Regenerative Comparator or Schmitt Trigger using Op-Amp                                                |
| 8.     | Astable Multivibrator Using IC 741                                                                     |
| 9.     | Waveform Generator using IC 741                                                                        |
| 10.    | Astable Multivibrator Using IC 555                                                                     |
| 11.    | Monostable Multivibrator Using IC 555                                                                  |
| 12.    | Study of Low voltage low current voltage regulator using IC 723                                        |
| 13.    | Study of LM 317 as adjustable voltage regulator                                                        |
| 14.    | Simulation of Integrator using Op-Amp IC 741                                                           |
| 15.    | Simulation of differentiator using Op-Amp IC 741                                                       |
| 16.    | Simulation of Second-order LPF Active Butterworth Filter using Op-Amp                                  |
| 17.    | Simulation of Regenerative Comparator                                                                  |

|     |                                                      |
|-----|------------------------------------------------------|
| 18. | Simulation of Astable Multivibrator Using IC 555     |
| 19. | Simulation of Monostable Multivibrator Using IC 555  |
| 20. | Simulation of LM 317 as adjustable voltage regulator |

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

## Suggested Learning Resources

1. Ramakant A. Gayakwad, “*Op-Amps and Linear Integrated Circuits*”, Pearson Prentice Hall, 4<sup>th</sup> Edition.
2. D. Roy Choudhury and S. B. Jain, “*Linear Integrated Circuits*”, New Age International Publishers, 4<sup>th</sup> Edition.

## Reference Books

1. K. R. Botkar, “*Integrated Circuits*”, Khanna Publishers (2004)
2. Sergio Franco, “*Design with operational amplifiers and analog integrated circuits*”, Tata McGraw Hill, 3<sup>rd</sup> Edition.
3. David A. Bell, “*Operation Amplifiers and Linear Integrated Circuits*”, Oxford University Press, Indian Edition.
4. R. F. Coughlin and F. F. Driscoll, “*Operation Amplifiers and Linear Integrated Circuits*”, Prentice Hall, 6<sup>th</sup> Edition.
5. J. Millman, Christos C. Halkias and Satyabrata Jit “*Millman's Electronic Devices and Circuits*”, McGraw Hill 3<sup>rd</sup> Edition.

## Web Resources

1. NPTEL course on ICs MOSFETs Op-Amps & Their Applications, Prof. Hardik Jeetendra Pandya, IISc Bangalore [https://swayam.gov.in/nd1\\_noc20\\_ee13/preview](https://swayam.gov.in/nd1_noc20_ee13/preview)

### 3.4 Microcontroller and Applications (ET4PC\_CR3)

#### Teaching Scheme

| Course Code | Course Name                      | Contact Hours | Credits |
|-------------|----------------------------------|---------------|---------|
| ET4PC_CR3   | Microcontroller and Applications | 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 Learn fundamentals of Microprocessor and Microcontrollers                    |
| 2      | To write Assembly Language Programming for 8051 microcontroller I/O Interfacing |
| 3      | To learn Interrupts, Timers and counters,                                       |
| 4      | To study basics of 32 bit Microcontroller                                       |

#### Course Outcomes

|                              |                                                                                                          |
|------------------------------|----------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                          |
| CO1                          | <i>Understand</i> fundamentals of microprocessor and Microcontrollers, 8086 architecture                 |
| CO2                          | <i>Develop</i> the basic knowledge and core expertise in 8051 microcontroller                            |
| CO3                          | <i>Write</i> assembly language program to Interface various peripheral devices with 8051 microcontroller |
| CO4                          | <i>Design</i> an applications in 8051 Microcontrollers                                                   |
| CO5                          | <i>Develop</i> the basic knowledge and core expertise in ARM7 microcontroller                            |

#### Course Contents

| Module   | Unit                                  | Detailed Contents                                                                                                                                                                            | Hours     |
|----------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Pre-requisite</b>                  |                                                                                                                                                                                              |           |
|          | Digital Logic Design                  |                                                                                                                                                                                              |           |
| <b>1</b> | <b>Introduction to Microprocessor</b> |                                                                                                                                                                                              | <b>07</b> |
|          | 1.1                                   | Block diagram of microprocessor based system: CPU, I/O Devices, Memory, Concept of Address, Data and Control Bus, Overview of 8085 microprocessor                                            |           |
|          | 1.2                                   | Introduction to 8086 microprocessor.<br>Overview of 8086 CPU Architecture & Organization, Registers, Instruction Prefetch, ALU, Control unit, 8bit / 16bit / 32 bit microprocessor features. |           |
| <b>2</b> | <b>8051 Microcontroller</b>           |                                                                                                                                                                                              | <b>07</b> |
|          | 2.1                                   | Features, Architecture of 8051, Pin Configuration, Comparison between Microprocessor and Microcontroller                                                                                     |           |

|                    |                                                            |                                                                                                                                                                                                                  |           |
|--------------------|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 2.2                                                        | Machine Cycle, 8051 flag bits and the PSW register, 8051 register banks Program counter, data pointer registers, stack and stack pointer, Special function registers, Memory Organization, Data & Program Memory |           |
|                    | 2.3                                                        | Machine Cycle, Timers and counters, Timers Modes & Operations, , Basic of Interrupts, 8051 Interrupt structure, hardware interrupts, Interrupt Programming                                                       |           |
|                    | 2.4                                                        | Basics of Serial Communication, Modes of Serial Communication, Programming Serial Communication using UART                                                                                                       |           |
| <b>3</b>           | <b>8051 Assembly Language Programming and Interfacing:</b> |                                                                                                                                                                                                                  | <b>05</b> |
|                    | 3.1                                                        | Addressing Modes ,Data types and Assembler directives                                                                                                                                                            |           |
|                    | 3.2                                                        | Overview of 8051 Instruction set: Data Transfer Instructions, Arithmetic and Logic Instructions, Loop & Jump instructions, Call instructions, Bit manipulation Instructions,                                     |           |
|                    | 3.3                                                        | Programming I/O Port, Timer, Serial communication                                                                                                                                                                |           |
| <b>4</b>           | <b>8051 Peripheral Interfacing</b>                         |                                                                                                                                                                                                                  | <b>05</b> |
|                    | 4.1                                                        | Relay Interfacing ,LED, Seven Segment, LCD Display Stepper Motor                                                                                                                                                 |           |
| <b>5</b>           | <b>ARM7: A 32-bit Core Architecture</b>                    |                                                                                                                                                                                                                  | <b>05</b> |
|                    | 5.1                                                        | Comparison between CISC & RISC, Features of ARM core architecture                                                                                                                                                |           |
|                    | 5.2                                                        | Data Flow Model, 3 Stage Pipeline                                                                                                                                                                                |           |
|                    | 5.3                                                        | Registers, operating modes.                                                                                                                                                                                      |           |
| <b>Total Hours</b> |                                                            |                                                                                                                                                                                                                  | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Microprocessors & Interfacing, Douglas V Hall, SSSP Rao, McGraw Hill
2. Microcontrollers: Theory and Applications, 6 th Edn, Ajay Deshmukh, Tata McGraw Hill Publication.
3. The 8051 Microcontroller & Embedded systems, 2 nd Edn, M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, Pearson Publication.
4. Embedded Systems: An Integrated Approach, 1 st Edn, Lyla Das, Pearson Publication Power Electronics Mohan Ned, John Wiley & Sons Inc.

### Reference Books

1. Microprocessors and Interfacing 8085, Douglas V Hall, Tata Mc Gram Hill
2. 8051 Microcontroller, Ayala, Cengage (Thomson)
3. The 8086/8088 Family, John Uffenbuck, Pearson Media,LPE
4. ARM System Developer's Guide, Andrew N Sloss, Domnic SYMES

### Web Resources

1. NPTEL Course on Microcontroller and Applications, Dr. S.P. Das, IIT Kanpur  
<https://nptel.ac.in/courses/117/104/117104072/>
1. NPTEL, [https://onlinecourses.nptel.ac.in/noc22\\_ee116/preview](https://onlinecourses.nptel.ac.in/noc22_ee116/preview)
2. NPTEL, <https://archive.nptel.ac.in/courses/106/105/106105032/>

### **3.5 Microprocessor and Applications Lab (ET4PC\_LR3)**

#### **Teaching Scheme**

| Course Code | Course Name                          | Contact Hours | Credits |
|-------------|--------------------------------------|---------------|---------|
| ET4 PC_LR3  | Microcontroller and Applications 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 Learn fundamentals of Microprocessor and Microcontrollers.                    |
| 2      | To write Assembly Language Programming for 8051 microcontroller I/O Interfacing. |
| 3      | To learn Interrupts, Timers and counters.                                        |
| 4      | To study basics of 32 bit Microcontroller.                                       |

## Course Outcomes

|                              |                                                                                                     |
|------------------------------|-----------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                     |
| CO1                          | Understand fundamentals of microprocessor and Microcontrollers, 8086 architecture.                  |
| CO2                          | Develop the basic knowledge and core expertise in 8051 microcontrollers.                            |
| CO3                          | Write assembly language program to Interface various peripheral devices with 8051 microcontroller . |
| CO4                          | To interface various peripherals with 8051 microcontroller.                                         |
| CO5                          | Design an applications in 8051 Microcontrollers.                                                    |

## Course Contents

| Sr. No. | Title of the Experiment:                                 |
|---------|----------------------------------------------------------|
| 1       | Arithmetic Operations in 8051 Microcontroller            |
| 2       | Transfer of Data Bytes from Internal RAM to External RAM |
| 3       | Ascending Order                                          |
| 4       | i) Largest & smallest number<br>ii) Delay Subroutine     |
| 5       | Timer Programming(LED Interfacing)                       |
| 6       | Serial Communication                                     |
| 7.      | Relay Interfacing                                        |
| 8       | Seven Segment Interfacing                                |
| 9.      | LCD Interfacing                                          |
| 10.     | MiniProject in 8051 Microcontrollers                     |

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. Douglas V Hall, SSSP Rao “Microprocessors & Interfacing”, McGraw Hill
2. Ajay Deshmukh, Microcontrollers: Theory and Applications, 6 th Edn, Tata McGraw Hill

Publication.

3. The 8051 Microcontroller & Embedded systems, 2<sup>nd</sup> Edn., M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, Pearson Publication.
4. Embedded Systems: An Integrated Approach, 1<sup>st</sup> Edn, Lyla Das, Pearson Publication Power Electronics Mohan Ned, John Wiley & Sons Inc.

### **Reference Books**

1. Microprocessors and Interfacing 8085, Douglas V Hall, Tata Mc Gram Hill
2. 8051 Microcontroller, Ayala, Cengage (Thomson)
3. The 8086/8088 Family, John Uffenbuck, Pearson Media,LPE
4. ARM System Developer's Guide, Andrew N Sloss, Domnic SYMES

## 3.6 Object Oriented Programming with Java (ET4VS\_LR1)

### Teaching Scheme

| Course Code | Course Name                            | Contact Hours | Credits |
|-------------|----------------------------------------|---------------|---------|
| ET4VS_LR1   | Object Oriented Programming using JAVA | 04            | 02      |

### Examination and Evaluation Scheme

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

### Course Objectives

| S. No. | Objectives                                                                                                                    |
|--------|-------------------------------------------------------------------------------------------------------------------------------|
| 1      | Understand the fundamental concepts of Object-Oriented Programming (OOP) and its advantages over other programming paradigms. |
| 2      | Apply OOP concepts such as classes, objects, inheritance, and polymorphism to develop Java programs.                          |
| 3      | Analyze the use of exception handling, multithreading, and file handling in Java for robust and efficient programming.        |
| 4      | Create web-based Java applications using applets, servlets, and Java Server technologies.                                     |

### Course Outcomes

|                              |                                                                                                                       |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                       |
| CO1                          | Explain the need for Object-Oriented Programming and differentiate it from other paradigms.                           |
| CO2                          | Implement Java classes, methods, and inheritance concepts to build object-oriented applications.                      |
| CO3                          | Demonstrate exception handling, multithreading, and file handling techniques to manage program execution effectively. |
| CO4                          | Evaluate Java-based packages, interfaces, and access control mechanisms to enhance code reusability and security.     |
| CO5                          | Develop interactive Java-based web applications using Java Script and servlets.                                       |

### Course Contents

| Module | Unit                                                                                                                                                                                                             | Detailed Contents          | Hours |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------|
|        | <b>Pre-requisite</b>                                                                                                                                                                                             |                            |       |
|        | Python Programming Language                                                                                                                                                                                      |                            |       |
|        | <b>1</b>                                                                                                                                                                                                         | <b>Introduction to OOP</b> |       |
| 1.1    | Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm : Procedural, Object Oriented, Functional and Logic & Rule based, Basic Concepts of Object-Oriented Programming, Benefits of OOP |                            |       |
| 1.2    | Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Difference between C++ and Java.                                   |                            |       |

|                    |                                                    |                                                                                                                                                                                                                                                                            |           |
|--------------------|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>2</b>           | <b>Object Oriented Programming</b>                 |                                                                                                                                                                                                                                                                            | <b>12</b> |
|                    | 2.1                                                | Classes and Methods: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword                                                                                                 |           |
|                    | 2.2                                                | Garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments.                                          |           |
|                    | 2.3                                                | Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, String Class: Operation on String, Mutable & Immutable String, Using Collection Bases Loop for String, Tokenizing a String, Creating Strings using StringBuffer .                             |           |
| <b>3</b>           | <b>Extending Classes: Inheritance and Packages</b> |                                                                                                                                                                                                                                                                            | <b>10</b> |
|                    | 3.1                                                | Inheritances: Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class.                                                             |           |
|                    | 3.2                                                | Packages and Interfaces: defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.                         |           |
| <b>4</b>           | <b>Exception Handling and Multithreading</b>       |                                                                                                                                                                                                                                                                            | <b>10</b> |
|                    | 4.1                                                | Exception Handling: fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception sub classes).                                |           |
|                    | 4.2                                                | Managing I/O: Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class.                                                                                                                      |           |
|                    | 4.3                                                | Threading: Introduction, Thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread, Thread Priorities, Synchronizing Threads, Inter Communication of Threads, Critical Factor in Thread –DeadLock |           |
| <b>5</b>           | <b>JAVA server technologies</b>                    |                                                                                                                                                                                                                                                                            | <b>10</b> |
|                    | 5.1                                                | Web Application Basics, Architecture and challenges of Web Application, Introduction to servlet, Servlet life cycle, Developing and Deploying Servlets, Exploring Deployment, Descriptor (web.xml), Handling Request and Response.                                         |           |
|                    | 5.2                                                | Introduction to JAVA script : Syntax and Basics, Function and event handling, Document Object Model Manipulation                                                                                                                                                           |           |
| <b>Total Hours</b> |                                                    |                                                                                                                                                                                                                                                                            | <b>48</b> |

## 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>

### 3.7 Business Forecasting (IL4HM\_CR1)

#### Teaching Scheme

| Course Code | Course Name          | Contact Hours | Credits |
|-------------|----------------------|---------------|---------|
| IL4HM_CR1   | 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     |
|------------|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Prerequisites: Nil</b>                                        |                                                                                                           |           |
| <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 Data Structures (CE4MM\_CX1)

#### Teaching Scheme

| Course Code | Course Name     | Contact Hours | Credits |
|-------------|-----------------|---------------|---------|
| CE4MM_CX1   | Data Structures | 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> the role and importance of data structures in solving computational problems.   |
| 2      | To <i>learn</i> the basic concepts and implementations of linear and non-linear data structures.     |
| 3      | To <i>analyze</i> different data structures to choose appropriate solutions for real-world problems. |
| 4      | To <i>understand</i> techniques for effective data representation and organization.                  |
| 5      | To Gain familiarity with fundamental searching, sorting, and hashing techniques.                     |
| 6      | To <i>understand</i> the role and importance of data structures in solving computational problems.   |

#### Course Outcomes

|                              |                                                                                                                                              |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                              |
| CO1                          | <i>implement</i> and differentiate between Linear and Non-Linear data structures.                                                            |
| CO2                          | <i>demonstrate</i> a thorough understanding of the behavior of basic data structures like arrays and use it to implement Stack and Queue ADT |
| CO3                          | <i>handle</i> operations like insertion, deletion, searching and traversing on linked list and develop applications using linked list        |
| CO4                          | <i>solve</i> problems using the appropriate type of trees and will be able to apply the concept of graphs for the real time applications.    |
| CO5                          | <i>implement</i> sorting algorithms and select the appropriate searching technique for a given problem.                                      |

#### Course Contents

| Module | Unit                                                                 | Detailed Contents | Hours    |
|--------|----------------------------------------------------------------------|-------------------|----------|
|        | <b>Prerequisites C Programming Language</b>                          |                   |          |
| 1.0    | <b>Introduction to Data Structures and Abstract Data Types (ADT)</b> |                   | <b>5</b> |

|                    |                                       |                                                                                                                                                                                                                                                               |           |
|--------------------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | <b>1.1</b>                            | Introduction to Data Structures, Concept of ADT, Types of Data Structures- Linear and Nonlinear, Primitive and Non-Primitive, Basic operations on Data Structures.                                                                                            |           |
|                    | <b>1.2</b>                            | Array data structure, Applications of Data Structures, real-life examples of stacks, queues, linked lists, trees, and graphs                                                                                                                                  |           |
| <b>2.0</b>         | <b>Stacks and Queues</b>              |                                                                                                                                                                                                                                                               | <b>5</b>  |
|                    | <b>2.1</b>                            | Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack: Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation,                                                                     |           |
|                    | <b>2.2</b>                            | Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Overview of Priority Queue and Double Ended Queue, Applications of Queue.                                                                      |           |
| <b>3.0</b>         | <b>Linked Lists</b>                   |                                                                                                                                                                                                                                                               | <b>5</b>  |
|                    | <b>3.1</b>                            | Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked Lists - Singly Linked List, Circular Linked List, Doubly Linked List                                                                                                      |           |
|                    | <b>3.2</b>                            | Operations on Singly Linked List and Doubly Linked List                                                                                                                                                                                                       |           |
|                    | <b>3.3</b>                            | Stack and Queue using Singly Linked List, Singly Linked List Application: Polynomial Representation and Addition                                                                                                                                              |           |
| <b>4.0</b>         | <b>Trees and Graphs</b>               |                                                                                                                                                                                                                                                               | <b>6</b>  |
|                    | <b>4.1</b>                            | Trees: Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Simple applications of Binary Tree - Expression Tree, Huffman Encoding, |           |
|                    | <b>4.2</b>                            | Graphs: Introduction, Graph Terminologies, Graph representation: Matrix and Adjacency list, Graph Traversals- Depth First Search (DFS) and Breadth First Search (BFS)                                                                                         |           |
| <b>5.0</b>         | <b>Sorting, Searching and Hashing</b> |                                                                                                                                                                                                                                                               | <b>5</b>  |
|                    | <b>5.1</b>                            | Basic Sorting and Searching Algorithm: Bubble Sort, Linear Search and Binary Search                                                                                                                                                                           |           |
|                    | <b>5.2</b>                            | Hashing-Concept, Hash Functions, Collision Resolution                                                                                                                                                                                                         |           |
| <b>Total Hours</b> |                                       |                                                                                                                                                                                                                                                               | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, "Data Structures Using C", 2<sup>nd</sup> Edition, Pearson Publication
2. Reema Thareja, "Data Structures using C," 2<sup>nd</sup> Edition, Oxford Press.
3. Richard F. Gilberg and Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C," 2<sup>nd</sup> Edition, Cengage Learning.
4. Jean Paul Tremblay, P. G. Sorenson, "Introduction to Data Structure and Its Applications," 2<sup>nd</sup> Edition, McGraw-Hill Education
5. Data Structures Using C, ISRD Group, 2<sup>nd</sup> Edition, Tata McGraw-Hill.

### Reference Books

1. Prof. P. S. Deshpande, Prof. O. G. Kakde, “C and Data Structures”, 3<sup>rd</sup> Edition DreamTech press.
2. E. Balagurusamy, “Data Structure Using C,” 4<sup>th</sup> Edition, Tata McGraw-Hill Education India.
3. Rajesh K Shukla, “Data Structures using C and C++,” 2<sup>nd</sup> Edition, Wiley-India
4. GAV PAI, “Data Structures,” Schaum’s Outlines.
5. Robert Kruse, C. L. Tondo, Bruce Leung, “Data Structures and Program Design in C,” 2<sup>nd</sup> Edition, Pearson.

### Web Resources

1. NPTEL Programming and Data Structures (IIT Madras)  
<https://nptel.ac.in/courses/106106130>
2. Data Structures and Algorithms Design (NPTEL)  
[https://onlinecourses.nptel.ac.in/noc25\\_cs81/preview](https://onlinecourses.nptel.ac.in/noc25_cs81/preview)
3. Tutorialspoint – Data Structures & Algorithms  
[https://www.tutorialspoint.com/data\\_structures\\_algorithms/index.htm](https://www.tutorialspoint.com/data_structures_algorithms/index.htm)
4. W3Schools DSA Tutorial <https://www.w3schools.com/dsa/>

## 3.8.2 Database and Management System (IT4MM\_CX1)

### Teaching Scheme

| Course Code | Course Name                | Contact Hours | Credits |
|-------------|----------------------------|---------------|---------|
| IT4MM_CX1   | Database Management System | 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>teach</i> the basic concepts of Database Management System                    |
| 2      | To <i>introduce</i> the conceptual data model and designing ER and EER diagrams     |
| 3      | To <i>teach</i> relational algebra and formulation of SQL queries                   |
| 4      | To <i>demonstrate</i> normalization for database                                    |
| 5      | To <i>discuss</i> transaction processing, concurrency control & recovery techniques |

### Course Outcomes

|                              |                                                                          |
|------------------------------|--------------------------------------------------------------------------|
| The student will be able to: |                                                                          |
| CO1                          | <i>discuss</i> the basic concepts of Database Management System          |
| CO2                          | <i>design</i> conceptual data models for real life applications          |
| CO3                          | <i>write</i> relational algebra queries and <i>formulate</i> SQL queries |
| CO4                          | <i>apply</i> the concept of normalization to relational database design  |
| CO5                          | <i>describe</i> the concept of transaction, concurrency and recovery     |

### Course Contents

| Module | Unit                                                  | Detailed Contents                                                                                                                            | Hours |
|--------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------|
|        | Pre-requisite: None                                   |                                                                                                                                              |       |
| 1      | Database System Concepts and Architecture             |                                                                                                                                              | 05    |
|        | 1.1                                                   | Basics of file systems, definition of databases, history of database system, characteristics of databases, file system v/s database system   |       |
|        | 1.2                                                   | Data abstraction and data independence                                                                                                       |       |
|        | 1.3                                                   | DBMS system architecture, Database Administrator (DBA), Role of DBA                                                                          |       |
|        | Self-learning topics: Identify the types of databases |                                                                                                                                              |       |
| 2      | The Entity- Relationship Model & Relational Model     |                                                                                                                                              | 05    |
|        | 2.1                                                   | The Entity- Relationship (ER) Model, entity type, entity sets, attributes and keys, Relationship types, relationship sets, weak entity types |       |
|        | 2.2                                                   | Extended Entity-Relationship (EER) Model - Generalization, Specialization and Aggregation                                                    |       |

|          |                                                                                                            |                                                                                                                                                                                                                            |           |
|----------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | 2.3                                                                                                        | Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Key, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model             |           |
|          | <b>Self-learning topics:</b> Design an ER model for any real time case study.                              |                                                                                                                                                                                                                            |           |
| <b>3</b> | <b>Relational Algebra &amp; Structured Query Language (SQL)</b>                                            |                                                                                                                                                                                                                            | <b>06</b> |
|          | 3.1                                                                                                        | Introduction to Relational Algebra: Relational Algebra expressions for - Unary relational operations, Set theory operations, Binary relational operations, Relational algebra queries                                      |           |
|          | 3.2                                                                                                        | Overview of SQL, Data definition commands, set operations, aggregate function, null values, Data manipulation commands, Data control commands, complex retrieval queries using Group By, recursive queries, nested queries |           |
|          | 3.3                                                                                                        | Integrity constraints in SQL, Event Condition Action (ECA) model (Triggers) in SQL, Database Programming with JDBC, Functions and Procedures in SQL                                                                        |           |
|          | <b>Self-learning topics:</b> Physical design of database for the relational model                          |                                                                                                                                                                                                                            |           |
| <b>4</b> | <b>Relational–Database Design</b>                                                                          |                                                                                                                                                                                                                            | <b>05</b> |
|          | 4.1                                                                                                        | Design guidelines for relational schema, Functional Dependencies                                                                                                                                                           |           |
|          | 4.2                                                                                                        | Normalization: The need for normalization, Definition of Normal Forms-1NF, 2NF, Definition of Normal Forms- 3NF, BCNF                                                                                                      |           |
|          | 4.3                                                                                                        | Converting Relational Schema to higher normal forms                                                                                                                                                                        |           |
|          | <b>Self-learning topics:</b> Normalization up to 3NF/BCNF on real time application                         |                                                                                                                                                                                                                            |           |
| <b>5</b> | <b>Transactions Management, Concurrency and Recovery</b>                                                   |                                                                                                                                                                                                                            | <b>05</b> |
|          | 5.1                                                                                                        | Transaction: Transaction concept, State Diagram, ACID Properties, Transaction Control Commands                                                                                                                             |           |
|          | 5.2                                                                                                        | Concurrent Executions, Serializability – Conflict and View, Concurrency Control protocols: Lock-based-protocols                                                                                                            |           |
|          | 5.3                                                                                                        | Deadlock handling and Timestamp-based protocols, Recovery System: Recovery Concepts, Log based recovery                                                                                                                    |           |
|          | <b>Self-learning topics:</b> Study the various deadlock situations which may occur for a database designed |                                                                                                                                                                                                                            |           |
|          |                                                                                                            | <b>Total Hours</b>                                                                                                                                                                                                         | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Korth, Silberchatz, Sudarshan, Database System Concepts, 6<sup>th</sup> Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6<sup>th</sup> Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

### Reference Books

1. Peter Rob and Carlos Coronel, — Database Systems Design, Implementation and Management, Thomson Learning, 9<sup>th</sup> Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : “Database Management Systems”, McGraw – Hill

### Web Resources

1. NPTEL Course, Database Management Systems, by Prof. Partha Pratim Das, <https://nptel.ac.in/courses/106/105/106105175/>

### 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 introduce students to the history, evolution, and significance of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs). |
| 2      | To familiarize students with various drivetrain topologies and power flow analysis in EVs and HEVs                                |
| 3      | To impart knowledge about different energy sources, storage systems, and propulsion technologies used in EVs.                     |
| 4      | To provide an overview of autonomous electric vehicles, their core technologies, and future trends.                               |
| 5      | To analyze 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>1</b> | <b>1.0 History and Evolution of Electric Vehicles</b> |                                                                                                                                                                                             | <b>05</b> |
|          | 1.1                                                   | <b>History of EVs:</b> Basics of vehicles mechanisms, history of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV,                              |           |
|          | 1.2                                                   | <b>Need and Importance of EVs:</b> 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</b>           | <b>2.0 Drive train Topology</b>                                   |                                                                                                                                                                                                                                                                                                                                                      | <b>05</b> |
|                    | 2.1                                                               | <b>Vehicle Transmission:</b> Configurations of Electric Vehicles and Various electric drive-train topologies.                                                                                                                                                                                                                                        |           |
|                    | 2.2                                                               | <b>Hybrid Electric Vehicles:</b> Concept of Hybrid Electric Drivetrains system, various hybrid drive-train topologies. Power flow control in drive-train topologies, fuel efficiency analysis.                                                                                                                                                       |           |
| <b>3</b>           | <b>3.0 Energy sources and Propulsion of EVs.</b>                  |                                                                                                                                                                                                                                                                                                                                                      | <b>06</b> |
|                    | 3.1                                                               | <b>Peaking Power Sources and Energy Storage:</b> 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                                                               | <b>DC and AC Machines for Propulsion Applications:</b> Electric system components for EV/HEV, types and suitability of DC and AC machines for EV/HEV applications.                                                                                                                                                                                   |           |
| <b>4</b>           | <b>4.0 Overview of autonomous Electric Vehicles</b>               |                                                                                                                                                                                                                                                                                                                                                      | <b>05</b> |
|                    | 4.1                                                               | <b>Introduction to Autonomous Vehicles:</b> Autonomous Vehicles, Core Technologies Behind Autonomous Vehicles                                                                                                                                                                                                                                        |           |
|                    | 4.2                                                               | <b>Synergy Between Autonomous Systems and EVs:</b> Benefits of Autonomous Electric Vehicles, Challenges in Developing Autonomous Electric Vehicles, Current and Future Trends in Autonomous EVs.                                                                                                                                                     |           |
| <b>5</b>           | <b>5.0 Indian Government Policies for Electric Vehicles (EVs)</b> |                                                                                                                                                                                                                                                                                                                                                      | <b>05</b> |
|                    | 5.1                                                               | <b>Introduction to Electric Vehicle Policies in India:</b> 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. I. Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press. 2005
3. Sheldon Williamsom, Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, Springer 2013
4. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003

### Reference Books

1. B. K Bose, Modern Power Electronics and AC Drives, Pearson Education 2002
2. C. MI, M. Abul and D. W. Gao, Hybrid Electrical Vehicle Principles and Application with Practical Perspectives, Wiley 2011
3. Robert A. Huggins, Energy Storage, Springer 2010
4. NPTEL/ Swayam Course: Intro. to Hybrid and Electric Vehicles - Prof. Praveen Kumar & Prof. S. Majhi (IIT Guwahati): <https://nptel.ac.in/courses/108/103/108103009>

### Web Resources

1. EV – Vehicle Dynamics and Electric Motor Drives, IIT Delhi,  
[https://onlinecourses.nptel.ac.in/noc24\\_ee30/preview](https://onlinecourses.nptel.ac.in/noc24_ee30/preview)
2. Electric Vehicles and Renewable Energy, 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 | 2             | 2       |

#### 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 introduce the fundamentals and classifications of Additive Manufacturing (AM) technologies.              |
| 2      | To provide knowledge of various AM systems including liquid-based, solid-based, and powder-based processes. |
| 3      | To develop understanding of AM machine specifications, working principles, and process parameters.          |
| 4      | To familiarize 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 |
|--------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1      | <b>Additive Manufacturing</b> |                                                                                                                                                                                                | 5     |
|        | 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. |       |
| 2      | <b>Liquid-based systems</b>   |                                                                                                                                                                                                | 5     |
|        | 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</b> | <b>Solid-based systems:</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>5</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</b> | <b>Powder-Based Systems:</b>                |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>5</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>6</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</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Dr R. B. Chaudary, Additive Manufacturing, 1st Edition, Khanna Publishers, (2022).
2. Chua Chee Kai and Kah Fai Leong, Rapid Prototyping: Principles and Applications, 2nd Edition, Tata McGraw-Hill (2018).

### Reference Books

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

### Web Resources

1. SWAYAM Course, Fundamentals of Additive Manufacturing Technologies, Prof. 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    |
|----------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|          |      | <b>Prerequisites:</b><br>Physics of Motion, Coordinate geometry                                                                                                                                                                     | --       |
| <b>1</b> |      | <b>History and Concepts in Robotics</b>                                                                                                                                                                                             | <b>5</b> |
|          | 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</b> | <b>Sensors and Actuators</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>5</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</b> | <b>Robot End Effectors</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>5</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</b> | <b>Robot Classification</b>                          |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>5</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</b> | <b>Ethical and Safety Considerations in Robotics</b> |                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>6</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</b>                                                                                                                                                                                                                                                                                                                                                                                                             | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. R. K. Mittal and I. J. Nagrath, Robotics and Control, 1st Edition, McGraw Hill Education, (2017).
2. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel and Ashish Dutta, Industrial Robotics -Technology, Programming and Applications, 2nd Edition, McGraw Hill Education, (2014).
3. Chikesh Ranjan and Kaushik Kumar, Robotics, 1st Edition, S. Chand, (2024).

### Reference Books

1. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani and Giuseppe Oriolo, *Robotics Modelling, Planning and Control*, 1<sup>st</sup> Edition, Springer, (2009).
2. Peter Corke, *Robotics, Vision and Control - Fundamental Algorithms in Python*, 3<sup>rd</sup> Edition, Springer, (2023).
3. S. K. Saha, *Introduction to Robotics*, 2<sup>nd</sup> Edition, McGraw Hill Education, (2014).

### Web Resources

1. SWAYAM Course, 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, Introduction to Robotics, Dr. Krishna Vasudevan, Dr. T Asokan and Dr. Balaraman Ravindran, IIT Madras, <https://nptel.ac.in/courses/107106090>.

### 3.8.5 Data Analytics Foundations (AI4MM\_CX1)

#### Teaching Scheme

| Course Code | Course Name                | Contact Hours | Credits |
|-------------|----------------------------|---------------|---------|
| AI4MM_CX1   | Data Analytics Foundations | 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      | Introduce students to data-centric thinking and the role of data analytics in engineering and industrial applications.          |
| 2      | Familiarize students with structured datasets and basic data handling operations required for analytical workflows.             |
| 3      | Provide students with an understanding of data quality issues and fundamental data preparation techniques used before modeling. |
| 4      | Prepare students to perform exploratory analysis and interpret patterns in real-world and time-series datasets                  |
| 5      | Enable students to communicate insights effectively using appropriate visualizations and simple analytical reports.             |

#### Course Outcomes

|                              |                                                                                                                                                                  |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                                                  |
| CO1                          | Explain the data analytics workflow and distinguish between data analytics, data science, and machine learning in the context of engineering applications. (BL2) |
| CO2                          | Apply basic data inspection, selection, aggregation, and reshaping techniques to structured datasets for analytical purposes. (BL3)                              |
| CO3                          | Identify data quality issues and perform basic data cleaning, transformation, and feature preparation tasks on real-world datasets. (BL3)                        |
| CO4                          | Perform exploratory data analysis to interpret distributions, relationships, trends, and anomalies in both tabular and time-series data. (BL3)                   |
| CO5                          | Create appropriate visualizations and present data-driven insights through clear and structured analytical summaries. (BL5)                                      |

#### Course Contents

| Module | Unit                        | Detailed Contents                                                                                                                                                                                                                                                        | Hours |
|--------|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1.0    | Prerequisites               |                                                                                                                                                                                                                                                                          |       |
|        |                             | Basic Mathematics and Statistics                                                                                                                                                                                                                                         |       |
|        | <b>Data Science Context</b> |                                                                                                                                                                                                                                                                          | 06    |
|        | 1.1                         | Data Science vs Data Analytics vs Machine Learning, Data-driven decision making, Engineering data sources: sensors, logs, measurements Structured vs unstructured data, Overview of the data analytics workflow, Position of this course in the Data Science minor track |       |

|     |                                                       |                                                                                                                                                                                       |    |
|-----|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|     | 1.2                                                   | Why programming is used for data analysis<br>Role of Python in data analytics, Jupyter notebooks as an analysis environment                                                           |    |
| 2.0 | <b>Working with Structured Data</b>                   |                                                                                                                                                                                       | 05 |
|     | 2.1                                                   | Tabular datasets: rows, columns, schema,<br>Common data formats: CSV, Excel, log files<br>Data types and units in engineering data<br>Basic dataset inspection and understanding      |    |
|     | 2.2                                                   | Filtering records and selecting attributes<br>Sorting and basic aggregation, Grouping data for analysis<br>Concept of merging datasets, Wide vs long data representation              |    |
| 3.0 | <b>Data Cleaning &amp; Preparation</b>                |                                                                                                                                                                                       | 05 |
|     | 3.1                                                   | Sources of poor data quality, Missing values: causes and impact,<br>Deletion vs imputation, Handling inconsistent and duplicate data,<br>Outliers: physical vs data errors            |    |
|     | 3.2                                                   | Data type conversion, Scaling and normalization (intuition only)<br>Introduction to features and feature creation<br>Timestamp-based feature extraction, Domain-driven feature design |    |
| 4.0 | <b>Exploratory Data Analysis (EDA)</b>                |                                                                                                                                                                                       | 05 |
|     | 4.1                                                   | Summary statistics, Distribution understanding,<br>Relationship between variables, Correlation: meaning and limitations<br>Identifying patterns and anomalies                         |    |
|     | 4.2                                                   | Time-indexed data concepts, Trend and seasonality,<br>Rolling statistics for exploration, Handling irregular timestamps                                                               |    |
| 5.0 | <b>Data Visualization &amp; Insight Communication</b> |                                                                                                                                                                                       | 05 |
|     | 5.1                                                   | Purpose of visualization, Choosing appropriate chart types,<br>Common visualization mistakes, Visualizing time-series and multivariate data                                           |    |
|     | 5.2                                                   | Interpreting visual patterns, Connecting data insights to decisions<br>Structuring a simple data analysis report,<br>Reproducibility and documentation basics                         |    |
|     |                                                       | Total Hours                                                                                                                                                                           | 26 |

## Suggested Learning Resources

### Textbooks

1. Wes McKinney, "Python for Data Analysis", O'Reilly
2. Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge University Press

### Reference Books

1. Foster Provost & Tom Fawcett, "Data Science for Business", O'Reilly
2. Hadley Wickham & Garrett Grolemund, "R for Data Science", O'Reilly
3. Andy Kirk, "Data Visualisation: A Handbook for Data Driven Design", Sage

### Web Resources

1. NPTEL course titled "Introduction to Data Analytics" by Prof. Nandan Sudarsanam, Prof. Balaraman Ravindran, <https://nptel.ac.in/courses/110106072>
2. Kaggle Learn: Data Cleaning & EDA (for demos)

### 3.8.6 Introduction of IoT and Core Technologies (EC4MM\_CX1)

#### Teaching Scheme

| Course Code | Course Name                               | Contact Hours | Credits |
|-------------|-------------------------------------------|---------------|---------|
| EC4MM_CX1   | Introduction to IoT and Core Technologies | 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> the fundamental concepts, components, and applications of IoT.                                            |
| 2      | To <i>learn</i> about key communication protocols used in IoT systems and their application in device communication.           |
| 3      | To <i>gain</i> practical knowledge of the hardware components used in IoT, including sensors, actuators, and microcontrollers. |
| 4      | To <i>explore</i> integration of IoT devices with cloud platforms for data storage and processing.                             |
| 5      | To <i>apprise</i> about the security challenges and best practices for securing IoT systems and protecting user data.          |

#### Course Outcomes

|                              |                                                                                                               |
|------------------------------|---------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                               |
| CO1                          | <i>describe</i> the architecture of an IoT system and identify common IoT applications in various industries. |
| CO2                          | <i>implement</i> communication between devices using protocols such as MQTT, HTTP, and CoAP.                  |
| CO3                          | <i>design</i> basic IoT circuits by interfacing sensors and actuators with microcontrollers.                  |
| CO4                          | <i>explain</i> connection of IoT devices to a cloud platform for visualization of sensor data in real time.   |
| CO5                          | <i>explore</i> basic security measures like encryption and authentication in an IoT system.                   |

#### Course Contents

| Module   | Unit                                      | Detailed Contents                                                                                                                                   | Hours     |
|----------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Prerequisites: Nil</b>                 |                                                                                                                                                     |           |
| <b>1</b> | <b>Introduction to Internet of Things</b> |                                                                                                                                                     | <b>05</b> |
|          | 1.1                                       | Overview of IoT: Introduction, definition, history, and evolution, Applications of IoT- Healthcare, smart cities, industrial IoT, smart homes, etc. |           |
|          | 1.2                                       | IoT Architecture: Layers (sensing, networking, data processing) and devices                                                                         |           |
|          | 1.3                                       | Core IoT Components: Sensors, actuators, microcontrollers,                                                                                          |           |

|          |                                           |                                                                                                                             |           |
|----------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------|
|          |                                           | communication technologies                                                                                                  |           |
| <b>2</b> | <b>IoT Hardware and Devices</b>           |                                                                                                                             | <b>05</b> |
|          | 2.1                                       | Sensors and Actuators: Types of sensors and actuators, its interfacing with IoT devices                                     |           |
|          | 2.2                                       | Microcontrollers: Introduction to Arduino, Raspberry Pi, and ESP32                                                          |           |
|          | 2.3                                       | Interfacing Sensors: Connecting and programming sensors with microcontrollers- GPIO, I2C, SPI, and other hardware protocols |           |
| <b>3</b> | <b>IoT Communication Protocols</b>        |                                                                                                                             | <b>05</b> |
|          | 3.1                                       | Wired vs. wireless communication; IoT Communication Protocols: MQTT, HTTP, CoAP                                             |           |
|          | 3.2                                       | Wireless Communication Technologies: Wi-Fi, Bluetooth, Zigbee, LoRa, LPWAN, 5G                                              |           |
|          | 3.3                                       | Networking in IoT: Overview of IoT networks, IP addressing, and protocols                                                   |           |
| <b>4</b> | <b>Cloud Integration and Data Storage</b> |                                                                                                                             | <b>06</b> |
|          | 4.1                                       | Cloud Computing for IoT: Introduction to cloud platforms (AWS IoT, Google Cloud IoT, Azure IoT)                             |           |
|          | 4.2                                       | Edge Computing in IoT: Benefits, challenges, and use cases                                                                  |           |
|          | 4.3                                       | Data Management: Storing and processing IoT data (local vs cloud storage)                                                   |           |
| <b>5</b> | <b>Security and Privacy in IoT</b>        |                                                                                                                             | <b>05</b> |
|          | 5.1                                       | IoT Security: Security challenges, encryption, authentication, and data integrity.                                          |           |
|          | 5.2                                       | Privacy Considerations in IoT: Protecting user data, Privacy concerns and regulations (GDPR, IoT security standards)        |           |
|          | <b>Total Hours</b>                        |                                                                                                                             | <b>26</b> |

## Suggested Learning Resources

### Textbooks

1. Internet of Things: A Hands-On Approach, II Ed., Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.
2. Internet of Things: Principles and Paradigms, I Ed., Rajkumar Buyya, Amir Vahid Dastjerdi, Morgan Kauffman, 2016.
3. Designing the Internet of Things, I Ed., Adrian McEwen, Hakim Cassimally, Wiley, 2013.
4. Practical Internet of Things Security, II Ed., Brian Russell, Drew Van Duren, Packt Publishing, 2018.

### Reference Books

1. The Internet of Things: A Guide to the Connected World, II Ed., Samuel Greengard, The MIT Press, 2021.
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, I Ed., David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, Cisco Press, 2017.

## **Web Resources**

1. NPTEL course on Introduction to IoT by Prof. Sudip Misra, IIT Kharagpur  
<https://archive.nptel.ac.in/courses/106/105/106105166/>

### 3.8.7 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 <i>analyze</i> 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\\_mg125/preview](https://onlinecourses.nptel.ac.in/noc24_mg125/preview)

### 3.9.2 Cybersecurity 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 understand and identify different types cybercrime and cyber law                          |
| 2      | To recognize Indian IT Act 2008 and its latest amendments                                    |
| 3      | To understand the types of attacks and how to tackle the amount of risk involved.            |
| 4      | To discuss the role of industry standards and legal requirements with respect to compliance. |
| 5      | Awareness about Incident Management and its life cycle.                                      |

#### Course Outcomes

|                              |                                                                                                     |
|------------------------------|-----------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                     |
| CO1                          | To <i>understand</i> and identify different types cybercrime and cyber law                          |
| CO2                          | To <i>recognize</i> Indian IT Act 2008 and its latest amendments                                    |
| CO3                          | To <i>understand</i> the types of attacks and how to tackle the amount of risk involved.            |
| CO4                          | To <i>discuss</i> the role of industry standards and legal requirements with respect to compliance. |
| CO5                          | <i>Awareness</i> about Incident Management and its life cycle.                                      |

#### Course Contents

| Module   | Unit                                                        | Detailed Contents                                                                                                                                                                                                         | Hours     |
|----------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Prerequisites:</b> Basic Computer science and Networking |                                                                                                                                                                                                                           |           |
| <b>1</b> | <b>Introduction to Cybersecurity</b>                        |                                                                                                                                                                                                                           | <b>06</b> |
|          | 1.1                                                         | <b>Fundamentals of cyber security:</b> Definition, Need and Importance, Evolution of Cyber Security, CIA Triad (Confidentiality, Integrity, Availability), Cyber Threats, Vulnerabilities, and Attacks                    |           |
|          | 1.2                                                         | <b>Types of cyber-attack:</b> 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                                                         | <b>Cybersecurity Challenges &amp; Trends:</b> Zero-Day Attacks, Cloud Security Risks, AI in Cybersecurity                                                                                                                 |           |
| <b>2</b> | <b>Cyber Security Mechanisms</b>                            |                                                                                                                                                                                                                           | <b>06</b> |
|          | 2.1                                                         | <b>Cyber Defense Strategies:</b> Encryption Techniques & Cryptography                                                                                                                                                     |           |

|          |                                                 |                                                                                                                                                                                                                     |           |
|----------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          |                                                 | Basics, Firewalls, Intrusion Detection & Prevention Systems (IDS/IPS), Endpoint Security & Antivirus Software                                                                                                       |           |
|          | 2.2                                             | <b>Authentication &amp; Access Control:</b> Multi-Factor Authentication (MFA), Role-Based Access Control (RBAC), Digital Signatures & Certificates                                                                  |           |
|          | 2.3                                             | <b>Cyber Security Frameworks &amp; Standards:</b> NIST Cybersecurity Framework, ISO 27001 Standard, GDPR, HIPAA, and Compliance Requirements                                                                        |           |
| <b>3</b> | <b>Ethical Hacking &amp; Cyber Forensics</b>    |                                                                                                                                                                                                                     | <b>05</b> |
|          | 3.1                                             | <b>Ethical Hacking &amp; Penetration Testing:</b> Phases of Ethical Hacking, Common Hacking Techniques, Vulnerability Assessment & Exploitation                                                                     |           |
|          | 3.2                                             | <b>Cyber Forensics &amp; Incident Response:</b> Digital Evidence Collection & Chain of Custody, Incident Handling & Recovery Strategies, Case Studies on Real-World Cybercrime Investigations                       |           |
| <b>4</b> | <b>Cyber Laws &amp; Legal Framework</b>         |                                                                                                                                                                                                                     | <b>05</b> |
|          | 4.1                                             | <b>Overview of Cyber Laws:</b> Importance of Cyber Laws, Cyber Crimes and Legal Challenges, International Perspectives on Cyber Laws                                                                                |           |
|          | 4.2                                             | <b>IT Act, 2000 &amp; Amendments:</b> 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                                             | <b>Global Cybersecurity Regulations &amp; Compliance:</b> General Data Protection Regulation (GDPR), California Consumer Privacy Act (CCPA), International Cyber Treaties & Agreements                              |           |
| <b>5</b> | <b>Case Studies &amp; Practical Application</b> |                                                                                                                                                                                                                     | <b>04</b> |
|          | 5.1                                             | <b>Real-World Cybercrime Case Studies:</b> Famous Cyber Attacks & Data Breaches, Lessons Learned from High-Profile Security Incidents                                                                               |           |
|          | 5.2                                             | <b>Cybersecurity in Business &amp; Government:</b> Corporate Cybersecurity Strategies, Role of Governments in Cybersecurity Policies                                                                                |           |
|          | 5.3                                             | <b>Future Trends in Cybersecurity &amp; Law:</b> 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 explain 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>analyse</i> and compare 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:</b> Nil         |                                                          |           |
| <b>1</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</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</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</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</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. Myers, D.G. (2004). Psychology.5 th Edition, Worth Publishers: New York.
3. Baron, R.A.. (2002) Psychology, 5th Edition, Prentice Hall, India.
4. Kalat, J. (2007) Introduction To Psychology, 8 th Edition, Wordsworth Pub. Co.
5. Hilgard ,E.R., Atkinson,R.L.,R.C.,(2003) Introduction To Psychology.14th Edition Wordsworth Pub. Co.

### Reference Books

1. Feldman, R.S. (2006) Understanding Psychology, 6th Edition, Tata McGraw Hill, New Delhi.
2. Kosslyn, S.M., & Rosenberg, R.S. (2006) Psychology In Context, 3rd Edition, Pearson Education Ltd.

### Web Resources

1. NPTEL Course on Introduction to Psychology, Dr. Braj Bhushan, IIT Kanpur



### 3.9.4 Personal Finance, Investment 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</b> | <b>Foundations of Personal Finance</b> |                                                                                                                                                                            | <b>05</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</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</b> | <b>Alternative Investments, and Retirement Planning</b> |                                                                                                                                                                                                                                                                                                                                              | <b>04</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</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</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, 65<sup>th</sup> 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 & Well-being (IL4OE\_CX5)

#### Teaching Scheme

| Course Code | Course Name                      | Contact Hours | Credits |
|-------------|----------------------------------|---------------|---------|
| IL4OE_CX5   | Adolescent Health and Well-Being | 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, [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 | 2             | 2       |

#### 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 equip students with a comprehensive understanding of core management concepts, theories, and functions (planning, organizing, leading, and controlling) |
| 2      | To encourage students to think critically and analytically about decision-making processes in an organizational context.                                   |
| 3      | To promote leadership development and team collaboration                                                                                                   |
| 4      | To prepare students to apply management skills in technical roles and interdisciplinary projects.                                                          |
| 5      | To help 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 decision-making                                                                                          |
| CO3                          | <i>demonstrate</i> leadership skills, effectively <i>manage</i> teams, and <i>communicate</i> 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 <i>propose</i> practical solutions to organizational challenges.          |

#### Course Contents

| Module   | Unit                                | Detailed Contents                                                                                                                                                                                                                            | Hours     |
|----------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          | <b>Prerequisites: NIL</b>           |                                                                                                                                                                                                                                              |           |
| <b>1</b> | <b>Fundamentals of Management</b>   |                                                                                                                                                                                                                                              | <b>05</b> |
|          | 1.1                                 | <b>Introduction to Management:</b><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</b> | <b>Planning and Decision-Making</b> |                                                                                                                                                                                                                                              | <b>05</b> |
|          | 2.1                                 | <b>Principles of Planning:</b><br>Types of Planning (Strategic, Tactical, Operational), Planning Tools: SWOT Analysis, PESTLE Analysis, Management by Objectives                                                                             |           |

|          |                                                    |                                                                                                                                                                                                                                      |           |
|----------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|          |                                                    | (MBO)                                                                                                                                                                                                                                |           |
|          | 2.2                                                | <b>Decision-Making in Management:</b><br>Types of Decisions (Programmed vs. Non-Programmed), Decision-Making Models and Techniques (Rational Model, Bounded Rationality, Heuristics)<br>Risk and Uncertainty in Decision-Making      |           |
| <b>3</b> | <b>Leadership, Motivation, and Team Management</b> |                                                                                                                                                                                                                                      | <b>06</b> |
|          | 3.1                                                | <b>Leadership in Management:</b><br>Leadership Theories (Trait, Behavioral, Contingency), Styles of Leadership (Autocratic, Democratic, Laissez-Faire)<br>Role of Engineers as Leaders in Organizations                              |           |
|          | 3.2                                                | <b>Motivation Theories and Practices:</b><br>Maslow's Hierarchy of Needs, McGregor's Theory X & Y, Herzberg's Two Factor Theory, Motivational Tools and Techniques in the Workplace<br>Empowerment and Employee Engagement           |           |
|          | 3.3                                                | <b>Team Management and Communication:</b><br>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                                                | <b>Basics of Financial Management:</b><br>Understanding Financial Statements (Balance Sheet, Income Statement), Budgeting, Costing, and Break-Even Analysis, Basics of Capital Investment Decisions (NPV, IRR)                       |           |
|          | 4.2                                                | <b>Operations and Project Management:</b><br>Introduction to Operations Management in Engineering, Project Management Tools (Gantt Charts, PERT, CPM), Resource Allocation and Time Management                                       |           |
| <b>5</b> | <b>Ethics and Sustainability in Management</b>     |                                                                                                                                                                                                                                      | <b>05</b> |
|          | 5.1                                                | <b>Business Ethics and Corporate Governance:</b><br>Ethical Issues in Management and Engineering, Corporate Social Responsibility (CSR) and Sustainability Practices, Legal and Regulatory Frameworks for Ethical Business Practices |           |
|          | 5.2                                                | <b>Globalization and Contemporary Issues in Management:</b><br>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</b> | <b>Introduction to German Language</b> |                   | <b>06</b> |

|          |                                                                |                                                                                             |           |
|----------|----------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------|
|          | 1.1                                                            | Basic grammar.                                                                              |           |
|          | 1.2                                                            | Pronunciation and basic expressions.                                                        |           |
| <b>2</b> | <b>Communication</b>                                           |                                                                                             | <b>06</b> |
|          | 2.1                                                            | Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates. |           |
| <b>3</b> | <b>Text Interpretation and Composition</b>                     |                                                                                             | <b>03</b> |
|          | 3.1                                                            | Reading, Comprehension and writing - (Type of Text).                                        |           |
|          | 3.2                                                            | Dialogs, Monologs, Biodata.                                                                 |           |
| <b>4</b> | <b>German Society, Work Culture, and Digital Communication</b> |                                                                                             | <b>08</b> |
|          | 4.1                                                            | Family Structures, Culture.                                                                 |           |
|          | 4.2                                                            | Computer and Multimedia.                                                                    |           |
|          | 4.3                                                            | Work culture.                                                                               |           |
| <b>5</b> | <b>Corporate Communication</b>                                 |                                                                                             | <b>03</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</b> | <b>Introduction to French Language</b> |                   | <b>06</b> |

|                    |                                                                |                                                                                            |           |
|--------------------|----------------------------------------------------------------|--------------------------------------------------------------------------------------------|-----------|
|                    | 1.1                                                            | Basic grammar.                                                                             |           |
|                    | 1.2                                                            | Pronunciation and basic expressions.                                                       |           |
| <b>2</b>           | <b>Communication</b>                                           |                                                                                            | <b>06</b> |
|                    | 2.1                                                            | Greetings, beginning of conversation, Introduction of oneself, numbers, counting and dates |           |
| <b>3</b>           | <b>Text Interpretation and Composition</b>                     |                                                                                            | <b>03</b> |
|                    | 3.1                                                            | Reading, Comprehension and writing - (Type of Text)                                        |           |
|                    | 3.2                                                            | Dialogs, Monologs, Biodata                                                                 |           |
| <b>4</b>           | <b>French Society, Work Culture, and Digital Communication</b> |                                                                                            | <b>08</b> |
|                    | 4.1                                                            | Family Structures, Culture                                                                 |           |
|                    | 4.2                                                            | Computer and Multimedia                                                                    |           |
|                    | 4.3                                                            | Work culture                                                                               |           |
| <b>5</b>           | <b>Corporate Communication</b>                                 |                                                                                            | <b>03</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     |
|------------|------|------------------------------------------------------------------------------------------------|-----------|
|            |      | <b>Prerequisites:</b> Basic knowledge of communication skills and minimal language proficiency |           |
| <b>1.0</b> |      | <b>Aptitude Tests and Competitive Exams</b>                                                    | <b>03</b> |

|            |                                                       |                                                                                                                                                                                                                                                   |           |
|------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | 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

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

#### Course Outcomes

|                               |                                                                                                  |
|-------------------------------|--------------------------------------------------------------------------------------------------|
| The students will be able to: |                                                                                                  |
| CO1                           | Solve aptitude and reasoning problems accurately within set time limits.                         |
| CO2                           | Create structured technical reports on engineering topics with correct citations and formatting. |
| CO3                           | Draft a professional resume, participate in group discussions, and perform in mock interviews.   |
| CO4                           | Present technical topics confidently using visual aids and effective communication.              |
| CO5                           | Apply AI tools for automated data analysis, visualization, and resume optimization.              |

#### Course Contents

| Sr. No. | Suggested 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. GATE mock tests  
<https://www.gateacademy.co.in/py-papers>
2. IELTS mock tests  
[https://www.bestmytest.com/ielts/test?gad\\_source=1&gclid=Cj0KCQiAkJO8BhCGARIsAMkswyigx134y2mioqs3S5\\_ZiHxK9ijqJ7QS\\_MHS4zGRvOajrDJYPbtOEJgaAiZeEALw\\_wcB](https://www.bestmytest.com/ielts/test?gad_source=1&gclid=Cj0KCQiAkJO8BhCGARIsAMkswyigx134y2mioqs3S5_ZiHxK9ijqJ7QS_MHS4zGRvOajrDJYPbtOEJgaAiZeEALw_wcB)
3. TOEFL material  
<https://tstprep.com/free-resources/>
4. GRE mock tests  
<https://magoosh.com/gre/gre-practice-test/>  
<https://crunchprep.com/gre/free-gre-practice-tests>

### 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 introduce and define core universal human values and aid understanding of their role in individual and social harmony. |
| 2      | To explore the principles of trust, respect, and justice in relationships.                                                |
| 3      | To understand the interconnectedness of humans and nature and the importance of developing sustainable practices.         |
| 4      | To learn about ethical decision-making frameworks in professional settings.                                               |
| 5      | To integrate intellectual, emotional, physical, and spiritual growth into personal development.                           |

#### Course Outcomes

|                              |                                                                                                                                     |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                                                                     |
| CO1                          | identify and explain the core universal values.                                                                                     |
| CO2                          | demonstrate the ability to resolve a real-life familial and societal conflict by applying principles of trust, respect and justice. |
| CO3                          | conduct an environmental audit of a local project or practice and propose sustainable changes.                                      |
| CO4                          | evaluate an ethical dilemma in a professional context and present a solution based on ethical decision-making frameworks.           |
| CO5                          | create and implement 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</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</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</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</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.                                             |           |
|                    | 4.4                                                  | Dealing with workplace challenges: Bias, corruption, and competition.     |           |
| <b>5</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 (ETSEX\_CR1)

#### Teaching Scheme

| Course Code | Course Name     | Contact Hours | Credits |
|-------------|-----------------|---------------|---------|
| ETSEX_CR1   | Embedded 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>study</i> basics of embedded system and <i>select</i> the relevant microcontrollers for various industrial applications. |
| 2      | To <i>use</i> programming language to develop embedded system.                                                                 |
| 3      | To <i>study</i> the communication standards & protocols of embedded systems.                                                   |
| 4      | 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 embedded 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> 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 |
|--------|----------------------------------------------------------------------|-------------------|-------|
|        | <b>Prerequisites:</b>                                                |                   |       |
|        | Digital System Design<br><b>Microprocessor &amp; Microcontroller</b> |                   |       |
| 1      | <b>Introduction to Embedded System:</b>                              |                   | 08    |

|                    |                                                                                    |                                                                                                                                                                                                                                                    |           |
|--------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                    | 1.1                                                                                | Embedded system definition, Examples, Design metrics, Processor Technologies, IC Technologies, Design Technologies                                                                                                                                 |           |
|                    | 1.2                                                                                | Custom Single Purpose Processor design: Basic architecture, FSM and FSMD with example                                                                                                                                                              |           |
|                    | 1.3                                                                                | General purpose processor architecture, Classification-GPP, ASIP, DSP.                                                                                                                                                                             |           |
| <b>2</b>           | <b>Communication protocols in Embedded systems</b>                                 |                                                                                                                                                                                                                                                    | <b>08</b> |
|                    | 2.1                                                                                | communication standards like SPI, I2C, CAN, USB                                                                                                                                                                                                    |           |
|                    | 2.2                                                                                | Wireless communication standards: IrDA, Bluetooth(BLE), WiFi (IEEE802.11), Zigbee, RF modules                                                                                                                                                      |           |
|                    | 2.3                                                                                | Examples on Parallel Communication, Serial Communication                                                                                                                                                                                           |           |
| <b>3</b>           | <b>Real Time Operating System</b>                                                  |                                                                                                                                                                                                                                                    | <b>09</b> |
|                    | 3.1                                                                                | Definition of RTOS, Key Characteristics of RTOS, Features of $\mu$ COS II, Kernel structure                                                                                                                                                        |           |
|                    | 3.2                                                                                | $\mu$ COS II RTOS services: Task management: Tasks, Task states and Control block, Task scheduling, task level context, switching, Idle task, Multitasking, Kernel structure, Task Management system, TCB, Scheduling, Inter-process communication |           |
|                    | 3.3                                                                                | Introduction of MUCOS-II                                                                                                                                                                                                                           |           |
| <b>4</b>           | <b>Inter-Process Communication and Synchronization</b>                             |                                                                                                                                                                                                                                                    | <b>09</b> |
|                    | 4.1                                                                                | Semaphore, Creating/deleting a Semaphore, Waiting, signalling semaphore, Mutex, Creating/deleting and handling Mutex                                                                                                                               |           |
|                    | 4.2                                                                                | Event flag management, Timer Interrupt Service Routines (ISR), Soft Timers                                                                                                                                                                         |           |
|                    | 4.3                                                                                | Mail box, sending / getting a message using mailbox as semaphore, message queue and its management                                                                                                                                                 |           |
|                    | 4.4                                                                                | Memory control block. Task communication & Synchronization, Case studies of uCOS based applications                                                                                                                                                |           |
| <b>5</b>           | <b>Design examples and case studies of program model and programming with RTOS</b> |                                                                                                                                                                                                                                                    | <b>05</b> |
|                    | 5.1                                                                                | Digital Camera, Automatic Vending Machine, Digital watch                                                                                                                                                                                           |           |
| <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. 8086 Assembly Language Programming  
<https://youtube.com/playlist?list=PLIGqj2KrYnpSAqx7fcng4AJJJ5rjG9CT&feature=shared>
2. 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)
3. Arduino website  
<https://www.arduino.cc>

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

### Teaching Scheme

| Course Code | Course Name                | Contact Hours | Credits |
|-------------|----------------------------|---------------|---------|
| ETSEX_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 develop background knowledge Embedded Systems.                      |
| 2      | To understand communication techniques.                                |
| 3      | To write programs for embedded systems and real time operating systems |

### Course Outcomes

|                              |                                                                                        |
|------------------------------|----------------------------------------------------------------------------------------|
| The student will be able to: |                                                                                        |
| CO1                          | Develop background knowledge of Embedded Systems along with program modeling concepts. |
| CO2                          | Understand the detailed single purpose processor design techniques.                    |
| CO3                          | Understand different communication methods & protocols.                                |
| CO4                          | Write embedded C programs for real time operating systems.                             |
| CO5                          | Design embedded system applications using RTOS.                                        |

### Course Contents

| S. No. | Suggested List of Experiments                   |
|--------|-------------------------------------------------|
| 1      | Serial Communication Block :UART                |
| 2      | I2C Communication Protocols                     |
| 3      | Single Purpose Processor Designing: GCD Example |
| 4      | Zigbee Interfacing with ARM controller          |
| 5      | RTOS: Multitasking I                            |
| 6      | RTOS: Multitasking II                           |
| 7      | RTOS : Semaphore Creation                       |
| 8      | RTOS: Mailbox Creation                          |

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. Embedded System Design, Frank Vahid, Wiley Publication,
2. Introduction to Embedded System, Shibu K. V, TMH
3. Embedded Systems Architecture, Programming & Design, Rajkamal, TMH.

### **Reference Books**

1. ARM System Developers Guide, Morgan Kaufman, Andrew Sloss, Symes, Wright, Elsevier
2. Embedded Systems: An Integrated Approach, Lyla Das, Pearson Publication.
3. LPC2148 User Manuals and data sheets

### **Web Resources**

1. ARM Architecture Reference Manuals, keil Development tools -ARM Documentation.  
<https://developer.arm.com/documentation/ddi0487/latest/>

## 4.3 Internship (ETSEX\_LR2)

### Teaching Scheme

| Course Code | Course Name | Contact Hours | Credits |
|-------------|-------------|---------------|---------|
| ETSEX_LR2   | 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/IIIC 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 (ETSEX\_LR3)

### Teaching Scheme

| Course Code | Course Name | Contact Hours | Credits |
|-------------|-------------|---------------|---------|
| ETSEX_LR3   | Project     | 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</i> and <i>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</i> out literature review and identify problems.     |
| CO2                          | <i>apply</i> knowledge and skill to solve the problem.        |
| CO3                          | <i>design, implement</i> and <i>test</i> a working prototype. |
| CO4                          | <i>document</i> and <i>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

| <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>   |