# Curriculum and Syllabus [Regulation-25]

## Incorporating Guidelines of NEP2020

# B.Tech. in Electrical Engineering

## (Effective from 2025-2026 Admission Batch)

# JIS College of Engineering

## (NAAC 'A' Accredited Autonomous Institute)

### (Affiliated to Maulana Abul Kalam Azad University of Technology)

# **Department:** Electrical Engineering
## ***Curriculum Structure & Syllabus***
## ***(Effective from 2025-26 admission batch)***

| 1st Year 1st Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE101 | Introduction to Electrical Engineering | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Minor | CS102 | Introduction to Artificial Intelligence | 2 | 0 | 0 | 2 | 2 |
| 3 | SCI | Multidisciplinary | CH101 | Engineering Chemistry | 2 | 0 | 0 | 2 | 2 |
| 4 | SCI | Multidisciplinary | M101 | Engineering Mathematics – I | 3 | 0 | 0 | 3 | 3 |
| 5 | HUM | Ability Enhancement Course | HU103 | Design Thinking and Innovation | 1 | 0 | 0 | 1 | 1 |
| 6 | HUM | Value Added Courses | HU105 | Constitution of India & Professional Ethics | 1 | 0 | 0 | 1 | 1 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE191 | Introduction to Electrical Engineering Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Minor | CS192 | Artificial Intelligence Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | SCI | Skill Enhancement Course | CH191 | Engineering Chemistry Lab | 0 | 0 | 2 | 2 | 1 |
| 10 | ENGG | Skill Enhancement Course | ME193 | IDEA Lab Workshop | 0 | 0 | 3 | 3 | 1.5 |
| **C. Mandatory Activities / Courses** | | | | | | | | | |
| 11 | MC | Mandatory Course | MC181 | Induction Program | 0 | 0 | 0 | 0 | 0 |
| **Total for Theory and Practical** | | | | | | | | **23** | **17.5** |

| 1st Year 2nd Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE201 | Electrical Circuit Analysis | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE202 | Signals and Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | SCI | Multidisciplinary | PH201 | Engineering Physics | 3 | 0 | 0 | 3 | 3 |
| 4 | SCI | Multidisciplinary | M201 | Engineering Mathematics – II | 3 | 0 | 0 | 3 | 3 |
| 5 | HUM | Value Added Course | HU201 | Environmental Science | 2 | 0 | 0 | 2 | 2 |
| 6 | HUM | Value Added Course | HU202 | Indian Knowledge System | 1 | 0 | 0 | 1 | 1 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE291 | Electrical Circuit Analysis Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE292 | Signals and Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Skill Enhancement Course | PH291 | Engineering Physics Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | ENGG | Skill Enhancement Course | ME294 | Engineering Graphics & Computer Aided Design Lab | 0 | 0 | 3 | 3 | 1.5 |
| 11 | HUM | Ability Enhancement Course | HU291 | Communication & Presentation Skill | 0 | 0 | 3 | 3 | 1.5 |
| **C. Mandatory Activities / Courses** | | | | | | | | | |
| 12 | MC | Mandatory Course | MC281 | NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club | 0 | 0 | 0 | 0 | 0 |
| **Total for Theory and Practical** | | | | | | | | **30** | **22.5** |

## 2nd Year 3rd Semester

| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week | | | | Credit Points |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE301 | Measurement and IoT | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE302 | Analog and Digital Electronics | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE303 | Electromagnetic Field Theory | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Minor | CS(EE)301 | Programming with Python | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | CS(EE)302 | Data Structure and Algorithms | 2 | 0 | 0 | 2 | 2 |
| 6 | HUM | Minor | HU(EE)301 | Engineering Economics | 2 | 0 | 0 | 2 | 2 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE391 | Measurement and IoT Lab | 0 | 0 | 2 | 2 | 1 |
| 8 | ENGG | Major | EE392 | Analog and Digital Electronics Lab | 0 | 0 | 2 | 2 | 1 |
| 9 | ENGG | Skill Enhancement Course | CS(EE)391 | Programming with Python Lab | 0 | 0 | 2 | 2 | 1 |
| 10 | ENGG | Minor | CS(EE)392 | Data Structure and Algorithms Lab | 2 | 0 | 0 | 2 | 1 |
| 11 | HUM | Ability Enhancement Courses | HU(EE)391 | Technical Presentation and Group Discussion | 0 | 0 | 2 | 2 | 1 |
| **Total for Theory and Practical** | | | | | | | | **26** | **21** |

## $2^{nd}$ Year $4^{th}$ Semester

| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week | | | | Credit Points |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE401 | Electrical Machines - I | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE402 | Control Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE403 | Power Electronics | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Major | PE(EE)401 | A. Utilization of Electric Power<br>B. Sensors and Actuators<br>C. Digital Communication | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | EC(EE)401 | Microprocessor and Microcontrollers | 3 | 0 | 0 | 3 | 3 |
| 6 | HUM | Ability Enhancement Courses | HU(EE)401 | Principles of Management | 2 | 0 | 0 | 2 | 2 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE491 | Electrical Machines - I Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE492 | Control Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Major | EE493 | Power Electronics Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | ENGG | Minor | EC(EE)491 | Microprocessor and Microcontrollers Lab | 0 | 0 | 3 | 3 | 1.5 |
| **Total for Theory and Practical** | | | | | | | | **29** | **23** |

| 3rd Year 5th Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week | | | | Credit Points |
| | | | | | L | T | P | Total | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE501 | Electrical Machines - II | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE502 | Power Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE503 | Renewable Energy Systems | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Minor | CS(EE)501 | Introduction to Machine Learning | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Major | PE(EE)501 | A. Discrete and Non-Linear Control Systems<br>B. Digital Signal Processing<br>C. Embedded Systems | 3 | 0 | 0 | 3 | 3 |
| **B. Practical** | | | | | | | | | |
| 6 | ENGG | Major | EE591 | Electrical Machines – II Lab | 0 | 0 | 3 | 3 | 1.5 |
| 7 | ENGG | Major | EE592 | Power Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Minor | CS(EE)591 | Introduction to Machine Learning Lab | 0 | 0 | 3 | 3 | 1.5 |
| **C. Sessional** | | | | | | | | | |
| 9 | PROJ | Skill Enhancement Courses | PR581 | Prototype Design and Development | 0 | 0 | 0 | 0 | 2 |
| **Total for Theory, Practical and Sessional** | | | | | | | | **24** | **21.5** |

## 3rd Year 6th Semester

| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week L | T | P | Total | Credit Points |
|---|---|---|---|---|---|---|---|---|---|
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE601 | Electric Drives and PLC | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE602 | Power System Protection | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE603 | Electric and Hybrid Vehicle | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Major | PE(EE)601 | A. Power System Operation and Control<br>B. Power Quality and FACTS<br>C. Energy Storage Technologies | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | OE(EE)601 | A. Database Management System<br>B. Computer Architecture and Network<br>C. Cloud Computing | 3 | 0 | 0 | 3 | 3 |
| **B. Practical** | | | | | | | | | |
| 6 | ENGG | Major | EE691 | Electric Drives and PLC Lab | 0 | 0 | 3 | 3 | 1.5 |
| 7 | ENGG | Major | EE692 | Power System Protection Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE693 | Electric and Hybrid Vehicle Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Minor | OE(EE)691 | A. Database Management System Lab<br>B. Computer Architecture and Network Lab<br>C. Cloud Computing Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | HUM | Ability Enhancement Courses | HU(EE)691 | Soft Skill and Aptitude | 0 | 0 | 3 | 3 | 1.5 |
| **C. Sessional** | | | | | | | | | |
| 11 | PROJ | Project | PR681 | Major Project - I | 0 | 0 | 0 | 0 | 4 |
| 12 | PROJ | Internship | PR682 | Industrial Training / Internship | 0 | 0 | 0 | 0 | 2 |
| 13 | PROJ | Skill Enhancement Course | PR683 | Seminar on Industrial Training / Internship | 0 | 0 | 0 | 0 | 2 |
| **Total for Theory, Practical and Sessional** | | | | | | | | **30** | **30.5** |

## 4th Year 7th Semester

| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week L | T | P | Total | Credit Points |
|---|---|---|---|---|---|---|---|---|---|
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE701 | Introduction to Smart Grid | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | PE(EE)701 | A. Energy Conservation and Audit<br>B. HVDC Transmission Systems<br>C. Power Generation Economics | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Minor | OE(EE)701 | A. Robotics and Drone Technology<br>B. Bio-Medical Instrumentation<br>C. Digital Image Processing | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Skill Enhancement Courses | HU(EE)701 | Industrial Management | 3 | 0 | 0 | 3 | 3 |
| **B. Sessional** | | | | | | | | | |
| 5 | PROJ | Project | PR781 | Major Project - II | 0 | 0 | 0 | 0 | 8 |
| **Total for Theory, Practical and Sessional** | | | | | | | | **12** | **20** |

## 4th Year 8th Semester

| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week L | T | P | Total | Credit Points |
|---|---|---|---|---|---|---|---|---|---|
| **B. Sessional** | | | | | | | | | |
| 1 | PROJ | Project | PR881 | Grand Viva | 0 | 0 | 0 | 0 | 2 |
| 2 | PROJ | Project | PR882 | Internship/Entrepreneurship | 0 | 0 | 0 | 0 | 4 |
| **Total for Sessional** | | | | | | | | **0** | **6** |

## Credit Distribution Ratio

| Category | 1st Semester | 2nd Semester | 3rd Semester | 4th Semester | 5th Semester | 6th Semester | Total Credit to obtain UG Degree (Category Wise) | Credit Allocation as per NEP to obtain UG Degree | 7th Semester | 8th Semester | Total Credit (Category Wise) | Credit Allocation as per NEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Major (Core) | 4.5 | 9 | 11 | 16.5 | 15 | 16.5 | **72.5** | **60** | 6 | - | **78.5** | **80** |
| Minor Stream | 3.5 | - | 8 | 4.5 | 4.5 | 4.5 | **25** | **24** | 3 | - | **28** | **32** |
| Multidisciplinary | 5 | 6 | - | - | - | - | **11** | **9** | - | - | **11** | **9** |
| Ability Enhancement Courses (AEC) | 1 | 1.5 | 1 | 2 | - | 1.5 | **7** | **8** | - | - | **7** | **8** |
| Skill Enhancement Courses (SEC) | 2.5 | 3 | 1 | - | 2 | 2 | **10.5** | **9** | 3 | - | **13.5** | **9** |
| Value Added Courses common for all UG | 1 | 3 | - | - | - | - | **4** | **6 to 8** | - | - | **4** | **6 to 8** |
| Summer Internship | - | - | - | - | - | 2 | **2** | **2 to 4** | - | - | **2** | **2 to 4** |
| Research Project | - | - | - | - | - | 4 | **4** | **-** | 8 | 6 | **18** | **12** |
| **Total Credit (Semester Wise)** | **17.5** | **22.5** | **21** | **23** | **21.5** | **30.5** | **136** | **120** | **20** | **6** | **162** | **160** |

***Syllabus Under Autonomy***

***With effective from Academic Year 2025-2026***

***(R25)***

# **Department:** Electrical Engineering
## ***Curriculum Structure & Syllabus***
## ***(Effective from 2025-26 admission batch)***

| 1st Year 1st Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE101 | Introduction to Electrical Engineering | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Minor | CS102 | Introduction to Artificial Intelligence | 2 | 0 | 0 | 2 | 2 |
| 3 | SCI | Multidisciplinary | CH101 | Engineering Chemistry | 2 | 0 | 0 | 2 | 2 |
| 4 | SCI | Multidisciplinary | M101 | Engineering Mathematics – I | 3 | 0 | 0 | 3 | 3 |
| 5 | HUM | Ability Enhancement Course | HU103 | Design Thinking and Innovation | 1 | 0 | 0 | 1 | 1 |
| 6 | HUM | Value Added Courses | HU105 | Constitution of India & Professional Ethics | 1 | 0 | 0 | 1 | 1 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE191 | Introduction to Electrical Engineering Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Minor | CS192 | Artificial Intelligence Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | SCI | Skill Enhancement Course | CH191 | Engineering Chemistry Lab | 0 | 0 | 2 | 2 | 1 |
| 10 | ENGG | Skill Enhancement Course | ME193 | IDEA Lab Workshop | 0 | 0 | 3 | 3 | 1.5 |
| **C. Mandatory Activities / Courses** | | | | | | | | | |
| 11 | MC | Mandatory Course | MC181 | Induction Program | 0 | 0 | 0 | 0 | 0 |
| **Total for Theory and Practical** | | | | | | | | **23** | **17.5** |

| 1st Year 2nd Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE201 | Electrical Circuit Analysis | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE202 | Signals and Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | SCI | Multidisciplinary | PH201 | Engineering Physics | 3 | 0 | 0 | 3 | 3 |
| 4 | SCI | Multidisciplinary | M201 | Engineering Mathematics – II | 3 | 0 | 0 | 3 | 3 |
| 5 | HUM | Value Added Course | HU201 | Environmental Science | 2 | 0 | 0 | 2 | 2 |
| 6 | HUM | Value Added Course | HU202 | Indian Knowledge System | 1 | 0 | 0 | 1 | 1 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE291 | Electrical Circuit Analysis Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE292 | Signals and Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Skill Enhancement Course | PH291 | Engineering Physics Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | ENGG | Skill Enhancement Course | ME294 | Engineering Graphics & Computer Aided Design Lab | 0 | 0 | 3 | 3 | 1.5 |
| 11 | HUM | Ability Enhancement Course | HU291 | Communication & Presentation Skill | 0 | 0 | 3 | 3 | 1.5 |
| **C. Mandatory Activities / Courses** | | | | | | | | | |
| 12 | MC | Mandatory Course | MC281 | NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club | 0 | 0 | 0 | 0 | 0 |
| **Total for Theory and Practical** | | | | | | | | **30** | **22.5** |

| 2nd Year 3rd Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week | | | | Credit Points |
| | | | | | L | T | P | Total | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE301 | Measurement and IoT | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE302 | Analog and Digital Electronics | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE303 | Electromagnetic Field Theory | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Minor | CS(EE)301 | Programming with Python | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | CS(EE)302 | Data Structure and Algorithms | 2 | 0 | 0 | 2 | 2 |
| 6 | HUM | Minor | HU(EE)301 | Engineering Economics | 2 | 0 | 0 | 2 | 2 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE391 | Measurement and IoT Lab | 0 | 0 | 2 | 2 | 1 |
| 8 | ENGG | Major | EE392 | Analog and Digital Electronics Lab | 0 | 0 | 2 | 2 | 1 |
| 9 | ENGG | Skill Enhancement Course | CS(EE)391 | Programming with Python Lab | 0 | 0 | 2 | 2 | 1 |
| 10 | ENGG | Minor | CS(EE)392 | Data Structure and Algorithms Lab | 2 | 0 | 0 | 2 | 1 |
| 11 | HUM | Ability Enhancement Courses | HU(EE)391 | Technical Presentation and Group Discussion | 0 | 0 | 2 | 2 | 1 |
| **Total for Theory and Practical** | | | | | | | | **26** | **21** |

| 2nd Year 4th Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE401 | Electrical Machines - I | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE402 | Control Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE403 | Power Electronics | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Major | PE(EE)401 | A. Utilization of Electric Power<br>B. Sensors and Actuators<br>C. Digital Communication | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | EC(EE)401 | Microprocessor and Microcontrollers | 3 | 0 | 0 | 3 | 3 |
| 6 | HUM | Ability Enhancement Courses | HU(EE)401 | Principles of Management | 2 | 0 | 0 | 2 | 2 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE491 | Electrical Machines - I Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE492 | Control Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Major | EE493 | Power Electronics Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | ENGG | Minor | EC(EE)491 | Microprocessor and Microcontrollers Lab | 0 | 0 | 3 | 3 | 1.5 |
| **Total for Theory and Practical** | | | | | | | | **29** | **23** |

<table>
<tr><th colspan="11">3rd Year 5th Semester</th></tr>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Broad Category</th><th rowspan="2">Category</th><th rowspan="2">Paper Code</th><th rowspan="2">Subject</th><th colspan="4">Contact Hours/Week</th><th rowspan="2">Credit Points</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>Total</th></tr>
<tr><th colspan="10">A. Theory</th></tr>
<tr><td>1</td><td>ENGG</td><td>Major</td><td>EE501</td><td>Electrical Machines - II</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>2</td><td>ENGG</td><td>Major</td><td>EE502</td><td>Power Systems</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>3</td><td>ENGG</td><td>Major</td><td>EE504</td><td>Renewable Energy Systems</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>4</td><td>ENGG</td><td>Minor</td><td>CS(EE)401</td><td>Introduction to Machine Learning</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">ENGG</td><td rowspan="3">Major</td><td rowspan="3">PE(EE)501</td><td>A. Discrete and Non-Linear Control Systems</td><td rowspan="3">3</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">3</td><td rowspan="3">3</td></tr>
<tr><td>B. Digital Signal Processing</td></tr>
<tr><td>C. Embedded Systems</td></tr>
<tr><th colspan="10">B. Practical</th></tr>
<tr><td>6</td><td>ENGG</td><td>Major</td><td>EE591</td><td>Electrical Machines – II Lab</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td>7</td><td>ENGG</td><td>Major</td><td>EE592</td><td>Power Systems Lab</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td>8</td><td>ENGG</td><td>Minor</td><td>CS(EE)491</td><td>Introduction to Machine Learning Lab</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><th colspan="10">C. Sessional</th></tr>
<tr><td>9</td><td>PROJ</td><td>Skill Enhancement Courses</td><td>PR581</td><td>Prototype Design and Development</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td colspan="8">Total for Theory, Practical and Sessional</td><td>24</td><td>21.5</td></tr>
</table>

| 3rd Year 6th Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE601 | Electric Drives and PLC | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE602 | Power System Protection | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE603 | Electric and Hybrid Vehicle | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Major | PE(EE)601 | A. Power System Operation and Control<br>B. Power Quality and FACTS<br>C. Energy Storage Technologies | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | OE(EE)601 | A. Database Management System<br>B. Computer Architecture and Network<br>C. Cloud Computing | 3 | 0 | 0 | 3 | 3 |
| **B. Practical** | | | | | | | | | |
| 6 | ENGG | Major | EE691 | Electric Drives and PLC Lab | 0 | 0 | 3 | 3 | 1.5 |
| 7 | ENGG | Major | EE692 | Power System Protection Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE693 | Electric and Hybrid Vehicle Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Minor | OE(EE)691 | A. Database Management System Lab<br>B. Computer Architecture and Network Lab<br>C. Cloud Computing Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | HUM | Ability Enhancement Courses | HU(EE)691 | Soft Skill and Aptitude | 0 | 0 | 3 | 3 | 1.5 |
| **C. Sessional** | | | | | | | | | |
| 11 | PROJ | Project | PR681 | Major Project - I | 0 | 0 | 0 | 0 | 4 |
| 12 | PROJ | Internship | PR682* | Industrial Training / Internship | 0 | 0 | 0 | 0 | 2 |
| 13 | PROJ | Skill Enhancement Course | PR683 | Seminar on Industrial Training / Internship | 0 | 0 | 0 | 0 | 2 |
| **Total for Theory, Practical and Sessional** | | | | | | | | **30** | **30.5** |

* Industrial Training/Internship is to be completed before 6th Semester Examination and the credit will be given subjected to submission of Reports and Certificates.

| 4th Year 7th Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE701 | Introduction to Smart Grid | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | PE(EE)701 | A. Energy Conservation and Audit<br>B. HVDC Transmission Systems<br>C. Power Generation Economics | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Minor | OE(EE)701 | A. Robotics and Drone Technology<br>B. Bio-Medical Instrumentation<br>C. Digital Image Processing | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Skill Enhancement Courses | HU(EE)701 | Industrial Management | 3 | 0 | 0 | 3 | 3 |
| **B. Sessional** | | | | | | | | | |
| 5 | PROJ | Project | PR781 | Major Project - II | 0 | 0 | 0 | 0 | 8 |
| **Total for Theory, Practical and Sessional** | | | | | | | | **12** | **20** |

| 4th Year 8th Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **B. Sessional** | | | | | | | | | |
| 1 | PROJ | Project | PR881 | Grand Viva | 0 | 0 | 0 | 0 | 2 |
| 2 | PROJ | Project | PR882 | Internship/Entrepreneurship | 0 | 0 | 0 | 0 | 4 |
| **Total for Sessional** | | | | | | | | **0** | **6** |

| 1st Year 1st Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE101 | Introduction to Electrical Engineering | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Minor | CS102 | Introduction to Artificial Intelligence | 2 | 0 | 0 | 2 | 2 |
| 3 | SCI | Multidisciplinary | CH101 | Engineering Chemistry | 2 | 0 | 0 | 2 | 2 |
| 4 | SCI | Multidisciplinary | M101 | Engineering Mathematics- I | 3 | 0 | 0 | 3 | 3 |
| 5 | HUM | Ability Enhancement Course | HU103 | Design Thinking and Innovation | 1 | 0 | 0 | 1 | 1 |
| 6 | HUM | Value Added Courses | HU105 | Constitution of India & Professional Ethics | 1 | 0 | 0 | 1 | 1 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE191 | Introduction to Electrical Engineering Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Minor | CS192 | Artificial Intelligence Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | SCI | Skill Enhancement Course | CH191 | Engineering Chemistry Lab | 0 | 0 | 2 | 2 | 1 |
| 10 | ENGG | Skill Enhancement Course | ME193 | IDEA Lab Workshop | 0 | 0 | 3 | 3 | 1.5 |
| **C. Mandatory Activities / Courses** | | | | | | | | | |
| 11 | MC | Mandatory Course | MC181 | Induction Program | 0 | 0 | 0 | 0 | 0 |
| **Total for Theory and Practical** | | | | | | | | **23** | **17.5** |

**Course Name: Introduction to Electrical Engineering**
**Course Code: EE101**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Basic 12th standard Physics and Mathematics, Concept of components of electric circuit.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the fundamental concepts of electrical quantities and circuit elements.
- **Obj.2.** Develop the ability to analyze basic DC and AC circuits using standard techniques.
- **Obj.3.** Provide an overview of electrical machines and their working principle.
- **Obj.4.** Familiarize students with electrical installations and various components associated.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Define different terminologies pertaining to electrical and/or electro-magnetic circuits and energy storage.
- **CO2.** Illustrate the working principle and installation of basic electrical and/or electro-magnetic circuits.
- **CO3.** Analyse various DC and AC circuits.

**CO-PO Mapping:**

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

***Course Content***

**Module 1: DC Circuits** **9L**

Definition of electric circuit, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, node, branch, and mesh analysis, active and passive elements, Kirchhoff‘s laws, Source equivalence and conversion, Star-Delta Conversions.

**Module 2: AC Fundamentals** **9L**

Representation of sinusoidal waveforms, peak and rms values, Form Factor and Peak Factor, phasor representation, real power, reactive power, apparent power, power factor. Steady-state analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). Three phase balanced circuits, voltage and current relations in star and delta connections.

**Module 3: Electrical Machines** **10L**

- **a)** **Transformer:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.
- **b)** **Rotating Machines:**
  - i. **DC Machines:** Brief idea on constructional features, classifications, working principle of both motor and generator.
  - ii. **Three-Phase Induction Motor:** Basic concept of three phase circuit and production of rotating magnetic field. Working principle of three-phase induction motor.

**Module 4: Electrical Installations** **3L**

Earthing of Electrical Equipment, ideas of basic components – MCB, MCCB, ELCB, SFU, Types of Wires and Cables.

**Module 5: Fundamentals of Energy Storage** **5L**

Working principle and example of Hydrogen cell, Battery – Dry cell and Wet cell, Fuel cell and Hydro-statics.

**Text Books:**

1. P. Kothari & I. J. Nagrath, Basic Electrical Engineering, TMH.
2. V. Mittle & Arvind Mittal, Basic Electrical Engineering, TMH.
3. Ashfaq Hussain, Basic Electrical Engineering, Dhanpat Rai Publication.
4. Chakrabarti, Nath & Chanda, Basic Electrical Engineering, TMH.
5. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education.

**Reference Books:**

1. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.
2. V. D. Toro, Electrical Engineering Fundamentals, Prentice Hall India, 1989.

**Course Name: Introduction to Artificial Intelligence**
**Course Code: CS102**
**Contact: 2L:0T:0P**
**Total Contact Hours: 30**
**Credit: 2**

**Prerequisite:** Basic Computer Knowledge.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Comprehend the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context.
- **Obj.2.** Formulate a problem as State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.
- **Obj.3.** Use the strategies of AI-Heuristics to find acceptable solutions avoiding brute-force techniques.
- **Obj.4.** Design AI-Frameworks for Inferencing based on knowledge base.
- **Obj.5.** Analyse the effectiveness of AI-Inferencing Model in offering solutions to the respective problem.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Understand and explain the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context for further exploration leading towards lifelong learning.
- **CO2.** Identify and formulate an engineering problem primarily to fit a State-Space Exploration Framework or an Inferencing Model/Agent Design Framework within the scope of Artificial Intelligence paradigm..
- **CO3.** Explore relevant literature and apply the concept of Heuristic Techniques of Artificial Intelligence to solve problems.
- **CO4.** Develop Inferencing Models for proposing solutions to the problems of Artificial Intelligence.
- **CO5.** Implement Inferencing Models of Artificial Intelligence through developing feasible algorithms and investigate their effectiveness by analysing their performances in solving the relevant problems.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction to Artificial Intelligence** **3L**

Why AI • Definition of AI • Goals of AI • History and evolution of AI • Types of AI: Narrow, General, Super • Human vs Artificial Intelligence • Applications of AI in various domains • AI for social good.

**Module 2: Intelligent Agents and Logic-Based Thinking 8L**

Intelligent systems • Agents and environments • Decision making using rules and logic • Symbolic AI concepts • Propositional Logic: Knowledge Representation and Inference using Propositional Logic • Predicate Logic: Knowledge Representation, Inference and Answer Extraction using First Order Predicate Logic.

**Module 3: Overview of AI Branches and Perception 8L**

Machine learning • Deep learning • Natural language processing • Computer vision • Expert systems • Fuzzy logic • Evolutionary algorithms • Reinforcement learning • Planning and scheduling • Human-AI collaboration.

**Module 4: Basics of Machine Learning 6L**

What is machine learning • AI vs ML • Types of learning: supervised, unsupervised • Concept of dataset, features, and labels • ML model and prediction flow • Common ML applications • Introduction to decision trees (concept only) • ML pipeline overview.

**Module 5: Applications and Ethics of AI 5L**

AI in robotics and automation • AI-enabled smart applications • Industry 4.0 and intelligent systems • AI in different sectors: healthcare, agriculture, transport, education, etc. • Human-AI teamwork • Basics of AI ethics: bias, fairness, privacy • Career opportunities and future scopes in AI.

**Text book:**

1. AI for Everyone: A Beginner's Handbook for Artificial Intelligence (AI), Saptarsi Goswami, Amit Kumar Das, Amlan Chakrabarti, Pearson.
2. Artificial Intelligence, Rich, E., Knight, K and Shankar, Tata McGraw Hill, 3rd Edition, B. 2009.
3. Artificial Intelligence - A Modern Approach, Russell, S. and Norvig, Prentice Hall, 3rd edition, P. 2015

**Reference Books:**

1. Artificial Intelligence: Beyond Classical AI, Reema Thareja, Pearson.
2. Introduction to Artificial Intelligence and Expert Systems, Patterson, Pearson.

**Course Name: Engineering Chemistry**
**Course Code: CH101**
**Contact: 2L:0T:0P**
**Total Contact Hours: 24**
**Credit: 2**

**Prerequisite:** 10+2.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the basic principles of atomic structures and periodic properties of elements, different engineering materials, advanced polymers.
- **Obj.2.** Apply the knowledge of free energy, energy storage device and semiconductors to design environment friendly and sustainable devices.
- **Obj.3.** Apply the concept of corrosion and fuel to improve its efficacy and application for industrial purpose.
- **Obj.4.** Analyze the organic reaction with the structure of organic molecules by applying the knowledge of different spectroscopic techniques.
- **Obj.5.** Evaluate the electrical, optical, and structural properties of semiconductors to analyze their potential applications in modern electronic and energy devices.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Understand the basic principles of atomic structures and periodic properties of elements, different engineering materials, advanced polymers.
- **CO2.** Apply the knowledge of free energy, energy storage device and semiconductors to design environment friendly and sustainable devices.
- **CO3.** Utilize the concept of corrosion and fuel to improve its efficacy and application for industrial purpose.
- **CO4.** Analyze the organic reaction with the structure of organic molecules by applying the knowledge of different spectroscopic techniques.
- **CO5.** Evaluate the electrical, optical, and structural properties of semiconductors to analyze their potential applications in modern electronic and energy devices.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1:** **6L**

*i. Quantum Properties of Atoms:* *4L*

Schrodinger Wave Equation (time independent – basic principles only), de Broglie Equation, Heisenberg Uncertainty Principle, Quantum Numbers, Effective nuclear charge, Slater's rule, penetration of orbitals, variations of orbital energies in the periodic table, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, oxidation properties.

*ii. Chemistry of materials:* *2L*

Semiconductor-Based Memory Materials (Si & Ge) [Introduction, Properties and role of Si & Ge), Intensive & Extensive semiconductor,

**Module 2:** **7L**

*i. Chemical Thermodynamics:* *5L*

1st & 2nd Law of Thermodynamics, Tendency for maximum randomness, Carnot Heat Engine [Derivation], Entropy characteristics, Mathematical explanation & physical significance of Entropy, Entropy change of ideal gas for isothermal reversible process, Gibbs free Energy Function, Standard free Energy, Criterion of spontaneity.

*ii. Electricity production through chemical reactions:* *2L*

Electrochemical Cell, writing of cell notation, free energy and EMF, Criterion of spontaneity in terms of Cell, Nernst equation (only expression, no derivation) and applications, calculation of EMF of a cell, calculation of single electrode potential, calculation of Kc, calculation of Kc from G0. Working principle and applications of Lithium-ion batteries

**Module 3:** **6L**

*i. Polymers for Engineering Applications:* *3L*

Polymers and their classifications (based on origin, chemical structure, polymeric structure, tacticity and molecular forces), Commercially important polymers: Synthesis and applications of Bakelite, nylon 6,6, HDPE & LDPE, Conducting polymers –Types examples and applications, Biodegradable polymers –definition, example and uses

*ii. Industrial Chemistry:* *3L*

Types of corrosion, Electrochemical theory of corrosion, rusting of iron, comparison of chemical & electrochemical corrosion. [Mechanism excluded], Factors affecting the rate of corrosion; nature of metal (physical state, purity, position in Galvanic series) & environment, Corrosion control: Cathodic protection, anodic protection, Inorganic coatings, Classification of Fuel (LPG, CNG, BIOGAS), Calorific value, Octane number, Cetane number, HCV, LCV. [Definition only]

**Module 4:** **5L**

*i. Organic Reactions & synthesis of drugs:* *3L*

Acidity and basicity comparison of organic compounds (acids, alcohols & amines), Nucleophilic Substitution reaction and Electrophilic Addition reactions, Markonikov's rule, peroxide effect, Synthesis of Paracetamol& Aspirin and uses.(Name reactions are not in syllabus)

*ii. Spectroscopy:* *2L*

Electromagnetic spectrum, Lambert-Beer Law, Finding of $\lambda_{max}$ value & concentration of the unknown solution, Applications of UV-VIS spectroscopy, Chromophores & Auxochromes.
Applications of IR spectroscopy, Fingerprint region.

**Text Books:**

1. Chemistry – I, Gourkrishna Das Mohapatro
2. A text book of Engineering Chemistry, Dr. Rajshree Khare
3. Engineering Chemistry, U. N. Dhar
4. Physical Chemistry, P.C. Rakshit

**Reference Books:**

1. Engineering Chemistry, Jain & Jain
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishna
3. Text book of Engineering Chemistry, Jaya Shree Anireddy.

**Course Name: Engineering Mathematics – I**
**Course Code: M101**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** The students to whom this course will be offered must have the understanding of (10+2) standard algebraic operations, coordinate geometry, and elementary calculus concepts including limits, continuity, differentiation, and integration.

**Course Objectives:** The objective of this course is to familiarize the prospective engineers with techniques in matrix algebra and calculus. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Apply linear algebra methods to perform matrix operations, classify matrix structures, solve systems of linear equations, and compute eigenvalues and eigenvectors in engineering contexts.
- **CO2.** Apply differential and integral calculus to evaluate and approximate the behavior of single- variable and multivariable real-valued functions relevant to engineering scenarios.
- **CO3.** Analyze the properties of eigenvalues and eigenvectors to assess matrix diagonalizability and interpret linear transformations using the Cayley-Hamilton theorem in engineering systems.
- **CO4.** Analyze single-variable and multivariable real-valued functions using differential and integral calculus to model and interpret complex behavior in engineering applications.

**CO-PO Mapping:**

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

***<u>Course Content</u>***

**Module 1: Liner Algebra 11L**
Echelon form and normal (canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigenvalues and eigenvectors; Diagonalization of matrix, Cayley-Hamilton theorem.

**Module 2: Single Variable Calculus 5L**
Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Taylor's series.

**Module 3: Multivariable Calculus (Differentiation) 13L**
Function of several variables; Concept of limit, continuity and differentiability; Partial derivatives, Total derivative and its application; chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function; Jacobian; Maxima and minima of functions of two variables.

**Module 4: Multivariable Calculus (Integration) 7L**

Double Integral, Triple Integral; Change of order in multiple integrals; Line Integral, Surface Integral, Volume Integral. Change of variables in multiple integrals.

**Text Books:**


1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.


**Reference Books:**


1. Guruprasad, S. A text book of Engineering Mathematics-I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
6. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
7. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
8. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
9. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
10. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

**Course Name: Design Thinking and Innovation**
**Course Code: HU103**
**Contact: 1L:0T:0P**
**Total Contact Hours: 15**
**Credit: 1**

**Prerequisite:** For a course on the Basics of Design Thinking, students should ideally possess basic computer skills, communication abilities, problem-solving aptitude, critical thinking, introductory knowledge of Sustainable Development Goals, curiosity, and openness to new ideas, as well as basic understanding of mathematics, technology, and manufacturing processes.
However, even if these prerequisites are not satisfied, the faculty will cover them in the first few classes.
An awareness of 21st-century skills, including creativity and collaboration, is also beneficial.
These prerequisites aim to provide a foundation, and any gaps in knowledge will be addressed by the instructor early in the course.

**Course Objectives:** The objective of this Course is to provide new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products and services which are useful for a student in preparing for an engineering career.

**Course Outcomes:** After successful completion of the course, student will be able to

**CO1.** Analyze emotional experience and expressions to better understand stakeholders while designing innovative products through group brainstorming sessions.

**CO2.** Generate and develop design ideas through different technique.

**CO3.** Develop new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing any innovative products using facility in AICTE IDEA LAB.

**CO-PO Mapping:**

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

***<u>Course Content</u>***

**Module 1: Basics of Design Thinking** **2L**

Definition of Design Thinking, Need for Design Thinking, history of Design Thinking, Concepts & Brainstorming, 2X2 matrix, 6-3-5 method, NABC method;

**Module 2: PROCESS OF DESIGN: Understanding Design thinking** **4L**

Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.
Stages of Design Thinking Process (explain with examples) –
Empathize (Methods of Empathize Phase: Ask 5 Why / 5W+H questions, Stakeholder map, Empathy Map, Peer observation, Trend analysis).
Define (Methods of Define Phase: Storytelling, Critical items diagram, Define success).
Ideate (Brainstorming, 2X2 matrix, 6-3-5 method, NABC method).
Prototype (Types of prototypes - Methods of prototyping - Focused experiments, Exploration map,

Minimum Viable Product).
Test (Methods of Testing: Feedback capture grid, A/B testing).

**Module 3: Tools for Design Thinking** **2L**
Real-Time design interaction captures and analysis – Enabling efficient collaboration in digital space– Empathy for design – Collaboration in distributed Design

**Module 4: Design Thinking in IT** **2L**
Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping

**Module 5: Design Thinking For strategic innovations** **2L**
Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model

**Module 6: Problem Solving & Critical thinking** **3L**
Introduction to TRIZ, SCAMPER, UI and UX,
**Sustainable development goals (SDG)**
Integrating and mapping 17 Sustainable development goals (SDG) during designing a product; goods or service. Introduction to 21st Century Skill Set

**Case Study & Project Report Submission**

**Text Books:**

1. Karmin Design Thinking by Dr. Bala Ramadurai, Mudranik Technology Private Ltd. ISBN 978-93-5419-0I0-0.
2. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013.
3. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press , 2009.
4. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011
5. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.


**Reference Books:**

1. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", Cengage Learning, Second Edition, 2011.
2. Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author).
3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins e-books, 2009.
4. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Toolbox, John Wiley & Sons, 2020.
5. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Playbook, John Wiley & Sons, 2018.
6. Kristin Fontichiaro, Design Thinking, Cherry Lake Publishing, USA, 2015.
7. Walter Brenner, Falk Uebernickel, Design Thinking for Innovation - Research and Practice, Springer Series, 2016.

8. Gavin Ambrose, Paul Harris, Design Thinking, AVA Publishing, 2010.
9. Muhammad MashhoodAlam, Transforming an Idea into Business with Design Thinking, First Edition, Taylor and Francis Group, 2019.
10. S. Balaram, Thinking Design, Sage Publications, 2011.

**Web References:**

1. https://designthinking.ideo.com/
2. https://thinkibility.com/2018/12/01/engineering-vs-design-thinking/
3. https://www.coursera.org/learn/design-thinking-innovation
4. https://swayam.gov.in/nd1_noc20_mg38/preview
5. www.tutor2u.net/business/presentations/. /productlifecycle/default.html
6. https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf
7. www.bizfilings.com › Home › Marketing › Product Developmen
8. https://www.mindtools.com/brainstm.html
9. https://www.quicksprout.com/. /how-to-reverse-engineer-your-competit
10. www.vertabelo.com/blog/documentation/reverse-engineering
11. https://support.microsoft.com/en-us/kb/273814
12. https://support.google.com/docs/answer/179740?hl=en

**Course Name: Constitution of India & Professional Ethics**
**Course Code: HU105**
**Contact: 1L:0T:0P**
**Total Contact Hours: 12**
**Credit: 1**

**Prerequisite:** A basic knowledge (10+2 level) of the Indian Constitution and moral science.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the salient features of the Indian constitution and form of government.
- **Obj.2.** Develop ethical awareness and responsible professional conduct.
- **Obj.3.** Understand ethical frameworks, guidelines and recognize ethical dilemmas.
- **Obj.4.** Understand professional responsibilities and applications of ethical principles in real-life scenarios.
- **Obj.5.** Develop an awareness of the social impact of the profession and act responsibly in the broader community.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Identify, define and understand the significance of the Constitution of India, its spirit and values and the fundamental rights and duties as a responsible citizen.
- **CO2.** Define and discover core ethical concepts, the basic perception of profession, and professional ethics that shape the ethical behaviour of an engineer.
- **CO3.** Identify, examine and apply codes of engineering ethics, engineers' social responsibilities and industrial standards and ethical dilemmas.
- **CO4.** Consider, correlate and appraise ethical leadership and principles in addressing gender issues, concerns of IPR and industrial responsibilities.

**CO-PO Mapping:**

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

***Course Content***

**Module 1: Introduction to the Constitution of India and Indian Government 2L**
Preamble: Salient Features, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliament -Powers and Functions – Executive - President - Governor - Council of Ministers.

**Module 2: Professional Ethics and Human Values 3L**
Introduction to Ethical Thinking; what is Ethics, Work ethics; Scope of Professional Ethics, Values and Characteristics, Types of values: Negative and positive values, Ethical values for Professional success.

**Module 3: Codes of Professional Ethics, Violation and Safeguards 4L**
Engineering Ethics, Ethical theories: a brief overview; utilitarianism, deontology, virtue ethics.
Professional Codes, Codes of professional ethics-Moral dilemmas, and moral autonomy- Internal ethics of business: whistle blowing, conflicts of interest, Job discrimination, and Exploitation of Employees; Social and ethical responsibilities of technologists: Responsibilities towards Customers,

shareholders, employees – Social Audit.
Case Studies: Bhopal Gas Tragedy, Chernobyl (linking ethics to real-world failures).

**Module 4: Business Ethics and Workplace Issues 3L**

Business ethics, ethical decision-making frameworks - Impact of ethics on business policies and strategies- Characteristics of ethical leaders; fostering integrity in teams; Addressing occupational crime, discrimination, and gender-based issues in workplaces-Intellectual property rights (IPR), Plagiarism and Academic Misconduct.

**Text Books:**


1. Durga Das Basu. Introduction to the Constitution of India. 27th ed. New Delhi: Lexis Nexis, 2024.
2. R. S. Naagarazan. A Textbook on Professional Ethics and Human Values. New Age International (P) Limited, 2022.
3. N. Subramanian. Professional Ethics. New Delhi: Oxford University Press, 2017.
4. A. N. Tripathi, Human Values. New Delhi: New Age Publishers, 2019.
5. S. K. Chakraborty. Values and Ethics for Organizations: Theory and Practices. New Delhi: Oxford University Press, 1997.


**Reference Books:**


1. O. C. Ferrell, John Friaedrich and Linda Ferrell. Business Ethics: Ethical Decision Making and Cases. New Delhi: Cengage India, 2024.
2. Charles Fledderman. Engineering Ethics. 3rd ed. New Delhi: Pearson Education, 2007.
3. Dinesh G. Harkut and Gajendra R. Bamnote. Professional Ethics for Engineers. Chennai: Notion Press, 2023.
4. U.C.Mathur, Corporate Governance and Business Ethics: Text and Cases. Chennai: Macmillan, 2012.
5. Fernando. A. C., K. P. Muralidheeran and E. K. Satheesh. Business Ethics – An Indian Perspective. New Delhi: Pearson Education, 2019.

**Course Name: Introduction to Electrical Engineering Lab**
**Course Code: EE191**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Basic Physics and applied physics, Basic Mathematics, Basic concept of Electric Circuit.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide hands-on experience in verifying basic electrical laws and theorems.
- **Obj.2.** Familiarize students with electrical components, circuit connections, and measurement instruments.
- **Obj.3.** Reinforce theoretical circuit analysis through practical implementation.
- **Obj.4.** Develop skills for safe experimentation and troubleshooting of basic electrical circuits.
- **Obj.5.** Introduce basic operation of transformers and electrical machines through experiments.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Identify various electrical equipment and safety measures.
- **CO2.** Evaluate performance characteristics of different electrical and/or electro-magnetic equipment.
- **CO3.** Interprete the observations of experiments conducted.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Basic safety precautions – earthing, introduction to measuring instruments – Voltmeter, Ammeter, Multimeter, Wattmeter, Real life Resistor, Capacitor, Inductor.
2. Characteristics of Fluorescent, lamp.
3. Characteristics of Tungsten and Carbon filament lamps.
4. Study of R-L-C series circuit.
5. Verification of Line and Phase voltage and current in a three-phase circuit.
6. Demonstration of cut-out sections of machines: DC Machine (commutator-brush arrangement), Induction Machine (squirrel cage rotor).
7. Measurement of primary and secondary voltage and current of single-phase transformer – Open Circuit and Short Circuit Test.
8. Starting and Reversing of a DC shunt motor
9. Speed control of a DC shunt motor.
10. Test on single-phase Energy Meter.
11. Characteristics of Charging and Discharging of a Dry-Cell.
12. Innovative experiments.

**Course Name: Artificial Intelligence Lab**
**Course Code: CS192**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Basic Computer Knowledge.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Gain foundational knowledge of PROLOG to implement an Artificial Intelligent Agent as an executable computer program for Knowledge Representation and Inferencing.
- **Obj.2.** Formulate a problem by analysing its characteristics to fit a State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.
- **Obj.3.** Apply the concepts of Artificial Intelligence to solve a problem by implementing well-known Artificial Intelligence strategies using proper techniques and tools of PROLOG.
- **Obj.4.** Build expert systems offering solutions to the challenging problems of Artificial Intelligence.
- **Obj.5.** Implement Artificial Intelligence based ideas as executable PROLOG programs through developing intelligent heuristic strategies.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Acquire foundational knowledge of PROLOG to implement an Artificial Intelligent Agent as an executable computer program for Knowledge Representation and Inferencing and understand the working principle of the agent and assess its utilitarian importance in current technological context leading towards lifelong learning.
- **CO2.** Identify and formulate an engineering problem by analyzing its characteristics to fit a State-Space Exploration Framework or an Inferencing Agent Formulation Framework of Artificial Intelligence.
- **CO3.** Explore relevant literature and apply the concepts of Artificial Intelligence to solve a problem by implementing well-known Artificial Intelligence strategies using proper techniques and tools of PROLOG.
- **CO4.** Develop ideas and propose an expert system offering solutions to the challenging problems of Artificial Intelligence.
- **CO5.** Plan and Implement Artificial Intelligence based ideas as executable PROLOG programs through developing intelligent heuristic strategies or expert systems with adequate documentation in a collaborative environment for successfully carrying out projects on Artificial Intelligence Problems and investigate their effectiveness by analysing the performances using proper techniques and tools.

**CO-PO Mapping:**

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

## ***List of Experiments***

**Module 1: Introduction to PROLOG Programming along with the IDE and its Basic Components 3L**

Assignments for understanding the Basic Components of Knowledge Representation and Inferencing in Artificial Intelligence using PROLOG Programming and its working strategy. Understanding facts, rules, queries, and syntax.

**Module 2: Recursive definitions in Prolog 5L**

Fibonacci Series, Calculator, Factorial, summation, list length, etc. Using recursive rules.

**Module 3: Defining facts and simple queries 4L**

Writing a knowledge base for family relationships, basic objects.

**Module 4: Rules and inference in Prolog 4L**

Creating logical rules and testing inferences.

**Module 5: List operations in Prolog 4L**

Checking membership, concatenation, reverse, max/min of list.

**Module 6: Pattern matching and symbolic reasoning 5L**

Simple examples involving pattern recognition (e.g., shape or name matching, Family Tree design)

**Module 7: Expert system simulation (Mini project) 5L**

Building a mini knowledge-based system (e.g., Animal Classification, Medical diagnosis, etc).

**Text Book:**

1. Prolog Programming for Artificial Intelligence, Ivan Bratko, Addison-Wesley, $4^{th}$ Edition.

**Course Name: Engineering Chemistry Lab**
**Course Code: CH191**
**Contact: 0L:0T:2P**
**Credit: 1**

**Prerequisite:** 10+2.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Study the basic principles of pH meter and conductivity meter for different applications.
- **Obj.2.** Analysis of water for its various parameters in relation to public health, industries & environment.
- **Obj.3.** Learn to synthesis Polymeric materials and drugs.
- **Obj.4.** Study the various reactions in homogeneous and heterogeneous medium.
- **Obj.5.** Designing of innovative experiments.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.
- **CO2.** Analyse and determine the composition and physical property of liquid and solid samples when working as an individual and also as a team member
- **CO3.** Analyse different parameters of water considering environmental issues
- **CO4.** Synthesize drug and sustainable polymer materials
- **CO5.** Design innovative experiments applying the fundamentals of modern chemistry

**CO-PO Mapping:**

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

## ***List of Experiments***

***Any 10 experiments to be conducted preferably a combination of estimation, water quality analysis, instrumental analysis and synthesis***

1. To determine strength of given sodium hydroxide solution by titrating against standard oxalic acid solution.
2. Estimation of amount of Fe2+ in Mohr's salt using permanganometry.
3. To determine the surface tension of a given liquid at room temperature using stalagmometer by drop number method.
4. To determine the viscosity of a given unknown liquid with respect to water at room temperature, by Ostwald's Viscometer.
5. Water quality analysis :
   i. Determination of total, permanent and temporary hardness of sample water by complexometric titration.
   ii. Determination of Cl- ion of the sample water by Argentometric method
   iii. Determination of alkalinity of the sample water.
   iv. Determination of dissolved oxygen present in a given water sample.
6. Determination of the concentration of the electrolyte through pH measurement.

7. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
8. Determination of cell constant and conductance of solutions.
9. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
10. Determination of Partition Coefficient of acetic acid between two immiscible liquids.
11. Drug design and synthesis
12. Synthesis of polymers (Bakelite) for electrical devices and PCBs.
13. Synthesis of Silver Nanoparticles doped organic thin film for organic transistors.
14. Determination of RF of any amino acid by thin layer chromatography.
15. Saponification /acid value of any oil.
16. Isolation of graphene from dead dry batteries.

**Course Name: IDEA Lab Workshop**
**Course Code: ME193**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Course Objectives:** The objectives of this course are to

- **Obj.1.** To learn all the skills associated with the tools and inventory associated with the IDEA Lab.
- **Obj.2.** Learn useful mechanical and electronic fabrication processes.
- **Obj.3.** Learn necessary skills to build useful and standalone system/ project with enclosures.
- **Obj.4.** Learn necessary skills to create print and electronic documentation for the system/project.

| Module | Topics | |
|---|---|---|
| 1. | Electronic component familiarisation, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf.<br>Version control tools - GIT and GitHub.<br>Basic 2D and 3D designing using CAD tools such as FreeCAD,<br>Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT. | Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives<br>Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits. |
| 2. | Familiarisation and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output)<br>Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines. | Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc.<br>Basic welding and brazing and other joining techniques for assembly.<br>Concept of Lab aboard a Box. |
| 3. | Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging | 3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering.<br><br>Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers.<br>Basics of IPR and patents; Accessing<br>and utilizing patent information in IDEA Lab |
| 4. | Discussion and implementation of a mini project. | |
| 5. | Documentation of the mini project (Report and video). | |

***List of Experiments***

1. Schematic and PCB layout design of a suitable circuit, fabrication and testi of the circuit.
2. Machining of 3D geometry on soft material such as soft wood or modelling w
3. 3D scanning of computer mouse geometry surface. 3D printing of scann geometry using FDM or SLA printer.
4. 2D profile cutting of press fit box/casing in acrylic (3 or 6 m thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5. 2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6. Familiarity and use of welding equipment.
7. Familiarity and use of normal and wood lathe.
8. Embedded programming using Arduino and/or Raspberry Pi.
9. Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

**Reference Books:**


1. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing, New Delhi.
2. All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
3. Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4. 3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5. The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6. The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978-1681881584.
7. Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978-9352137374
8. The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9. Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
10. Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978- 9352131952, 978-9352133703
11. Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586
12. Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13: 978-1260019193.
14. Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978- 1484200773
15. Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer, 2004.
16. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
17. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition, 2002.

| 1st Year 2nd Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Broad Category** | **Category** | **Paper Code** | **Subject** | **Contact Hours/Week** | | | | **Credit Points** |
| | | | | | **L** | **T** | **P** | **Total** | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE201 | Electrical Circuit Analysis | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE202 | Signals and Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | SCI | Multidisciplinary | PH201 | Engineering Physics | 3 | 0 | 0 | 3 | 3 |
| 4 | SCI | Multidisciplinary | M201 | Engineering Mathematics – II | 3 | 0 | 0 | 3 | 3 |
| 5 | HUM | Value Added Course | HU201 | Environmental Science | 2 | 0 | 0 | 2 | 2 |
| 6 | HUM | Value Added Course | HU202 | Indian Knowledge System | 1 | 0 | 0 | 1 | 1 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE291 | Electrical Circuit Analysis Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE292 | Signals and Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Skill Enhancement Course | PH291 | Engineering Physics Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | ENGG | Skill Enhancement Course | ME294 | Engineering Graphics & Computer Aided Design Lab | 0 | 0 | 3 | 3 | 1.5 |
| 11 | HUM | Ability Enhancement Course | HU291 | Communication & Presentation Skill | 0 | 0 | 3 | 3 | 1.5 |
| **B. Practical** | | | | | | | | | |
| 12 | MC | Mandatory Course | MC281 | NSS/ Physical Activities / Meditation & Yoga / Photography/ Nature Club | 0 | 0 | 0 | 0 | 0 |
| **Total for Theory and Practical** | | | | | | | | **30** | **22.5** |

**Course Name: Electrical Circuit Analysis**
**Course Code: EE201**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** The students to whom this course will be offered must have the concept of Basic electrical engineering, Laplace transform, First order ordinary differential equation and Second order ordinary differential equation.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand and apply fundamental circuit laws and theorems (such as Thevenin, Norton, Superposition, Maximum Power Transfer and Millman) to analyze both DC and AC electrical networks.
- **Obj.2.** Analyze coupled and resonant circuits, including magnetic coupling, mutual inductance, and the behavior of RLC circuits under series and parallel resonance conditions.
- **Obj.3.** Utilize Laplace Transform techniques for solving first and second-order circuit differential equations to evaluate transient and steady-state responses of electrical circuits.
- **Obj.4.** Apply network analysis tools, including graph theory and two-port network parameters (Z, Y, H and T) to model and simplify complex circuits and their interconnections.
- **Obj.5.** Design and evaluate basic analog filters (low-pass, high-pass, band-pass, band-reject, and all-pass) using operational amplifiers and understand their practical applications in circuit synthesis.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Explain the application of circuit components.
- **CO2.** Apply different methods to solve network problems.
- **CO3.** Analyze various complex problems pertaining to different circuit combinations.
- **CO4.** Evaluate circuit problems using different tools.
- **CO5.** Design different electrical circuits to develop prototype.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Network Theorems** **6L**

Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Millman's Theorem Solution of Problems with DC and AC sources.

**Module 2: Coupled Circuits** **4L**

Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, Solution of problems.

**Module 3: Laplace Transform in Circuit Analysis 8L**

The Laplace's transform, Initial value theorem and final value theorem, Transient phenomena of Electrical circuits (RL, RC, RLC) with the Laplace transform, Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, inverse Laplace transform, Laplace transformation of special signal waveforms.

**Module 4: Resonance 5L**

Properties Series and Parallel Resonant Circuits, Expression of Half Power Frequencies in RLC Series Resonating Circuits and Relationship between f0, f1 and f2, Quality Factor, Bandwidths, Variation of resistant, inductive and capacitive reactance with frequency and Applications.

**Module 5: Graph Theory 3L**

Concept of Tree, Branch, Tree link, Incidence Matrix, Cut Set Matrix, Tie Set Matrix of electric circuits.

**Module 6: Two Port Network 6L**

Open circuit Impedance and Short circuit Admittance parameter, Transmission parameter, Hybrid Parameter, Conditions of Reciprocity and Symmetry, Inter-relationship between the parameters of Two Port Network, Different types of interconnection of Two Port Networks, Solution of problems.

**Module 7: Filter 4L**

Analysis and synthesis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier.

**Text Books:**

1. Sudhakar, "Circuits & Networks: Analysis & Synthesis", 2nd Edition, Tata McGraw Hill.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. D. Chattopadhyay and P. C. Rakshit, "Electrical Circuits".

**Reference Books:**

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. K. V. V. Murthyand and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
3. Sivanandam, "Electric Circuits Analysis",
4. V. K. Chandna, "A Text Book of Network Theory & Circuit Analysis", Cyber Tech References.
5. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.

**Course Name: Signals and Systems**
**Course Code: EE202**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concepts in electrical and electronics circuits, Knowledge in algebra and calculus with problem solving capability (studied in Mathematics), Fundamental concepts on Laplace Transformation (studied in Mathematics).

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce fundamental concepts of continuous and discrete-time signals and systems, including classifications, transformations, and key properties such as linearity, causality, and stability.
- **Obj.2.** Develop mathematical tools such as Fourier and Laplace transforms to analyze signals in the time and frequency domains and understand their application to LTI systems.
- **Obj.3.** Foster understanding of convolution operations and system responses, enabling analysis of both deterministic and random inputs in linear systems.
- **Obj.4.** Establish knowledge of sampling theory, including the conditions for perfect reconstruction and issues such as aliasing in sampled signals.
- **Obj.5.** Provide insight into random signals and systems, including statistical descriptions, correlation, spectral analysis, and LTI system response to stochastic inputs.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Understand mathematical description and representation of continuous and discrete time signals and systems.
- **CO2.** Understand the basic concept random variables & random signals and develop the ability to find correlation, spectral densities and response of LTI systems to random inputs.
- **CO3.** Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
- **CO4.** Demonstrate the transform-domain signals and systems and analyze its responses.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction to signal and systems 8L**

Continuous and discrete time signals: Classification of Signals – Periodic aperiodic even – odd – energy and power signals – Deterministic and random signals – complex exponential and sinusoidal signals –periodicity –unit impulse – unit step – Transformation of independent variable of signals: time scaling, time shifting. System properties: Linearity, Causality, time invariance and stability. Dirichlet’s conditions, Determination of Fourier series coefficients of signal.

**Module 2: Signal Transformation 8L**

Fourier transformation of continuous and discrete time signals and their properties. Laplace transformation- analysis with examples and properties. Parseval's theorem; Convolution in time (both discrete and continuous) and frequency domains with magnitude and phase response of LTI systems.

**Module 3: Laplace Transform 4L**

Analysis and characterization of LTI systems using Laplace transform: Computation of unit step, ramp, impulse responses and transfer function using Laplace transform.

**Module 4: Sampling Theorem 4L**

Representation of continuous time signals by its sample –Types of sampling, Sampling theorem. Reconstruction of a Signal from its samples, aliasing –sampling of band pass signals.

**Module 5: Z-Transforms 7L**

Basic principles of z-transform - z-transform definition –, Relationship between z-transform and Fourier transform, region of convergence – properties of ROC – Properties of z-transform – Poles and Zeros – inverse z-transform using Contour integration - Residue Theorem, Power Series expansion and Partial fraction expansion.

**Module 6: Random Signals & Systems 5L**

Definitions, distribution & density functions, mean values & moments, function of two random variables, concepts of correlation, random processes, spectral densities, response of LTI systems to random inputs.

**Text Books**:

1. A.V.Oppenheim, A.S.Willsky and S.H.Nawab -Signals & Systems, Pearson
2. S.Haykin & B.V.Veen, Signals and Systems- John Wiley
3. A.Nagoor Kani- Signals and Systems- McGraw Hill
4. P.Ramesh Babu & R.Anandanatarajan- Signals and Systems 4/e- Scitech

**Reference Books**:

1. J.G.Proakis & D.G.Manolakis- Digital Signal Processing Principles, Algorithms and Applications, PHI.
2. C-T Chen- Signals and Systems- Oxford
3. E WKamen & BS Heck- Fundamentals of Signals and Systems Using the Web and Matlab- Pearson
4. B.P.Lathi- Signal Processing & Linear Systems- Oxford
5. M.J.Roberts, Signals and Systems Analysis using Transform method and MATLAB, TMH
6. S Ghosh- Signals and Systems- Pearson
7. M.H.Hays- Digital Signal Processing, Schaum's outlines, TMH
8. Ashok Ambardar, -Analog and Digital Signal Processing- Thomson.
9. Phillip, Parr & Riskin- Signal, Systems and Transforms- Pearson

**Course Name: Engineering Physics**
**Course Code: PH201**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Knowledge of Physics up to $12^{th}$ standard.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide foundational understanding of core physical principles such as optics, quantum mechanics, solid-state physics, and statistical mechanics relevant to engineering disciplines.
- **Obj.2.** Develop the ability to apply theoretical knowledge of physical sciences in interpreting engineering phenomena and solving problems using scientific reasoning and quantitative analysis.
- **Obj.3.** Expose students to the working principles of modern devices and technologies like lasers, fiber optics, semiconductors, and nanomaterials used in engineering and industrial applications.
- **Obj.4.** Encourage scientific curiosity and innovation by connecting physical theories with practical tools and techniques in emerging fields like nanotechnology and quantum systems.
- **Obj.5.** Understand the role of physics in interdisciplinary domains for the advancement of science, technology, and sustainable development through real-life engineering contexts.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Explain the principles of lasers, fibre optics, and holography and apply them in modern optical and communication systems.
- **CO2.** Identify different crystal structures and compute structural parameters such as Miller indices and packing factors; distinguish between metals, semiconductors, and insulators using band theory.
- **CO3.** Utilize the principles of quantum theory, wave-particle duality, and Schrödinger equation – to interpret fundamental quantum phenomena.
- **CO4.** Illustrate the basic concepts of statistical mechanics and examine their implications on microscopic particle behaviour.
- **CO5.** Describe the properties of nanomaterials and display/storage devices and analyze their applications in modern technology.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Modern Optics 11L**

***1.01. Laser:*** Concepts of various emission and absorption processes, Einstein A and B coefficients and equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser, related numerical problems. 6L

***1.02. Fibre Optics:*** Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. 3L

***1.03. Holography:*** Theory of holography (qualitative analysis), viewing of holography, applications. 2L

**Module 2: Solid State Physics 5L**

***2.01. Crystal Structure:*** Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices – Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. 3L

***2.02. Semiconductor:*** Physics of semiconductors, electrons and holes, metal, insulator and semiconductor, intrinsic and extrinsic semiconductor, p-n junction. 2L

**Module 3: Quantum and Statistical Mechanics 14L**

***3.01. Quantum Theory:*** Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: Black body radiation, Photoelectric and Compton Effect: no derivation required), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment, related numerical problems. 5L

***3.02. Quantum Mechanics 1:*** Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions - Qualitative discussion; uncertainty principle, relevant numerical problems, Introduction of Schrödinger wave equation (only statement). 4L

***3.03. Statistical Mechanics:*** Concept of energy levels and energy states, phase space, microstates, macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)-physical significance, conception of bosons, fermions, classical limits of quantum statistics, Fermi distribution at zero & non-zero temperature, Concept of Fermi level-Qualitative discussion. 5L

**Module 4: Physics of Nanomaterials 4L**

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, graphene, electronic, environment, medical).

**Module 5: Storage and display devices 2L**

Different storage and display devices-Magnetic storage materials, Operation and application of CRT, CRO, LED and OLED.

**Text Books:**

1. Concepts of Modern Engineering Physics- A. S. Vasudeva. (S. Chand Publishers)
2. Engineering Physics - Rakesh Dogra
3. Introduction to Nanoscience and Nanotechnology, An Indian Adaptation-Charles P. Poole, Jr., Frank J. Owens.
4. Quantum Mechanics – S. N. Ghosal
5. Nanotechnology – K. K. Chattopadhyay

**Reference Books:**

1. Optics - Ajay Ghatak (TMH)
2. Solid state Physics - S. O. Pillai

3. Quantum mechanics - A.K. Ghatak and S Lokenathan
4. Fundamental of Statistical Mechanics: B. B. Laud
5. Perspective & Concept of Modern Physics – Arthur Beiser

**Course Name: Engineering Mathematics – II**
**Course Code: M201**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** The students to whom this course will be offered must have the understanding of (10+2) standard algebraic operations, and elementary calculus concepts including limits, continuity, differentiation, and integration.

**Course Objectives:** The objective of this course is to familiarize the prospective engineers with techniques in ordinary differential equations, Laplace transform and numerical methods. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Apply analytical methods to solve ordinary differential equations in engineering contexts.
- **CO2.** Apply the properties and inverse of Laplace Transforms to compute improper integrals and determine solutions of linear ordinary differential equations with constant coefficients in engineering scenarios.
- **CO3.** Apply numerical methods to interpolate data, perform numerical integration, and solve ordinary differential equations in engineering applications.
- **CO4.** Analyze the behavior of solutions using analytical and numerical approaches, including Laplace transforms, to assess stability, convergence, and accuracy in engineering contexts.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: First Order Ordinary Differential Equations (ODE) 9L**

Solution of first order and first degree ODE: Exact ODE, Rules for finding Integrating factors, Linear ODE, Bernoulli's equation.
Solution of first order and higher degree ODE: solvable for$p$, solvable for $y$ and solvable for $x$and Clairaut's equation.

**Module 2: Second Order Ordinary Differential Equations (ODE) 8L**

Solution of second order ODE with constant coefficients: Complementary Function and Particular Integral, Method of variation of parameters, Cauchy-Euler equations.

**Module 3: Laplace Transform (LT) 12L**

Concept of improper integrals; Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $tf(t)$, LT of $\frac{f(t)}{t}$, LT of derivatives of $f(t)$, LT of integral of $f(t)$, Evaluation of improperintegrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties,Convolution theorem (statement only) and its application to the evaluation of inverse LT, Solution oflinear ODE with constant coefficients (initial value problem) using LT.

**Module 4: Numerical Methods 7L**

Introduction to error analysis, Calculus of finite difference. Interpolation: Newton forward and backward interpolation, Lagrange's interpolation. Numerical integration: Trapezoidal rule, Simpson's 1/3 Rule. Numerical solution of ordinary differential equation: Euler method, Fourth order Runge-Kutta method.

**Text Books:**

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

**Reference Books:**

1. Guruprasad, S. A text book of Engineering Mathematics-I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
6. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
7. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
8. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
9. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
10. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

**Course Name: Environmental Science**
**Course Code: HU201**
**Contact: 2L:0T:0P**
**Total Contact Hours: 24**
**Credit: 2**

**Prerequisite:** 10+2.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Realize the importance of environment and its resources.
- **Obj.2.** Apply the fundamental knowledge of science and engineering to assess environmental and health risk.
- **Obj.3.** Know about environmental laws and regulations to develop guidelines and procedures for health and safety issues.
- **Obj.4.** Solve scientific problem-solving related to air, water, land and noise pollution.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Able to understand the natural environment and its relationships with human activities
- **CO2.** The ability to apply the fundamental knowledge of science and engineering to assess environmental and health risk
- **CO3.** Ability to understand environmental laws and regulations to develop guidelines and procedures for health and safety issues
- **CO4.** Acquire skills for scientific problem-solving related to air, water, noise & land pollution.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Resources and Ecosystem** **6L**

*i. Resources* *4L*

Types of resources, Human resource, Population Growth models: Exponential Growth, Logistic growth curve with explanation. Maximum Sustainable Yield [Derivation]
Alternative sources of Energy [Solar energy, tidal energy, geothermal energy, biomass energy]

*ii. Ecosystem* *2L*

Components of ecosystem, types of ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Pond eco system, Food chain, Food web.

**Module 2: Environmental Degradation** **10L**

*i. Air Pollution and its impact on Environment* *3L*

Air Pollutants, primary & secondary pollutants, Criteria pollutants, Smog, Photochemical smog and London smog, Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion.

*ii. Water Pollution and its impact on Environment* *4L*

Water Pollutants, Oxygen demanding wastes, heavy metals, BOD [Rate equation], COD, Eutrophication, Hardness, Alkalinity, TDS and Chloride, Heavy metal (As, Hg, Pb) poisoning and toxicity. Numerical on BOD, Hardness.

*iii. Land Pollution and its impact on Environment* *1L*

Solid wastes, types of Solid Waste, Municipal Solid wastes, hazardous wastes, bio-medical wastes, E-wastes,

*iv. Noise Pollution and its impact on Environment* *2L*

Types of noise, Noise frequency, Noise pressure, Measurement of noise level and decibel (dB) Noise intensity, Noise Threshold limit, Effect of noise pollution on human health. Numerical on Measurement of noise level and decibel (dB) and Noise Threshold limit.

**Module 3: Environmental Management** **6L**

*i. Environmental Impact Assessment* *1L*

Environmental Auditing, Environmental laws and Protection Acts of India, carbon footprint, Green building practices. (GRIHA norms)

*ii. Pollution Control and Treatment* *2L*

Air Pollution controlling devices, Catalytic Converter, Electrostatic Precipitator.
WasteWater Treatment (Surface water treatment &Activated sludge process), Removal of hardness of water (Temporary &Permanent -Permutitprocess ).

*iii. Waste Management* *3L*

Solid waste management, Open dumping, Land filling, incineration, composting & Vermicomposting, E-waste management, and Biomedical Waste management.

**Module 4: Disaster Management** **2L**

*i. Study of some important disasters* *1L*

Natural and Man-made disasters, earthquakes, floods drought, landslide, cyclones, volcanic eruptions, tsunami, oil spills, forest fires.

*ii. Disaster Management Techniques* *1L*

Basic principles of disaster management, Disaster Management cycle, Disaster management policy, Awareness generation program

**Text Books:**

1. Basic Environmental Engineering and Elementary Biology (For MAKAUT),
2. Gourkrishna Dasmohapatra, Vikas Publishing.
3. Basic Environmental Engineering and Elementary Biology, Dr. Monindra Nath Patra & Rahul Kumar Singha, Aryan Publishing House.
4. Textbook of Environmental Studies for Undergraduate Courses, Erach Barucha for UGC, Universities Press

**Reference Books:**

1. A Text Book of Environmental Studies, Dr. D.K. Asthana & Dr. Meera Asthana, S.Chand Publications.
2. Environmental Science (As per NEP 2020), Subrat Roy, Khanna Publisher.

**Course Name: Indian Knowledge System**
**Course Code: HU202**
**Contact: 21L:0T:0P**
**Total Contact Hours: 12**
**Credit: 1**

**Prerequisite:** A basic knowledge (10+2 level) of Indian history, civilization and culture.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the extent and aspects of ancient Indian cultural, philosophical and scientific heritage.
- **Obj.2.** Explore the philosophical roots of Indian knowledge, the scientific temper and quest for advanced understanding of the universe and deeper knowledge of the self.
- **Obj.3.** Identify and describe the Indian scientific and technological tools, techniques and discoveries and assess their significance and continuing relevance.
- **Obj.4.** Develop a liberality and open-mindedness of outlook to foster lifelong learning.
- **Obj.5.** Acquire the skills to apply traditional knowledge in their everyday lives.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Define, identify, describe and classify the philosophical, literary and socio-religious heritage of ancient India and the core concepts of the Vedic corpus and way of life.
- **CO2.** Discover, enumerate, compare, contrast and categorize the importance of pioneering developments in science and mathematics and evaluate their continuing relevance.
- **CO3.** Analyze, appraise, correlate and describe the ancient Indian heritage in science and technology and examine technological correlations with present-day technological applications.
- **CO4.** Discover, assess and describe traditional knowledge in health care, architecture, agriculture and other sectors and to explore the history of traditional Indian art forms.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: An overview of Indian Knowledge System (IKS) 3L**

Importance of Ancient Knowledge - Definition of IKS - Classification framework of IKS - Unique aspects of IKS.
The Vedic corpus: Vedas and Vedangas - Distinctive features of Vedic life.
Indian philosophical systems: Different schools of philosophy (Orthodox and Unorthodox).

**Module 2: Salient features of the Indian numeral system 3L**

Developments in Indian Mathematics in ancient India - Importance of decimal representation - The discovery of zero and its importance - Unique approaches to represent numbers- Contribution of ancient Indian mathematicians
Highlights of Indian Astronomy: Historical development of astronomy in India- key contributions of ancient Indian astronomers.

**Module 3: Indian science and technology heritage 3L**

Metals and metalworking - Mining and ore extraction –Structural engineering and architecture in ancient India: planning, materials, construction and approaches- Dyes and painting; Shipbuilding.

**Module 4: Traditional Knowledge in Different Sectors 3L**

Traditional knowledge and engineering. Traditional Agricultural practices (resources, methods, technical aids); Traditional Medicine and Surgery; History of traditional Art forms and Culture.

**Text Books:**


1. Amit Jha . Traditional Knowledge System in India. New Delhi: Atlantic Publishers, 2024.
2. B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana . Introduction to Indian Knowledge System: Concepts and Applications. New Delhi: PHI, 2022.
3. Angad Godbole. Science and Technology in Ancient India. New Delhi: Biblia Implex, 2023.
4. Pritilakshmi Swain. Indian Knowledge System. New Delhi: Redshine Publication, 2024.
5. Vishnudut Purohit. Fundamentals of Indian Knowledge System. New Delhi: ABD Publishers, 2024.


**Reference Books:**


1. A. L. Basham. The Wonder that was India. Vol. I. New Delhi: Picador, 2019.
2. Arun Kumar Jha and Seema Sahay ed. Aspects of Science and Technology in Ancient India. Oxford and New Delhi: Taylor and Francis, 2023.
3. Kapil Kapoor and Awadhesh Kumar Singh. Indian Knowledge Systems. Vols. 1 and 2. New Delhi: D. K. Printworld, 2005.
4. S. N. Sen and K. S. Shukla, History of Astronomy in India. New Delhi: Indian National Science Academy, 2$^{nd}$ edition, 2000.
5. Arpit Srivastava. Indian Knowledge System. Rewa: AKS University, 2024.

**Course Name: Electrical Circuit Analysis Lab**
**Course Code: EE291**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concepts of Basic Electrical Engineering.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Familiarize students with basic electrical components and instruments for observing and measuring circuit behavior under various conditions.
- **Obj.2.** Provide hands-on experience in verifying fundamental circuit theorems such as Kirchhoff's laws, Superposition, Thevenin's, Norton's, and Maximum Power Transfer theorems.
- **Obj.3.** Enable analysis of transient and steady-state responses in RL, RC, and RLC circuits, including resonance and power factor measurements.
- **Obj.4.** Develop practical skills in characterizing two-port networks and filter circuits, and in comparing experimental results with theoretical predictions

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Identify electrical components to study the responses of the circuit at different operating conditions.
- **CO2.** Analyze different complex electrical networks.
- **CO3.** Justify results of the experiment with theoretical solutions.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Experimental verification of electrical circuit problems using Kirchhoff's voltage and current law.
2. Experimental verification of electrical circuit problems using Superposition Theorem.
3. Experimental verification of electrical circuit problems using Thevenin's Theorem.
4. Experimental verification of electrical circuit problems using Norton's Theorem.
5. Experimental verification of electrical circuit problems using Maximum Power Transfer Theorem.
6. Verification of Series/Parallel Resonance circuit.
7. Transient response of series R-L, R-C and R-L-C circuits with verification of time constant.
8. Transient response of parallel R-L and R-C and R-L-C circuits with verification of time constant.
9. Measurement of power factor of different electrical circuits using oscilloscope.
10. Study the effect of inductance on step response of series RL circuit.
11. a) Determination of Impedance (Z) parameter of two port network.
    b) Determination of Admittance (Y) parameter of two port network.
12. Frequency response of LP and HP filters.
13. Frequency response of BP and BR filters.
14. Innovative Experiments.

**Course Name: Signals and Systems Lab**
**Course Code: EE292**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concepts of Basic Electrical Engineering and Engineering Mathematics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the use of MATLAB and Simulink for analyzing, visualizing, and simulating continuous-time and discrete-time signals and systems.
- **Obj.2.** Provide practical experience in generating and manipulating basic signals, including operations like time-scaling, time-shifting, and amplitude-scaling.
- **Obj.3.** Develop the ability to apply computational tools for performing convolution, correlation, and system response analysis (impulse and step response).
- **Obj.4.** Implement and analyze Fourier series and Z-Transform techniques for understanding signals in frequency and z-domains.
- **Obj.5.** Design and interpret the frequency response of systems, and examine the properties of linearity and time-invariance through simulations.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Analyse the time domain and frequency domain signals.
- **CO2.** Implement the concept of Fourier series and Z-Transform.
- **CO3.** Find cross correlation, autocorrelation of sequence & impulse response, step response of a system.
- **CO4.** Design frequency response of the system.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Introduction to MATLAB: To define & use variables, vectors, Matrices & its functions in MATLAB. To study various arithmetic operators and mathematical functions in MATLAB. To create & use m-files.
2. Write a MATLAB program to plot the following continuous time and discrete time Signals.
   i. Step Function
   ii. Impulse Function
   iii. Exponential Function
   iv. Ramp Function
   v. Sine Function.
3. Write a MATLAB program to obtain linear convolution of the given sequences.
4. Write a MATLAB program to perform amplitude-scaling, time-scaling and time-shifting on a given signal.
5. Write a MATLAB program to obtain Cross correlation of sequence x(n) and y(n) & autocorrelation of a sequence x(n) of the given sequences & verify the property.
6. Write a MATLAB program to generate Fourier series of a Square Wave.

7. Write a MATLAB program to Calculate and plot using Z-Transform of a given signal.
8. Write a MATLAB program to find the impulse response and step response of a system from its difference equation. Compute and plot the response of a given system to a given input.
9. Write a MATLAB program to plot magnitude and phase response of a given system.
10. Checking linearity/non-linearity of a system using SIMULINK. Build a system that amplifies a sine wave by a factor of two.

**Course Name: Engineering Physics Lab**
**Course Code: PH291**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Knowledge of Physics up to 12th standard.

**Course Objectives:** The objectives of this course are to

**Obj.1.** Become familiar with scientific instruments and measurement techniques used to determine various physical parameters of materials and systems.
**Obj.2.** Reinforce theoretical concepts learned in classroom physics by performing related practical experiments and observing real-time outcomes.
**Obj.3.** Develop a systematic and analytical approach to collecting, organizing, and interpreting experimental data for error analysis and validation of physical laws.
**Obj.4.** Engage in the experimental validation of physical laws through laboratory activities involving classical mechanics, optics, electronics, and quantum phenomena.
**Obj.5.** Encourage innovation and problem-solving abilities through hands-on investigation of advanced and application-oriented physics experiments, including specially designed extension activities.

**Course Outcomes:** After successful completion of the course, student will be able to

**CO1.** Determine mechanical properties such as Young's modulus and rigidity modulus through hands-on experiments and analyze material behaviour under applied forces.
**CO2.** Perform optical experiments including Newton's Rings, laser diffraction, and optical fiber characterization, and interpret the results based on wave optics principles.
**CO3.** Investigate quantum effects such as the photoelectric effect and atomic transitions, and relate experimental outcomes to basic quantum principles.
**CO4.** Study the performance of semiconductor and electronic devices like solar cells, LEDs, and LCR circuits, and investigate their operational characteristics.
**CO5.** Conduct experiments such as Hall Effect, e/m determination, prism dispersion, or optical rotation to demonstrate the application of advanced physical principles in practical scenarios.

**CO-PO Mapping:**

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

## ***List of Experiments***

**Module 1: General idea about Measurements and Errors (One Mandatory)**

a) Error estimation using Slide callipers/ Screw-gauge/travelling microscope for one experiment.

**Module 2: Experiments on Classical Physics (Any 4 to be performed from the following experiments)**

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.

2. Determination of Young's moduli of different materials.
3. Determination of Rigidity moduli of different materials.
4. Determination of wavelength of light by Newton's ring method.
5. Determination of wavelength of light by Laser diffraction method.
6. Optical Fibre-numerical aperture, power loss.

**Module 3: Experiments on Quantum Physics (Any 2 to be performed from the following experiments)**

7. Determination of Planck's constant using photoelectric cell.
8. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
9. Determination of Stefan's Constant.
10. a) Study of characteristics of solar cell (illumination, areal, spectral)
    b) Study of characteristics of solar cell (I-V characteristics, Power-load characteristics, Power-wavelength characteristics)

**Module 4: Perform at least one of the following experiments**

11. Determination of Q factor using LCR Circuit.
12. Study of I-V characteristics of a LED/LDR.
13. Determination of band gap of a semiconductor.

**In addition, it is recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

**Module 5: Probable experiments beyond the syllabus**

1. Determination of the specific charge of the electron (e/m) from the path of an electron beam by Thomson method.
2. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor3. Study of dispersive power of material of a prism.
3. Determination of thermal conductivity of a bad/good conductor using Lees-Charlton / Searle apparatus.
4. Determination of the angle of optical rotation of a polar solution using polarimeter.
5. Any other experiment related to the theory.

**Text Books:**

1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)
2. Practical Physics by K.G. Mazumder (New Central Publishing) 3. Practical Physics by R. K. Kar (Book & Allied Publisher)

**Course Name: Engineering Graphics & Computer Aided Design Lab**
**Course Code: ME294**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Basic knowledge of geometry.

**Course Objectives:** The objective of the course is to teach detailed engineering drawing and modeling of a component or system for a given dimension or constraints through ample understanding of engineering views, projections and sections. It will help students to acquire the manual drawing techniques as well as computer aided graphics skills, using modern engineering tools to communicate their design effectively in industries.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Use common drafting tools with the knowledge of drafting standards
- **CO2.** Understand the concepts of engineering scales, projections, sections.
- **CO3.** Apply computer aided drafting techniques to represent line, surface or solid models in different Engineering viewpoints
- **CO4.** Produce part models; carry out assembly operation and represent a design project work.

**CO-PO Mapping:**

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

## ***Course Content***

**Basic Engineering Graphics:** **3P**

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

**Module 1: Introduction to Engineering Drawing** **6P**

Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

**Module 2: Orthographic & Isometric Projections** **6P**

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes on inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

**Module 3: Sections and Sectional Views of Right Angular Solids** **6P**

Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only).

**Computer Graphics: 3P**

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

**Module 4: Overview of Computer Graphics 3P**

Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

**Module 5: CAD Drawing, Customization, Annotations, layering 6P**

Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerance; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, changing line lengths (extend/lengthen); Drawing sectional views of solids; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wireframe modeling, Part editing and printing documents.

**Module 6: Demonstration of a simple team design project 3P**

Illustrating Geometry and topology of engineered components: creation of engineering models and tpresentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; use of solid-modeling software for creating associative models at the component and assembly levels.

**Text Books:**

1. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House
2. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers

**Reference Books:**

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

**Course Name: Communication & Presentation Skill**
**Course Code: HU291**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Basic knowledge of LSRW skills.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Acquire interpersonal communication skills of listening comprehension and speaking in academic and professional situations.
- **Obj.2.** Understand English pronunciation basics and remedy errors.
- **Obj.3.** Operate with ease in reading and writing interface in global professional contexts.
- **Obj.4.** Deliver professional presentations before a global audience.
- **Obj.5.** Develop confidence as a competent communicator.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Recognize, identify and express advanced skills of Technical Communication in English and Soft Skills through Language Laboratory.
- **CO2.** Understand, categorize, differentiate and infer listening, speaking, reading and writing skills in societal and professional life.
- **CO3.** Analyze, compare and adapt the skills necessary to be a competent interpersonal communicator in academic and global business environments.
- **CO4.** Deconstruct, appraise and critique professional writing documents, models and templates.
- **CO5.** Adapt, negotiate, facilitate and collaborate with communicative competence in presentations and work-specific conclaves and interactions in the professional context.

**CO-PO Mapping:**

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

## ***<u>Course Content</u>***

**Module 1: Introduction Theories of Communication and Soft Skills**

a. Communication and the Cyclic Process of Communication (Theory, benefits and application)
b. Introduction to Workplace Communication (Principles and Practice)
c. Non-Verbal communication and its application
d. Soft Skills Introduction: Soft-Skills Introduction

What is Soft Skills? Significance of Soft-Skills
Soft-Skills Vs. Hard Skills
Components of Soft Skills
Identifying and Exhibiting Soft-Skills (Through classroom activity)

**Module 2: Active Listening**

a. What is Active Listening?

b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c. Differences between Listening and Hearing, Critical Listening, Barriers to Active Listening, Improving Listening.
d. Listening in Business Telephony and Practice

Practical (Role plays, case studies)

**Module 3: Speaking Skills**

a. Effective Public Speaking: Public Speaking, Selecting the topic for public speaking, (Understanding the audience, Organizing the main ideas, Language and Style choice in the speech, delivering the speech, Voice Clarity). Practical (Extempore)

Self Learning Topics: Preparation, Attire, Posture and Delivery techniques

b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation
c. Fluency-focused activities—JAM, Conversational Role Plays, Speaking using Picture/Audio Visual inputs
d. Group Discussion: Principles, Do's and Don'ts and Practice;

**Module 4: Writing and Reading Comprehension**

a. Reading and Writing a Book Review (classroom activity)
b. Writing a Film Review after watching a short film (classroom activity)
c. Reading Strategies: active reading, note-taking, summarizing, and using visual aids like diagrams and graphs
d. Solving Company-Specific Verbal Aptitude papers.( Synonyms, Antonyms, Error Correction and RC Passages)

**Module 5: Presentation Skills**

Kinds of Presentation. Presentation techniques, planning the presentation,
Structure of presentation: Preparation, Evidence and Research, Delivering the presentation, handling questions, Time management, Visual aids.

- Self Introduction, Creation of Video Resume`
- Need for expertise in oral presentation.•Assignment on Oral presentation.
- Rules of making micro presentation (power point). Assignment on micro presentation

**Text Books:**

1. Pushp Lata and Sanjay Kumar. A Handbook of Group Discussions and Job Interviews. New Delhi: PHI, 2009.
2. Jo Billingham. Giving Presentations. New Delhi: Oxford University Press, 2003.
3. B. Jean Naterop and Rod Revell. Telephoning in English. 3rd ed. Cambridge: Cambridge University Press, 2004.
4. Jeyaraj John Sekar. English Pronunciation Skills: Theory and Praxis. New Delhi: Authorspress, 2025.
5. Career Launcher. IELTS Reading: A Step-by-Step Guide. G. K. Publications. 2028

**Reference Books:**

1. Ann Baker. Ship or Sheep? An Intermediate Pronunciation Course. Cambridge: Cambridge University Press, 2006.
2. Barry Cusack and Sam McCarter. Improve Your IELTS: Listening and Speaking Skills. London: Macmillan, 2007.
3. Eric H. Glendinning and Beverly Holmström. Study Reading. Cambridge: Cambridge University Press, 2004.
4. Malcolm Goodale. Professional Presentations. New Delhi: Cambridge University Press, 2005.

5. Mark Hancock. English Pronunciation in Use. Cambridge: Cambridge University Press, 2003.
6. Tony Lynch, Study Listening. Cambridge: Cambridge University Press, 2004.
7. J. D. O'Connor. Better English Pronunciation. Cambridge: Cambridge University Press, 2005.
8. Peter Roach. English Phonetics and Phonology: A Practical Course. Cambridge: Cambridge University Press, 2000.

## 2nd Year 3rd Semester

| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week | | | | Credit Points |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | Total | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE301 | Measurement and IoT | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE302 | Analog and Digital Electronics | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE303 | Electromagnetic Field Theory | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Minor | CS(EE)301 | Programming with Python | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | CS(EE)302 | Data Structure and Algorithms | 2 | 0 | 0 | 2 | 2 |
| 6 | HUM | Minor | HU(EE)301 | Engineering Economics | 2 | 0 | 0 | 2 | 2 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE391 | Measurement and IoT Lab | 0 | 0 | 2 | 2 | 1 |
| 8 | ENGG | Major | EE392 | Analog and Digital Electronics Lab | 0 | 0 | 2 | 2 | 1 |
| 9 | ENGG | Skill Enhancement Course | CS(EE)391 | Programming with Python Lab | 0 | 0 | 2 | 2 | 1 |
| 10 | ENGG | Minor | CS(EE)392 | Data Structure and Algorithms Lab | 2 | 0 | 0 | 2 | 1 |
| 11 | HUM | Ability Enhancement Courses | HU(EE)391 | Technical Presentation and Group Discussion | 0 | 0 | 2 | 2 | 1 |
| **Total for Theory and Practical** | | | | | | | | **26** | **21** |

**Course Name: Measurement and IoT**
**Course Code: EE301**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Basic knowledge of electrical circuits, physics, mathematics at 12th standard level, and familiarity with electronic components.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the fundamental principles and industrial standards for electrical and electronic measurement.
- **Obj.2.** Equip students with knowledge to select, use, and calibrate modern measurement instruments for practical engineering tasks.
- **Obj.3.** Foster understanding of sensor technologies, signal conditioning, and data acquisition as per contemporary applications.
- **Obj.4.** Familiarize students with IoT architecture, protocols, and integration for smart measurement and automation.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Define, classify, and differentiate industrial measurement techniques and instrumentation.
- **CO2.** Illustrate principles, operational characteristics, and calibration of various industry-standard sensors and electronic measuring instruments.
- **CO3.** Analyze data and errors, ensuring precision and reliability in industrial measurement applications.
- **CO4.** Describe IoT architecture, communication protocols, and apply them for smart measurement and remote monitoring.
- **CO5.** Design sensor-based systems integrated with IoT for automated measurement and data analytics in real-world engineering scenarios.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Fundamentals of Measurement** **7L**

Definition and classification of industry-standard measuring instruments, measurement accuracy, precision, sensitivity, resolution, and error analysis. Principles of calibration, traceability, and international measurement standards.

**Module 2: Electrical Measurement Methods** **8L**

Practical measurement of voltage, current, resistance, and power using digital and analog meters. Moving coil, moving iron, dynamometer type instruments. Industrial application of energy meters. Instrument transformers (CT/PT), safety, and integration with control systems.

**Module 3: Electronic Measurement Techniques 7L**

Use and selection of electronic voltmeters, digital multimeters, oscilloscopes in professional settings. Measurement of frequency, time, capacitance, inductance. Implementation of signal conditioning and computerized data acquisition systems.

**Module 4: Transducers and Sensors 6L**

Operating principles and characteristics of transducers: resistive, capacitive, inductive, piezoelectric, and temperature sensors in line with engineering industry applications. Use of industrial sensors for physical parameter measurement and automation.

**Module 5: Introduction to IoT in Measurement Systems 8L**

Overview of IoT architecture and protocols (MQTT, CoAP, HTTP) favored in automation and monitoring. Integration of industrial sensors with microcontrollers and cloud platforms. Industry case studies in smart metering, environmental monitoring, predictive maintenance, and process automation. Security, scalability, and future directions of IoT-enabled measurements.

**Text Books:**


1. A.K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co.
2. H.S. Kalsi, Electronic Instrumentation, McGraw Hill Education.
3. Rajesh Singh, IoT and Its Applications, Pearson Education.
4. R.P. Jain, Modern Digital Electronics, McGraw Hill Education.


**Reference Books:**


1. David G. Alciatore and Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw Hill Education.
2. John P. Bentley, Principles of Measurement Systems, Pearson Education.
3. Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-On Approach, VPT.

**Course Name: Analog and Digital Electronics**
**Course Code: EE302**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Basic knowledge of physics, mathematics, and introductory electrical circuits.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce fundamental principles of analog electronic devices and circuits, emphasizing industry-relevant applications.
- **Obj.2.** Develop proficiency in designing and analyzing digital logic circuits for computation and control.
- **Obj.3.** Equip students to select and implement suitable electronic and digital solutions for engineering problems.
- **Obj.4.** Familiarize students with methodologies and tools used in modern electronics, including simulation and prototyping.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Describe the working principles and industrial roles of key analog components and circuits (diodes, transistors, op-amps).
- **CO2.** Design, simulate, and analyze basic amplifiers, oscillators, and filters in alignment with contemporary engineering practices.
- **CO3.** Illustrate and apply digital number systems, Boolean algebra, and logic gates for electronics systems.
- **CO4.** Design and optimize combinational and sequential digital circuits used in automation and control.
- **CO5.** Employ analog and digital circuit concepts in the development of integrated and embedded engineering solutions.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Semiconductor Devices and Circuits** **8L**

Characteristics and industrial uses of PN junction and Zener diodes. Analysis of Bipolar Junction Transistor (BJT) configurations, operation, and biasing to design amplifiers and switches. Introduction to Field Effect Transistors (FET), types and engineering principles. Practical amplifier design using BJT and FET (CE, CS amplifiers). Feedback and oscillator circuits for signal generation and system stability in electronics.

**Module 2: Operational Amplifiers and Applications** **7L**

Operational amplifier (Op-amp) characteristics, parameters, and industrial significance. Design of inverting/non-inverting amplifiers, voltage follower, summing amplifier, integrator, differentiator, and comparators. Basic active filters for signal processing in embedded and automation systems.

**Module 3: Number Systems and Codes 5L**

Binary, octal, and hexadecimal number systems and conversions for IoT, networking, and embedded systems. Binary arithmetic. Codes: BCD, Gray, ASCII. Application and relevance for modern industry communication and storage systems.

**Module 4: Logic Gates and Combinational Circuits 8L**

Fundamental logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR), minimization using Boolean algebra and Karnaugh maps. Design of combinational circuits: adders, subtractors, multiplexers, demultiplexers, encoders, decoders—critical in computing, signal routing, and automated control.

**Module 5: Sequential Circuits and Digital Systems 8L**

Flip-flops (SR, JK, D, T), working principles and real-time applications. Design of counters (asynchronous, synchronous), shift registers for automation and communication. Memory devices (RAM, ROM) and intro to ADC/DAC for digital-interfacing in modern embedded systems.

**Text Books:**

1. A.P. Malvino, Electronic Principles, McGraw Hill Education.
2. R.P. Jain, Modern Digital Electronics, McGraw Hill Education.
3. J.B. Gupta, Electronics: Principles and Applications, S.K. Kataria & Sons.
4. M. Morris Mano, Digital Logic and Computer Design, Pearson Education.

**Reference Books:**

1. Millman & Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, McGraw Hill.
2. Sedra & Smith, Microelectronic Circuits, Oxford University Press.
3. Floyd & Jain, Digital Fundamentals, Pearson Education.

**Course Name: Electromagnetic Field Theory**
**Course Code: EE303**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Knowledge of Physics and Mathematics (Calculus, Vector Algebra), and basic electric circuits.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the mathematical and physical foundations of electromagnetic field theory used in modern engineering.
- **Obj.2.** Develop practical competence in modeling and analyzing electric and magnetic fields using vector calculus and Maxwell's equations.
- **Obj.3.** Explain principles of electromagnetic wave propagation and their influence in various industrial and communication systems.
- **Obj.4.** Prepare students to apply field theory in transmission lines, waveguides, and emerging technologies in electronics and electrical engineering.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Define and describe key concepts of electrostatics, magnetostatics, and electromagnetic fields applicable in power, communication and electronic systems.
- **CO2.** Apply vector analysis and Maxwell's equations for the solution of real-world field problems relevant to electrical, electronics, and telecommunications industries.
- **CO3.** Analyze propagation, reflection, refraction, and absorption of electromagnetic waves for microwave engineering, wireless communication, and sensing applications.
- **CO4.** Design and interpret transmission line and waveguide behavior for modern electric power and high-frequency systems.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Review of Vector Analysis and Electrostatics 7L**

Vector algebra, coordinate systems (Cartesian, cylindrical, spherical), and their application for field computation. Electrostatics: electric field intensity from various charge distributions, electric potential, capacitance, conductors and dielectrics, Gauss's law, and its use in industrial applications.

**Module 2: Magnetostatics 7L**

Magnetic field generation by current-carrying conductors, analysis using Biot–Savart and Ampere's circuital law. Key concepts: magnetic flux, flux density, magnetic materials, field computation in industrial equipment, boundary conditions, electromagnetic force and torque, magnetic dipoles in devices.

**Module 3: Time-Varying Fields and Maxwell's Equations 8L**

Faraday's law, electromagnetic induction and real-world energy conversion systems. Displacement current, continuity equation, Maxwell's equations (differential and integral forms), their physical significance, and application in electrical machines and communication hardware.

**Module 4: Electromagnetic Wave Propagation 7L**

Electromagnetic wave equations and solutions in free space, conductors, and dielectrics. Industrially relevant properties of uniform plane waves, attenuation, reflection, refraction, skin depth. Poynting vector for evaluating power flow in circuits, antennas, and energy transfer systems.

**Module 5: Transmission Lines and Waveguides 7L**

Transmission line theory, parameters, and industrial impact on signal integrity. Lossless and lossy lines, impedance matching for optimized communication and energy transfer. Introduction to waveguides, types, propagation modes, relevance for microwave, radar, and optical networks.

**Text Books:**

1. W.H. Hayt & J.A. Buck, Engineering Electromagnetics, McGraw Hill Education.
2. David K. Cheng, Field and Wave Electromagnetics, Pearson Education.
3. M.N.O. Sadiku, Elements of Electromagnetics, Oxford University Press.

**Reference Books:**

1. J.D. Kraus, Electromagnetics, McGraw Hill Education.
2. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill.
3. Mathew N.O. Sadiku, Principles of Electromagnetics, Oxford University Press.

**Course Name: Programming with Python**
**Course Code: CS(EE)301**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Basic mathematical reasoning, logical thinking, and prior exposure to any programming language at school level.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce core programming concepts and Python syntax used in leading technology companies.
- **Obj.2.** Develop practical programming skills for automation, scripting, data processing, and prototyping.
- **Obj.3.** Enable students to implement and debug Python programs using industry-relevant libraries and tools.
- **Obj.4.** Design object-oriented solutions and implement concepts for engineering applications using Python.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Apply Python syntax, data types, and operators for writing efficient programs.
- **CO2.** Implement decision-making, iterative constructs, and modularity through functions, following professional coding standards.
- **CO3.** Utilize Python data structures (lists, tuples, dictionaries, sets) for storing, processing, and retrieving data in scalable applications.
- **CO4.** Employ file operations, exception handling, and serialization for robust automation tasks.
- **CO5.** Design, develop, and debug real-world software solutions using object-oriented concepts, and employ Python libraries such as NumPy, Pandas, and Matplotlib for engineering analysis and visualization.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Python Foundations & Scripting 7L**

Introduction to contemporary Python usage in real-world apps. Python syntax, data types (with emphasis on scalability), operators, variables, expressions, and interactive scripting. Strong focus on code readability (PEP8 standards) and documenting code.

**Module 2: Control Structures, Functions and Debugging 7L**

Industry-style decision control and loops (if, elif, else, for, while). Functions, anonymous functions (lambda), recursion, scope, modular programming. Debugging, error types, and best practices for writing maintainable code.

**Module 3: Data Structures for Industry Applications** **7L**
Comprehensive discussion on lists, tuples, sets, and dictionaries for managing structured/unstructured data (as used in web, automation, and analytics). Real-world data operations, searching, sorting, and performance considerations.

**Module 4: File Handling, Exceptions & Data Serialization** **7L**
Best practices for handling text, CSV, JSON, XML files as in engineering, business, and data science. Exception handling for robust code, custom exceptions, serialization (pickle, JSON), and data interchange—essential for modern software development and automation.

**Module 5: Object-Oriented Design & Essential Python Libraries** **8L**
Industry-relevant OOP concepts: classes, objects, attributes, inheritance, encapsulation, polymorphism. Use of Python packages: NumPy (numerical computation for engineering), Pandas (data analysis as used in data-centric firms), Matplotlib (visualization techniques for data reporting), introduction to software testing and professional development environments.

**Text Books:**

1. Y. Daniel Liang, Introduction to Programming Using Python, Pearson Education.
2. Mark Lutz, Learning Python, O'Reilly Media.
3. R.L. Sweigart, Automate the Boring Stuff with Python, No Starch Press.

**Reference Books:**

1. Wesley J. Chun, Core Python Programming, Prentice Hall.
2. Paul Barry, Head First Python, O'Reilly Media.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media.

**Course Name: Data Structure and Algorithms**
**Course Code: CS(EE)302**
**Contact: 2L:0T:0P**
**Total Contact Hours: 24**
**Credit: 2**

**Prerequisite:** Basic programming knowledge (preferably in C/C++/Python), logical reasoning, and problem-solving abilities.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce key concepts and implementation techniques for fundamental data structures.
- **Obj.2.** Develop proficiency in designing efficient algorithms for problem-solving in software and engineering.
- **Obj.3.** Provide hands-on experience with analysis of algorithm complexity using practical examples.
- **Obj.4.** Prepare students for real-world applications in software development, including interviews and coding challenges.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Define and apply core data structures (arrays, stacks, queues, linked lists, trees, graphs) in developing practical software solutions.
- **CO2.** Analyze algorithm efficiency using Big-O notation and resource management strategies relevant to industry practices.
- **CO3.** Implement and compare searching, sorting, and traversal algorithms in terms of runtime and memory.
- **CO4.** Solve complex computational problems using recursive and iterative programming techniques.
- **CO5.** Design and optimize data-driven systems using advanced structures for real-world engineering and technology applications.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction & Algorithm Analysis** **5L**
Definition, necessity, and application of data structures in engineering. Performance analysis: time and space complexity, Big-O, Omega, Theta notation. Recursion and iterative design in algorithms, use of in-place and out-of-place solutions.

**Module 2: Linear Data Structures** **4L**
Implementation and applications of arrays, linked lists (single, double, circular), stacks, and queues. Stack and queue operations, applications in real computing systems, memory management, and conversions.

**Module 3: Non-Linear Data Structures 5L**

Trees (binary, BST, AVL, B-tree): traversal (preorder, inorder, postorder), insertion, deletion, balancing. Graphs: representation (adjacency matrix/list), traversal algorithms (DFS, BFS), connectivity, shortest-path algorithms fundamentals.

**Module 4: Searching and Sorting Algorithms 5L**

Linear and binary search techniques. Sorting algorithms: bubble, selection, insertion, merge, quick, heap sort. Complexity analysis, stability, and industry relevance in data management and pipeline systems.

**Module 5: Advanced Data Structures and Real-world Applications 5L**

Introduction to hash tables, heaps, priority queues, tries. Applications in databases, compilers, operating systems, networking, and modern software engineering (such as interview problems and online judges). Emerging trends: industry tools/libraries for efficient data structure management.

**Text Books:**

1. Ellis Horowitz, Sartaj Sahni, S. Anderson-Freed, Fundamentals of Data Structures in C, Universities Press.
2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C/C++, Pearson Education.
3. Y. Daniel Liang, Introduction to Data Structures with Applications, Pearson Education.

**Reference Books:**

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, MIT Press.
2. Robert Lafore, Data Structures and Algorithms in Java, Sams Publishing.
3. Michael T. Goodrich, Roberto Tamassia, Data Structures and Algorithms in Python, Wiley.

**Course Name: Engineering Economics**
**Course Code: HU(EE)301**
**Contact: 2L:0T:0P**
**Total Contact Hours: 24**
**Credit: 2**

**Prerequisite:** Basic mathematics, knowledge of high school economics, and awareness of engineering management principles.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce core concepts and principles of economics relevant to engineering projects and organizations.
- **Obj.2.** Develop analytical methods for evaluating the financial feasibility of engineering solutions and investments.
- **Obj.3.** Familiarize students with cost estimation, budgeting, and economic decision-making in industry settings.
- **Obj.4.** Equip students to perform break-even, cash-flow, and depreciation analyses for asset management and project evaluation.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Describe key concepts of engineering economics, including demand, supply, market structures, and cost analysis.
- **CO2.** Apply methods for economic evaluation, such as present worth, annual worth, and rate of return, to real engineering projects.
- **CO3.** Analyze alternatives and perform cost-benefit, break-even, and sensitivity analyses to guide industry decisions.
- **CO4.** Evaluate the impact of depreciation, taxation, and inflation on capital budgeting and project viability.
- **CO5.** Prepare and interpret engineering cost estimates, budgets, and financial statements for professional management practice.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction to Engineering Economics and Cost Concepts 5L**

Nature and scope of engineering economics; importance in decision-making for projects and industries. Demand and supply analysis; elements of cost, types of costs, cost estimation, and cost allocation in engineering firms.

**Module 2: Economic Analysis Methods 5L**

Time value of money, cash-flow diagrams, present and future worth analysis, annual equivalent method, rate of return method. Use of these methods in evaluating engineering alternatives and projects as practiced in industry.

**Module 3: Cost-Benefit and Break-Even Analyses 5L**

Cost-benefit analysis, break-even analysis and charting; sensitivity analysis. Applications in technology selection, manufacturing processes, and investment decisions.

**Module 4: Depreciation, Taxation, and Inflation Effects 5L**

Depreciation methods (straight-line, declining balance, sum-of-years-digits), impact of depreciation on asset management in industry. Taxation and its influence on project decisions. Inflation analysis, adjusting economic evaluations for changing value over time.

**Module 5: Budgets, Financial Statements, and Project Evaluation 4L**

Preparation and analysis of engineering cost estimates, budgets, and financial statements for organizations. Capital budgeting, asset evaluation, risk and uncertainty in project selection. Overview of professional practice in project costing and financial management.

**Text Books:**

1. Sullivan, W.G., Wicks, E.M. & Koelling, C.P., Engineering Economy, Pearson Education.
2. Chan S. Park, Contemporary Engineering Economics, Pearson Education.
3. R.Panneerselvam, Engineering Economics, PHI Learning.

**Reference Books:**

1. Tarquin, A.J. & Blank, L., Engineering Economy, McGraw Hill Education.
2. S.C. Sharma & T.R. Banga, Industrial Organization and Engineering Economics, Khanna Publishers.
3. P.L. Mehta, Managerial Economics, Sultan Chand & Sons.

**Course Name: Measurement and IoT Lab**
**Course Code: EE391**
**Contact: 0L:0T:2P**
**Credit: 1**

**Prerequisite:** Basic Physics and applied physics, Basic Mathematics, Basic concepts of Electric Circuit and Electronics.

**Course Objectives:** The objectives of this course are to

**Obj.1.** Familiarize students with modern electrical and electronic measuring instruments and safety practices.
**Obj.2.** Introduce sensors and transducers, and their integration with IoT platforms.
**Obj.3.** Develop skills in experimental data acquisition, calibration, and analysis.
**Obj.4.** Train students to design IoT-enabled measurement systems for smart monitoring applications.

**Course Outcomes:** After successful completion of the course, student will be able to

**CO1.** Identify and use modern electrical and electronic measuring instruments and implement essential safety measures in lab and industry environments.
**CO2.** Evaluate the accuracy, performance, and characteristics of sensors and instruments for measurement—including integration with IoT platforms.
**CO3.** Interpret experimental data and observations for calibration, troubleshooting, and reporting using digital tools.
**CO4.** Design and demonstrate basic IoT-enabled measurement setups for smart monitoring and data acquisition.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Basic safety precautions and lab protocols; demonstration of earthing systems and safe operation of instruments.
2. Introduction to measuring instruments—Voltmeter, Ammeter, Multimeter, Wattmeter—and identification of industrial-grade resistors, capacitors, and inductors.
3. Study of sensor types: temperature, humidity, and proximity sensors commonly used in IoT.
4. Measurement of electrical parameters (voltage, current, resistance) using digital and analog instruments; calibration methods.
5. Analysis of R-L-C series and parallel circuits, verification of electrical laws using hands-on setups.
6. Experimentation with IoT microcontroller platforms (e.g., Arduino/Raspberry Pi): interface sensors and collect measurement data.
7. Verification and analysis of power, line and phase voltage/current in single-phase and three-phase electrical circuits using energy meters and data logging devices.
8. Measurement and assessment of primary and secondary voltage/current of transformers—performing open-circuit and short-circuit tests.

9. Testing of energy meters for load measurement; understanding digital data acquisition from such meters.
10. Demonstration and analysis of real-time data transmission via Wi-Fi/Bluetooth from sensors to cloud/artificial dashboards.
11. IoT application demonstration: monitoring environmental data, remote equipment status, and alert generation.
12. Innovative experiments including student-designed measurement setups or IoT integrated applications for smart labs and industries.

**Course Name: Analog and Digital Electronics Lab**
**Course Code: EE392**
**Contact: 0L:0T:2P**
**Credit: 1**

**Prerequisite:** Basic knowledge of electronic devices, electrical circuits, and introductory concepts in analog and digital electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide hands-on experience with analog and digital electronic components and circuits.
- **Obj.2.** Develop analytical skills in evaluating amplifiers, oscillators, and logic circuits.
- **Obj.3.** Train students in designing and testing combinational, sequential, and mixed-signal circuits.
- **Obj.4.** Enable students to implement mini-projects applying analog/digital electronics in real-world applications.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Identify, use, and troubleshoot key analog and digital electronic components and instruments commonly applied in industry.
- **CO2.** Evaluate performance and characteristics of analog amplifiers, oscillators, and digital logic circuits through hands-on experiments.
- **CO3.** Analyze real-world electronic circuits and interpret experimental results for calibration and optimization.
- **CO4.** Design, implement, and test basic electronics circuits and logic systems relevant to industrial and embedded applications.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Identification and testing of electronic components: resistors, capacitors, diodes, transistors, ICs.
2. Characteristics and application of PN junction diode and Zener diode as rectifiers and voltage regulators.
3. Design and analysis of transistor (BJT) amplifier circuits: Common Emitter (CE) configuration—measurement of voltage gain and input/output resistance.
4. Implementation and testing of basic oscillators using transistor circuits.
5. Study and realization of operational amplifier (OP-AMP) circuits: inverting/non-inverting amplifiers, summing amplifier, integrator, and differentiator.
6. Digital electronics experiments: implementation and verification of logic gates (AND, OR, NOT, NAND, NOR, XOR) using ICs and breadboards.
7. Design, testing, and analysis of combinational circuits: adders, subtractors, multiplexers, demultiplexers, encoders, and decoders.
8. Construction of basic flip-flop circuits: SR, JK, D, and T—characterization and truth table verification.

9. Implementation of asynchronous and synchronous counters; demonstration and analysis of counting sequences.
10. Design and testing of shift registers for basic data storage and transfer applications.
11. Interfacing digital circuits with microcontrollers for experimentation and demonstration of embedded applications.
12. Mini-project or innovative experiment: students build and test a simple analog/digital system (e.g., sensor interface, digital timer, basic automation circuit).

**Course Name: Programming with Python Lab**
**Course Code: CS(EE)391**
**Contact: 0L:0T:2P**
**Credit: 1**

**Prerequisite:** Basic programming knowledge, understanding of Python syntax and concepts, and logical reasoning skills.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce students to Python programming environment, syntax, and core programming constructs.
- **Obj.2.** Develop problem-solving skills through the use of control statements, functions, and data structures.
- **Obj.3.** Enable students to design modular and object-oriented Python programs.
- **Obj.4.** Familiarize students with file handling, error management, and Python libraries for computation and visualization.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Identify and implement foundational programming constructs in Python to solve real-world problems.
- **CO2.** Design, code, and debug Python programs using data structures, control statements, and functions for industry-relevant tasks.
- **CO3.** Develop applications involving file operations, error handling, and use of specialized Python libraries.
- **CO4.** Create and test object-oriented and modular Python code for typical engineering and data analysis applications.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Introduction to Python programming environment: installation, IDE setup, basic syntax, and execution of Python scripts.
2. Implementation of data types, variables, operators, and input/output operations for interactive programs.
3. Use of conditional statements (if, elif, else) and loops (for, while) for flow control in problem solving.
4. Functions and modules: definition, use, parameter passing, recursion, and modular program organization.
5. Programming with lists, tuples, sets, and dictionaries for storing and manipulating various types of data.
6. String manipulation and regular expressions for parsing and processing textual data.
7. File handling: reading/writing text and CSV files, data serialization with pickle and JSON for persistent storage.
8. Error and exception handling for robust program execution, demonstration of try-except blocks.

9. Introduction to object-oriented programming in Python: classes, objects, inheritance, and encapsulation.
10. Application of Python libraries (NumPy, Pandas, Matplotlib) for numerical computation, data analysis, and visualization.
11. Mini-project involving real-world application development, e.g., data analytics, automation scripts, or sensor interfacing.
12. Innovative experiment or extended project using Python for engineering applications, demonstrated by students.

**Course Name: Data Structure and Algorithms Lab**
**Course Code: CS(EE)392**
**Contact: 0L:0T:2P**
**Credit: 1**

**Prerequisite:** Basic programming knowledge (preferably in C/C++/Python) and understanding of foundational programming concepts.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide practical knowledge of fundamental data structures and their applications.
- **Obj.2.** Develop the ability to design and implement algorithms for searching, sorting, and traversing data.
- **Obj.3.** Train students in analyzing time and space complexity of algorithms.
- **Obj.4.** Strengthen problem-solving ability using iterative and recursive approaches.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Implement and test fundamental data structures (arrays, stacks, queues, linked lists, trees, graphs) through practical coding exercises.
- **CO2.** Analyze the efficiency and performance of algorithms using running time and memory usage measurements.
- **CO3.** Design and execute programs for sorting, searching, and traversing data structures, reflective of real-world industry requirements.
- **CO4.** Address and solve computational problems using recursive and iterative approaches with professional programming standards.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Implementation of arrays: insertion, deletion, searching, sorting, and applications in scientific and engineering data processing.
2. Creation and manipulation of linked lists (single, circular, doubly) and comparison with array-based structures for dynamic data storage.
3. Development of stack and queue operations: applications in expression parsing, recursion, and scheduling tasks.
4. Construction and traversal (preorder, inorder, postorder) of various trees: binary trees, BST, AVL trees.
5. Implementation and traversal algorithms (DFS, BFS) for graphs; analysis of connectivity and shortest-path problems.
6. Coding and evaluation of sorting algorithms: bubble, selection, insertion, merge, quick, and heap sort with time complexity measurement.
7. Programming searching techniques: linear and binary search on sorted/unsorted datasets.
8. Application of hash tables and management of collisions; efficiency comparison in storing and retrieving data.
9. Use of recursion for solving mathematical and engineering computational problems; comparison with iterative solutions.

10. Design and implementation of mini-projects to solve real-life engineering or interview-style problems using data structures and algorithms.
11. Use of industry-relevant coding practices, documentation, and debugging techniques; measurement and improvement of program efficiency.
12. Innovative experiment: group or individual development of an application employing multiple data structures (e.g., dynamic scheduling, data analytics, simulation).

**Course Name: Technical Presentation and Group Discussion**
**Course Code: HU(EE)391**
**Contact: 0L:0T:2P**
**Credit: 1**

**Prerequisite:** Basic proficiency in English communication and written skills; foundational understanding of technical topics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Develop effective oral communication and technical presentation skills.
- **Obj.2.** Ttrain students in organizing and delivering structured technical content using modern tools.
- **Obj.3.** Build confidence and competence in group discussions, debates, and mock interviews.
- **Obj.4.** Enhance teamwork, leadership, and critical thinking skills for professional environments.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Demonstrate effective oral presentation skills for communicating technical ideas and solutions.
- **CO2.** Organize and deliver logical, audience-oriented technical content using visual aids and modern tools.
- **CO3.** Participate productively in group discussions, applying critical thinking, leadership, and interpersonal skills valued in industry.
- **CO4.** Communicate technical information clearly in individual and team settings, addressing contemporary engineering topics.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Introduction to technical presentation skills, structure, and delivery methods.
2. Preparation and presentation of technical topics using PowerPoint, whiteboard, and other industry-standard visual aids.
3. Individual technical talks on current engineering trends, emerging technologies, or research topics.
4. Group discussions on technical case studies, problem solving, and contemporary issues in engineering and technology.
5. Peer evaluation and constructive feedback for presentations and group discussions.
6. Mock interviews: technical rounds, HR scenarios, and panel interactions.
7. Role-play and team-building activities to foster collaborative and leadership skills.
8. Extempore speaking sessions on technical subjects and problem-based scenarios.
9. Debates on ethical, societal, and global issues relevant to engineering practice.
10. Preparation of written summaries, abstract writing, and technical reports based on presented topics.
11. Industry-oriented seminars or webinars: participation, critical review, and reporting.

12. Innovative presentation or group activity, such as technical quiz or brainstorming session, driven by contemporary engineering challenges.

## 2nd Year 4th Semester

| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week L | T | P | Total | Credit Points |
|---|---|---|---|---|---|---|---|---|---|
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE401 | Electrical Machines - I | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE402 | Control Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE403 | Power Electronics | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Major | PE(EE)401 | A. Utilization of Electric Power<br>B. Sensors and Actuators<br>C. Digital Communication | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Minor | EC(EE)401 | Microprocessor and Microcontrollers | 3 | 0 | 0 | 3 | 3 |
| 6 | HUM | Ability Enhancement Courses | HU(EE)401 | Principles of Management | 2 | 0 | 0 | 2 | 2 |
| **B. Practical** | | | | | | | | | |
| 7 | ENGG | Major | EE491 | Electrical Machines - I Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Major | EE492 | Control Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 9 | ENGG | Major | EE493 | Power Electronics Lab | 0 | 0 | 3 | 3 | 1.5 |
| 10 | ENGG | Minor | EC(EE)491 | Microprocessor and Microcontrollers Lab | 0 | 0 | 3 | 3 | 1.5 |
| **Total for Theory and Practical** | | | | | | | | **29** | **23** |

**Course Name: Electrical Machines – I**
**Course Code: EE401**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Basic Electrical Engineering, Electrical Circuit Analysis.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Impart knowledge of the basic principles of electromechanical energy conversion and the concept of energy balance in electrical machines.
- **Obj.2.** Understand the magnetic circuits, construction, phasor diagrams, testing, and performance characteristics of transformers.
- **Obj.3.** Analyze the construction, principle of operation, characteristics, performance, and applications of DC machines.
- **Obj.4.** Develop analytical skills for modeling, analyzing, and solving numerical problems related to transformers and DC machines.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Analyse the connections of single-phase transformers and their applications.
- **CO2.** Analyse the connections of three-phase & special transformer phase transformers and their applications.
- **CO3.** Demonstrate the operation of different types of dc generator and their applications.
- **CO4.** Demonstrate the operation of different types of dc motor and their applications.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Review of magnetic circuits** **4L**
MMF, flux, reluctance, self-inductance, mutual inductance, coupled circuits.

**Module 2: Single-Phase Transformer** **8L**
Phasor diagram, voltage regulation, losses and efficiency. Per unit representation of single-phase transformers. Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses. Single-phase Auto transformer – Comparison of weight, copper loss with Two-winding transformer, equivalent circuit, applications.

**Module 3: Three-Phase Transformer** **8L**
Construction, types of connection and their comparative features, Parallel operation of single-phase and three- phase transformers. Scott-connected transformer and open-delta connection – working principle, connection diagram, practical application. Effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Effect of unbalanced loading and neutral shifting - Tertiary winding, Tap-changer and Grounding transformer.

**Module 3: DC Machines 16L**

Single conductor generating and motoring action. DC machine construction and armature winding. Generated voltage and torque equation. Armature reaction and its minimization – Interpole, Compensating winding and Commutation method.

*i. DC Generator:*

Concepts of excitation system, voltage builds up process, critical resistance and critical speed. OCC and Load characteristics of DC generators.

*ii. DC Motor:*

Operating characteristics of DC motors. Starting, Braking and Speed Control techniques used for DC motors. Test on DC machines – Brake Test, Hopkinson's Test, Ward Leonard method and Swinburne Test.

**Text Books:**


1. Electrical Machinery, P.S.Bhimra,6thEdition,Khanna Publishers.
2. Electric machines, D.P. Kothari & I.J Nagrath, 3rd Edition, Tata Mc Graw-Hill Publishing Company Limited.
3. Electrical Machines, P.K.Mukherjee & S.Chakrabarty, Dhanpat Rai Publication.


**Reference Books:**


1. Electric Machinery & Transformers, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electrical Machines, R.K.Srivastava, Cengage Learning
3. TheoryofAlternatingCurrentMachinery,AlexanderSLangsdorf,TataMcGrawHill Edition.
4. The performance and Design of Alternating Current Machines, M. G. Say, CBS Publishers & Distributors.
5. Electric Machinery & transformer, Irving LKoskow, 2nd Edition, Prentice Hall India.

**Course Name: Control Systems**
**Course Code: EE402**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Basic Electrical Engineering, Circuit Theory and Engineering Mathematics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the fundamental concepts of control systems and mathematical modeling of physical systems.
- **Obj.2.** Develop the ability to analyze system behavior in time and frequency domains for stability and performance evaluation.
- **Obj.3.** Impart knowledge on the design and implementation of controllers and compensators for achieving desired system specifications.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Calculate mathematical model and transfer function of the physical systems.
- **CO2.** Analyze the linear systems in time domain.
- **CO3.** Illustrate the linear systems in frequency domain.
- **CO4.** Design simple compensators and controllers for the given specifications.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Systems and their Representations** **6L**
Basic elements in control systems - open loop & closed loop - Transfer functions of mechanical, electrical and analogous systems. Block diagram reduction - signal flow graphs.

**Module 2: Time Domain Analysis** **6L**
Standard test signals, Time response of first and second order system for Unit Step and Unit Impulse Signal, Time domain specifications, Steady state error, error constants, generalized error coefficient, Effect of addition of poles and zeros to a system.

**Module 3: Stability Analysis and Root Locus** **6L**
Stability - concept and definition, Characteristic equation – Location of poles – Routh Hurwitz criterion - Root locus techniques: construction, properties and applications.

**Module 4: Frequency Response Analysis** **5L**
Bode plot - Polar plot - Correlation between frequency domain and time domain specifications.

**Module 5: Stability in Frequency Domain** **5L**
Relative stability, Gain margin, Phase margin, stability analysis using frequency response methods, Nyquist stability criterion.

**Module 6: Controllers and Compensators 8L**

Challenges and Constraints of Classical Control Systems design: Concept of P, PI, PD and PID Controller and their effect on closed-loop system, Design of P, PI, PD and PID Controllers, Types of PID Controller configuration, Tuning of PID Controllers, Case Studies.

Compensator Design: Controller vs Compensator, Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance, Case Studies.

**Text Books:**

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education.
2. Norman S. Nise, “Control System Engineering”, John Wiley & Sons, 6th Edition, 2011.
3. Benjamin C Kuo “Automatic Control System” John Wiley & Sons, 8th Edition, 2007.

**Reference Books:**

1. M. Gopal, “Control Systems-Principles And Design”, Tata McGraw Hill – 4th Edition, 2012.
2. R.C. Dorf & R.H. Bishop, “Modern Control Systems”, Pearson Education, 11th Edition, 2008.
3. I. J. Nagrath and M.Gopal,” Control System Engineering”, New Age International Publishers, 4th Edition, 2006.
4. Graham C. Goodwin, Stefan F. Graebe, Mario E. Sagado, “Control System Design”, Prentice Hall, 2003.

**Course Name: Power Electronics**
**Course Code: EE403**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the characteristics, operation, and application of various power electronic switching devices such as power diodes, MOSFETs, IGBTs, SCRs, TRIACs, and GTOs used in modern power electronic circuits.
- **Obj.2.** Analyze the operation and performance of controlled and uncontrolled rectifiers, DC-DC converters, inverters, and cycloconverters, including their impact on different types of loads and associated performance parameters.
- **Obj.3.** Explore various control techniques and protection methods for power electronic devices and converters.
- **Obj.4.** Examine practical applications of power electronics in real-world systems such as UPS, SMPS, battery chargers, electric vehicles, and FACTS devices, emphasizing efficiency and reliability.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Evaluate the performance of various power electronic switches by analyzing their static and dynamic characteristics, triggering methods, and protection techniques in practical circuits.
- **CO2.** Analyze the operational behavior of different power converters under varying load conditions and control strategies to optimize their performance.
- **CO3.** Design and simulate power converter systems tailored to specific applications, incorporating efficiency, reliability, and safety considerations.
- **CO4.** Assess and propose solutions for the integration of power electronic converters in real-world applications such as electric vehicles, UPS, SMPS, and FACTS, considering performance metrics and constraints.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Power Electronic Switching Devices** **2L**
Uncontrolled converters, advantages and disadvantages of power electronics converters, power Diode, Fast recovery diodes, Power MOSFET, UJT, TRIAC, IGBT and GTO.

**Module 2: Thyristors** **5L**
V-I characteristics, Two transistor model of SCR, SCR turn on methods, gate triggering circuits switching characteristics, ratings, SCR protection, series and parallel operation, different commutation techniques of SCR.

**Module 3: Phase Controlled Rectifiers 8L**

Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads. Effects of free-wheeling diode, source inductance on the performance of converters. Performance parameters of converters, Dual converters, Solution of problems.

**Module 4: DC-DC Converters 5L**

Principle of operation, control strategies, Step up and Step-down choppers, Performance parameters, Buck, Boost, Buck - Boost Converters, Quadrant operation of DC-DC converters.

**Module 5: Inverters 8L**

Inverters: Principle of operation of single-phase inverter, 120° and 180° conduction mode of operation of three phase inverter, performance parameters of inverters, PWM techniques, sinusoidal PWM, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. Brief idea of Resonant Pulse inverters.

**Module 6: Cycloconverters and AC Voltage Regulators 6L**

Principle of operation of cycloconverters, circulating and non-circulating mode of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase Cycloconverters, three phase to three phase Cycloconvetter.

Principle of on-off and phase control, single phase and three phase controllers with R and R-L loads.

**Module 7: Applications 2L**

UPS (Online and Offline), SMPS, Battery Chargers. Electric Vehicle, FACTS.

**Text Books:**

1. L. Umanand, Power Electronics: Essentials and Applications.
2. M. H. Rashid, Power Electronics, PHI/ Pearson Education.
3. P. S. Bhimra, Power Electronics, Khanna Publications.
4. K. Hari Babu: Power Electronics

**Reference Books:**

1. C.W. Lander, Power Electronics, McGraw Hill.
2. B. K. Bose, Modern Power Electronics, JAICO.
3. Mohan, N Undeland, TM & Robbins, WP- Power Electronics, John Wiley & Sons.

**Course Name: Utilization of Electric Power**
**Course Code: PE(EE)401A**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

**Course Objectives:** The objectives of this course are to

**Obj.1.** Explain the fundamental principles and operation of electric traction systems, including various traction motors and their control under different operating conditions.
**Obj.2.** Analyze lighting requirements for various applications and select suitable lighting systems based on technical specifications.
**Obj.3.** Describe the working principles and applications of electric heating and electric welding processes in industrial contexts.
**Obj.4.** Explain the principles and industrial applications of electrolysis in electrical engineering.

**Course Outcomes:** After successful completion of the course, student will be able to

**CO1.** Demonstrate the working of traction motor and their control under different working conditions.
**CO2.** Anlyze illumination level for a given application and select the suitable specification for installation.
**CO3.** Illustrate the working of Electric Heating, welding processes.
**CO4.** Explain the process of electrolysis.

**CO-PO Mapping:**

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

## ***Course Content***

**Module1: Electric Traction 18L**

Requirement of an ideal traction system, Supply system for electric traction, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed), Mechanism of train movement (energy consumption, tractive effort during acceleration, tractive effort on a gradient, tractive effort for resistance, power and energy output for the driving axles, factors affecting specific energy consumption, coefficient of adhesion). Electric traction motor & their control: Parallel and series operation of Series and Shunt motor with equal and unequal wheel diameter, effect of sudden change of in supply voltage, Temporary interruption of supply, Tractive effort and horse power. Use of AC series motor and Induction motor for traction. Traction motor control: DC series motor control, Multiple unit control, Braking of electric motors, Electrolysis by current through earth, current collection in traction system, Power electronic controllers in traction system.

**Module 2: Illumination 8L**

The nature of radiation, Polar curve, Law of illumination, Photometry (Photovoltaic cell, distribution photometry, integrating sphere, brightness measurement). Types of Lamps: Conventional and energy efficient, Basic principle of light control, Different lighting scheme and their design methods, Flood and Street lighting.

**Module 3: Electric Heating and Welding 6L**

Types of heating, Resistance heating, Induction heating, Arc furnace, Dielectric heating, Microwave heating.

**Module 4: Electrolytic Processes 4L**

Basic principles, Faraday's law of Electrolysis, Electro deposition, Extraction and refining of Metals, Power supply of Electrolytic processes.

**Text Books:**

1. T. Starr, "Generation, Transmission and Utilization of Electrical Power", Pitman.
2. J. B. Gupta, "Utilization of Electric Power & Electric Traction", S. K. Kataria & Sons.
3. C. L. Wadhawa, "Generation Distribution and Utilization of Electrical Energy", New Age International Publishers.

**Reference Books:**

1. H. Partab, "Art and Science of Utilization of Electrical Energy", Dhanpat Rai & Sons.
2. E. Openahaw Taylor, Orient Longman, "Utilisation of Electric Energy".

**Course Name: Sensors and Actuators**
**Course Code: PE(EE)401B**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Measurement and Transducers.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Differentiate between sensors, transmitters, and transducers, and analyze their characteristics and operational principles.
- **Obj.2.** Explain the construction, working principles, and applications of inductive, capacitive, and other conventional transducers.
- **Obj.3.** Select suitable actuators including electrical, mechanical, pneumatic, and hydraulic—for specific engineering applications.
- **Obj.4.** Describe the concepts of micro-sensors, micro-actuators, sensor materials, and fabrication processes used in modern sensor technology.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Differentiate between sensors, transmitters, and transducers, and analyze their characteristics.
- **CO2.** Explain principles, construction, and applications of inductive, capacitive, and other conventional transducers.
- **CO3.** Select appropriate actuators (electrical, mechanical, pneumatic, hydraulic) for engineering applications.
- **CO4.** Demonstrate understanding of micro-sensors, micro-actuators, sensor materials, and fabrication processes.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Sensors** **8L**

Difference between sensor, transmitter and transducer. Primary measuring elements.

Selection and characteristics: Range, resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band.

Signal transmission: Pneumatic signal, Hydraulic signal, Electronic Signal.

Principle of operation, construction details, characteristics and applications of potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor.

**Module 2: Inductive and Capacitive Transducers** **7L**

Inductive transducers: Principle, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn.

Capacitive transducers: Principle, construction details, characteristics, types, signal conditioning.

Applications: Capacitor microphone, capacitive pressure sensor, proximity sensor.

**Module 3: Actuators** **8L**

Definition, types and selection of Actuators: linear, rotary, logical, continuous.

Pneumatic actuators and Electro-Pneumatic actuators: cylinders, rotary actuators.

Mechanical actuating systems: Hydraulic actuators, control valves – construction, characteristics, types, and selection.

Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors – DC motors, AC motors (single-phase & three-phase induction motors), Synchronous Motor, Stepper motor, Piezoelectric actuator.

**Module 4: Micro Sensors and Micro Actuators** **8L**

Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors, flow micro sensors.

Micro Actuators: Actuation principles, shape memory effects (one way, two way, pseudo elasticity). Types: Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles.

**Module 5: Sensor Materials and Processing Techniques** **5L**

Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nanomaterials.

Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electroplating, photolithography, silicon micromachining (bulk and surface), LIGA process.

**Text Books:**

1. Patranabis.D, "Sensors and Transducers", Wheeler publisher, 1994.
2. Sergej Fatikow and Ulrich Rembold, " Microsystem Technology and Microbotics", First edition, Springer –Verlag NEwyork, Inc, 1997.
3. Jacob Fraden, "Hand Book of Modern Sensors: Physics, Designs and Application" Fourth edition, Springer, 2010.

**Reference Books:**

1. Robert H Bishop, "The Mechatronics Hand Book", CRC Press, 2002.
2. Thomas. G. Bekwith and Lewis Buck.N, Mechanical Measurements, Oxford and IBH publishing Co. Pvt. Ltd.,
3. Massood Tabib and Azar, "Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures", First edition, Kluwer academic publishers, Springer, 1997.
4. Manfred Kohl, "Shape Memory Actuators", first edition, Springer.

**Course Name: Digital Communication**
**Course Code: PE(EE)401C**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Explain the importance and principles of modulation and demodulation in digital communication systems.
- **Obj.2.** Analyze and design various digital modulation schemes such as ASK, FSK, PSK, QPSK, and MSK.
- **Obj.3.** Develop skills to analyze and implement spread spectrum techniques used in digital communications.
- **Obj.4.** Evaluate the design trade-offs and performance metrics of digital communication systems.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Explain the importance of modulation and demodulation in digital communication systems.
- **CO2.** Develop skills in analysis and design of digital modulation schemes such as ASK,FSK,PSK,QPSK and MSK
- **CO3.** Develop skills in analysis and design of Spread Spectrum Techniques.
- **CO4.** Analyze the design trade-offs and performance of digital communication systems.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1:** **8L**

Introduction to probability and random processes, Sampling and quantization, PCM, Delta modulation, Adaptive delta modulation, Matched filter detector and optimum filter detector.

**Module 2:** **10L**

Representation of bandpass signals in signal space diagram, memoryless modulation (PAM, PSK, QAM, PPM), M-ary transmissions, properties of modulation schemes (error probability, spectral efficiency), classification of signal sets, modulation with memory (DPSK, CPM, MSK, GMSK).

**Module 3:** **8L**

Introductory information theory and channel models, Source coding techniques (arithmetic, Ziv-Lempel, ShannonFano-Elias, Huffman), Lossy source coding, Channel coding (parity, Huffman, cyclic codes)

**Module 4:** **10L**

Communication through band-limited channels, ISI-free communication, equalization, decision feedback equalisation, adaptive equalisation, synchronization, Introduction to propagation of the signals (fading), Introduction to OFDM, CDMA, MIMO.

**Text Books:**

1. Simon Haykin, Digital Communication System, John Wiley & Sons, 2014.
2. J. G. Proakis and S. Salehi, Contemporary Communication Systems Engineering, 2/e, PHI, 2005.
3. S. Haykin, Communication Systems, 4/e, John Wiley and Sons, 2006.
4. B. Sklar, Digital Communication- Fundamentals and Applications, 2/e, Pearson, 2001.
5. B.P. Lathi, Modern Digital and Analog Communication Systems, 4/e, Oxford University Press, 2010.

**Reference Books:**

1. J. G. Proakis and S. Salehi, Contemporary Communication Systems Engineering, 2/e, PHI, 2005.
2. S. Haykin, An Introduction to Analog and Digital Communications, Willey Eastern, New York, 1989.
3. Taub H., Schilling D L. and Saha G., Principles of Communication Systems, 3/e, TMH Publishing Company Ltd, New Delhi, 2008.

**Course Name: Microprocessor and Microcontrollers**
**Course Code: EC(EE)401**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Knowledge in Digital Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the fundamental architecture and operation of microprocessors and microcontrollers, with emphasis on 8085, 8086, and 8051 families.
- **Obj.2.** Develop the ability to program microprocessors and microcontrollers using assembly language and high-level languages, and to understand instruction sets, addressing modes, and timing diagrams.
- **Obj.3.** Enable students to design and interface memory and peripheral devices with microprocessors/microcontrollers for real-time applications in electrical engineering.
- **Obj.4.** Apply microprocessor and microcontroller concepts in solving practical problems, such as measurement, monitoring, control, and embedded system applications in electrical engineering.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Explain the architecture, instruction sets, addressing modes, and timing diagrams of 8085, 8086, 8051.
- **CO2.** Apply programming skills to develop algorithms for microprocessor/microcontroller-based applications.
- **CO3.** Analyze the functioning of memory interfacing, peripheral devices, interrupts, and data communication techniques.
- **CO4.** Design and implement interfacing circuits for in real-time applications such as motor control, power system monitoring, and embedded system solutions.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: 8085 Microprocessor** **10L**

8085 Architecture, Pin details, Familiarization of basic Instruction Set & Programming, addressing modes, Timing Diagram, memory segmentation, Interrupts & Direct Memory Access, Memory interfacing.

**Module 2: 8086 Microprocessor** **8L**

8086 Architecture, Pin details timing diagram, instruction set, Familiarization of basic Instruction Set & Programming, addressing modes, Interrupts & Direct Memory Access, Memory interfacing.

**Module 3: 8051 Microcontroller Architecture** **4L**

Features of MCS51, Architecture of 8051, pin diagram, memory organization, external memory interfacing, register in MCS51 series.

**Module 4: Instruction set of 8051 microcontroller 6L**

Addressing modes and instructions set, assembly programing, Parallel I/O interrupts ports, timer / counter and serial communication.

**Module 5: Support IC chips 8L**

8255A: features, architecture, I/O addressing group A and group B controls operating modes, control word, example of determine the control word, interfacing with 8085 and 8051, I/O devices interfacing with 8251 using 8255A.

**Text Books:**


1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 6$^{th}$ Edition, Penram International Publishing, New Delhi, 2013
2. Mohammad Ali Mazidi, Janice Gillispie Mazidi, “The 8051 Microcontroller and Embedded”.
3. Microprocessor architecture, programming and application with 8085 – R. Gaonkar, Penram International.
4. The 8051 microcontroller and Embedded systems - Mazidi, Mazidi and McKinley, Pearson.
5. B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, 8$^{th}$ edition 2021.


**Reference Books:**


1. Kenneth J. Ayla, “The 8051 Micro controller", Thomson learning, 3rd Edition, 2010.
2. D Karuna Sagar, “Microcontroller 8051, Oxford: Alpha Science, 2011.
3. P.V Guruprasad, “Arm Architecture System on Chip and More ", Apress, 2013.
4. A. NagoorKani, Microprocessor & Microcontroller, Tata McGraw Hill, 3$^{rd}$ Edition, 2012.

**Course Name: Principles of Management**
**Course Code: HU(EE)401**
**Contact: 2L:0T:0P**
**Total Contact Hours: 24**
**Credit: 2**

**Prerequisite:** NA.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Recall and identify key management concepts and their relevance in organizational contexts.
- **Obj.2.** Apply management techniques to address current and future challenges faced by organizations.
- **Obj.3.** Compare and critically evaluate management theories and models to solve real-life organizational problems.
- **Obj.4.** Implement principles of management effectively to perform managerial roles within an organization.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Recall and identify the relevance of management concepts.
- **CO2.** Apply management techniques for meeting current and future management challenges faced by the organization.
- **CO3.** Compare the management theories and models critically to solve real life problems in an organization.
- **CO4.** Apply principles of management in order to execute the role as a manager in an organization.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Management Concepts 4L**
Definition, roles, functions and importance of Management, Evolution of Management thought contribution made by Taylor, Fayol, Gilbreth, Elton Mayo, McGregor, Maslow.

**Module 2: Planning and Control 4L**
Planning: Nature and importance of planning, -types of planning, Levels of planning - The Planning Process. –MBO, SWOT analysis, McKinsey's7S Approach. Organizing for decision making: Nature of organizing, span of control, Organizational structure line and staff authority. Basic control process -control as a feedback system – Feed Forward Control – Requirements for effective control – control.

**Module 3: Group Dynamics 4L**
Types of groups, characteristics, objectives of Group Dynamics. Leadership: Definition, styles & functions of leadership, qualities for good leadership, Theories of leadership

**Module 4: Work Study and work measurement 4L**

Definition of work study, Method Study Steps, Tools and Techniques used in the Method Study and Work Measurement Time Study: Aim & Objectives. Use of stopwatch procedure in making Time Study. Performance rating, allowances and its types. Calculation of Standard Time. Work sampling.

**Module 5: Marketing Management 2L**

Functions of Marketing, Product Planning and development, Promotional Strategy

**Module 6: Quality management 6L**

Quality definition, Statistical quality control, acceptance sampling, Control Charts – Mean chart, range chart, cchart, pchart, np chart, Zero Defects, Quality circles, , Kaizen & Six Sigma , ISO-9000 Implementation steps, Total quality management.

**Text Books:**

1. Essentials of Management, by Harold Kooritz & Heinz Weihrich, Tata McGraw Hill Education
2. Production and Operations Management - K. Aswathapa, K .Shridhara Bhat, Himalayan Publishing House.

**Reference Books:**

1. Organizational Behavior, by Stephen Robbins Pearson Education, NewDelhi New era
2. Management, Daft, 11th Edition, Cengage Learning.
3. Principles of Marketing, Kotlar Philip and Armstrong Gary, Pearson publication.

**Course Name: Electrical Machines–I Lab**
**Course Code: EE491**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concept of Basic Electrical Engineering Laboratory, Electrical Measurement Laboratory.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Enable students to determine efficiency, voltage regulation, and performance characteristics of transformers and DC machines experimentally.
- **Obj.2.** Train students in setting up, conducting, and analyzing standard experiments such as Heat-run test, load test, and efficiency determination.
- **Obj.3.** Provide hands-on experience in operating and testing transformers and DC machines.
- **Obj.4.** Reinforce the principles of electromechanical energy conversion, transformer characteristics, and DC machine performance through experiments.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Conduct different tests on Single-Phase and Three-phase Transformers.
- **CO2.** Analyze the characteristics of Single-Phase and Three-phase Transformers.
- **CO3.** Identifying and conducting various controlling tests of D.C Machines.
- **CO4.** Analyze the characteristics of D.C Machines.

**CO-PO Mapping:**

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

## ***List of Experiments***

**List of Experiment (At least *ten* experiments to be performed):**

1. Heat-run test of a single-phase transformer.
2. Regulation and Efficiency of single-phase transformer by direct loading method.
3. Parallel operation of two single-phase transformers and find out the load sharing.
4. Efficiency of a single-phase transformer by Back-to-Back test.
5. Polarity test and vector grouping of a three-phase transformer.
6. Identification of different parts of a D.C. machine.
7. Voltage build-up of a D.C. shunts generator and find out critical resistance and critical speed.
8. Brake test of D.C. series motor.
9. Brake Test of D.C. shunt motor.
10. Swinburne test of a D.C. shunt motor.
11. Load test of Differentially Compound D.C. Motor
12. Innovative Experiments.

**Course Name: Control Systems Lab**
**Course Code: EE492**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concept of Simulation Software and Control System.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Enable students to analyze and evaluate the response and stability of LTI systems in time and frequency domains using software and hardware tools.
- **Obj.2.** Impart knowledge and skills for designing compensators and controllers to achieve desired system performance.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Analyse the time domain and frequency domain response of LTI system using software/hardware.
- **CO2.** Evaluate the stability of LTI system in time and frequency domain by using MATLAB/ SciLab
- **CO3.** Design compensators, controllers to meet desired performance of system.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Familiarization with MATLAB/Scilab control system toolbox, MATLAB simulink tool box and PSPICE.
2. Determination of Step response for first order and Second order system with unity feedback on CRO and calculation of control system specification like Time constant, % peak overshoot, settling time etc. from the response.
3. Simulation of Step response and Impulse response for Type-0, Type-1 and Type-2 system with unity feedback using MATLAB / Scilab / PSPICE.
4. Determination of Root locus, Bode plot, Nyquist plot using MATLAB/Scilab control system tool box for 2$^{nd}$ order system and determination of different control system specification from the plot.
5. Determination of PI, PD and PID controller action of first order simulated process.
6. Determination of approximate transfer functions experimentally from Bode plot.
7. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of Lead.
8. To study the position control system using servomotor.

**Reference Books:**


1. MATLAB and Simulink for Engineers, Agam Kumar Tyagt, Oxford.
2. Modeling and Simulation Using MATLAB - Similink, Dr. S. Jain, Wiley India.
3. MATLAB and Its Application in Engineering, Raj K Bansal, A.K. Goel and M.K. Sharma, Pearson.
4. MATLAB programming for Engineers, S.J. Chapman, 3$^{rd}$ Edition, Cengage.

**Course Name: Power Electronics Lab**
**Course Code: EE493**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Experimentally analyze the static and dynamic characteristics of power semiconductor devices such as SCR, TRIAC, MOSFET, IGBT, and GTO.
- **Obj.2.** Develop practical skills in designing and testing various power electronic converters such as rectifiers, choppers, inverters, and AC voltage controllers under different load conditions.
- **Obj.3.** Simulate and analyze power electronic circuits using software tools for evaluating performance metrics such as output voltage, current waveform, harmonics, and efficiency.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Analyse the response of any power electronics devices.
- **CO2.** Troubleshoot the operation of a power electronics circuit.
- **CO3.** Choose suitable power electronic devices for any given application.
- **CO4.** Illustrate how to control and convert output signal as per requirements.

**CO-PO Mapping:**

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

## ***List of Experiments***

**List of Experiment (At least ten experiments to be performed):**

1. Study of the characteristics of an SCR.
2. Study of the characteristics of a TRIAC
3. Study of different triggering circuits of an SCR.
4. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
5. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converters.
6. Study of performance of three phase six pulse controlled bridge converters.
7. Study the performance of step down chopper.
8. Study the performance of step up chopper.
9. Study the performance of single-phase inverter with 180° conduction mode of operation.
10. Study of performance of single phase controlled converter with and without source inductance (Simulation).
11. Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation).
12. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter (Simulation).
13. Study of performance of three phase controlled converter with R & R-L load (simulation).
14. Innovative Experiments.

**Course Name: Microprocessor and Microcontrollers Lab**
**Course Code: EC(EE)491**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Knowledge in Digital Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide hands-on experience in assembly language programming using 8085, 8086, and 8051 trainer kits for arithmetic, logical, and bit manipulation operations.
- **Obj.2.** Familiarize students with interfacing techniques of microprocessors/ microcontrollers with peripheral devices such as LEDs, seven-segment displays, and stepper motors.
- **Obj.3.** Develop the ability to implement subroutines, timers, counters, and interrupts for real-time applications using 8051 and peripheral interface controllers.
- **Obj.4.** Bridge theory with practice by applying microprocessor and microcontroller concepts to practical applications relevant to electrical engineering, such as automation and control systems.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Conduct arithmetic and Logical operations, using assembly language programming in 8085 & 8086 Trainer Kits.
- **CO2.** Perform arithmetic, logical and bit manipulation instructions of 8051.
- **CO3.** Validate the interfacing technique of 8255 Trainer kit with 8085 and 8086, through Subroutine Call and IN/OUT instructions like glowing LEDs accordingly, to control stepper motor rotation, interfacing Seven Segment Display and to display a string etc.
- **CO4.** Relate theoretical concepts of microprocessors and microcontrollers with practical applications in control, automation, and electrical engineering systems.

**CO-PO Mapping:**

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

## ***List of Experiments***

**A. Demonstration Programs for 8085 Trainer Kit**

1. Familiarization with the process of storing, executing and viewing the contents of memory as well as registers in the trainer kit 8085 and simulator through small assignments.
2. Programming using 8085 kit and simulator for: Addition, Subtraction, Multiplication by repeated addition method, Square, Complement, lookup table, copying a block of memory, Shifting, Packing and unpacking of BCD numbers, Addition of BCD numbers, Binary to ASCII conversion.

**B. Demonstration Programs for 8086 Trainer Kit**

3. Addition, Subtraction, Multiplication & division of two 16-bit numbers using 8086 trainer kit.
4. Smallest and Largest number from an array of numbers, Ascending order, Descending Order, String Matching, Multiplication using shift and add method using 8086 trainer kit.

**C. Interfacing with 8085/8086**

5. Interfacing Stepper motor with any 8085/8086 trainer kit using 8255.
6. Interfacing Seven Segment Display using 8086 trainer kit and to display a string.

**D. Interfacing with 8051**

7. Programming using arithmetic, logical and bit manipulation instructions of 8051.
8. Program and verify Timer/Counter in 8051.

**E. Additional Programs**

9. Read a character from a keyboard and display it on Screen.
10. To check for a Password.

| 3rd Year 5th Semester | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Broad Category | Category | Paper Code | Subject | Contact Hours/Week | | | | Credit Points |
| | | | | | L | T | P | Total | |
| **A. Theory** | | | | | | | | | |
| 1 | ENGG | Major | EE501 | Electrical Machines - II | 3 | 0 | 0 | 3 | 3 |
| 2 | ENGG | Major | EE502 | Power Systems | 3 | 0 | 0 | 3 | 3 |
| 3 | ENGG | Major | EE503 | Renewable Energy Systems | 3 | 0 | 0 | 3 | 3 |
| 4 | ENGG | Minor | CS(EE)501 | Introduction to Machine Learning | 3 | 0 | 0 | 3 | 3 |
| 5 | ENGG | Major | PE(EE)501 | A. Discrete and Non-Linear Control Systems<br>B. Digital Signal Processing<br>C. Embedded Systems | 3 | 0 | 0 | 3 | 3 |
| **B. Practical** | | | | | | | | | |
| 6 | ENGG | Major | EE591 | Electrical Machines – II Lab | 0 | 0 | 3 | 3 | 1.5 |
| 7 | ENGG | Major | EE592 | Power Systems Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ENGG | Minor | CS(EE)591 | Introduction to Machine Learning Lab | 0 | 0 | 3 | 3 | 1.5 |
| **C. Sessional** | | | | | | | | | |
| 9 | PROJ | Skill Enhancement Courses | PR581 | Prototype Design and Development | 0 | 0 | 0 | 0 | 2 |
| **Total for Theory, Practical and Sessional** | | | | | | | | **24** | **21.5** |

**Course Name: Electrical Machines – II**
**Course Code: EE501**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Knowledge of Physics up to B. Tech. 1st year Physics-I course and Electrical Machines – I.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the construction, working principles, and operating characteristics of three-phase and single-phase induction motors and synchronous machines.
- **Obj.2.** Analyze machine performance using equivalent circuits, phasor diagrams, and torque-speed characteristics.
- **Obj.3.** Evaluate starting methods, speed control techniques, and efficiency optimization for various types of AC machines.
- **Obj.4.** Familiarize students with testing and maintenance methods for industrial AC machines.
- **Obj.5.** Apply theoretical knowledge to practical applications through laboratory experiments and problem-solving related to machine performance and design.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Describe the concept of rotating magnetic fields.
- **CO2.** Demonstrate the operation of AC Machines.
- **CO3.** Analyse performance characteristics of ac machines.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Fundamentals of AC machine windings 4L**

Physical arrangement of windings in stator, relationship between electrical and mechanical degree, single-turn coil – active portion and overhang; full-pitch coils, fractional pitched coils and its arrangement, factors pertaining to the windings.

**Module 2: Induction Machines 13L**

Induction motor as a transformer, Concept of rotating magnetic field, Power stages in 3-phase induction motor and their relation, torque-slip characteristics. Determination of equivalent circuit parameters, Separation of losses, Efficiency, Concept of Deep bar and Double cage rotor. Starting braking and speed control of three phase induction motor. Space harmonics: Crawling and Cogging, Industrial applications of 3-phase induction motor. Construction and operating principle of single-phase Induction Motor, Double-revolving field theory. Development of equivalent circuit, Determination of equivalent circuit parameters, Methods of starting using auxiliary winding, Selection of capacitor value during starting and running. Speed-Torque characteristics, Phasor diagram, Condition of Maximum torque. Application of single-phase motors. Brief idea on Induction Generator and Linear Induction Motor and its Applications.

**Module 3: Synchronous Machines 15L**

Construction of 3-phase Synchronous Machines, Advantages of Stationary armature and Rotating field system. Methods of excitation systems. Armature reaction at various p.f, concept of Synchronous reactance. Phasor diagrams of alternator at different p.f. loads. Open circuit characteristics, Short circuit characteristics and determination of synchronous reactance. Voltage regulation of alternator by synchronous impedance method. Two reaction theory, phasor diagram of salient pole generator at different loads. Power angle characteristics of Synchronous machines. Short circuit ratio (SCR) – concept and significance. Method of control of Active & Reactive Power of an alternator. Reasons and advantages of Parallel operation. Synchronization alternators and Load sharing. Methods of starting of Three-Phase Synchronous Motor. Effect of variation of excitation – V curves and inverted V curves. Hunting and its prevention. Applications of synchronous motor, Synchronous condenser.

**Module 4: Fractional HP Machines 4L**

Constructional features and performance characteristics of Universal Series Motors, Compensated and uncompensated motors. Principle and construction of switched reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper Motor.

**Text Books:**

1. Electrical Machines, Nagrath & Kothary, TMH
2. The performance and design of Alternating Current machines, M. G. Say, C.B.S Publishers & Distributors
3. Electrical Machinery, P.S. Bhimra, Khanna Publishers.
4. Electrical Machines, Ashfaq Husain, Dhanpat Rai & Co.
5. Electrical Machines, S.K.Bhattacharya, T.M.H Publishing Co. Ltd.

**Reference Books:**

1. Electrical Machines, Theory & Applications, M.N. Bandyopadhyay, PHI
2. Electrical Technology, H.Cotton, C.B.S. Publisher New Delhi
3. Electric Machinery & Transformes, Irving L. Kosow, PHI
4. Electric Machinery, A.E.Fitzgerald, Charles Kingsley, Jr. & Stephen D. Umans, 6th Edition, Tata McGraw Hill Edition.
5. Problems in Electrical Engineering, Parker smith, 9th Edition, CBS publishers & distributors.

**Course Name: Power Systems**
**Course Code: EE502**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concepts of basic electrical engineering, circuit theory and electrical machine.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the structure and operation of modern electric power systems including generation, transmission, and distribution networks.
- **Obj.2.** Develop analytical skills to model and analyze power system components such as transmission lines, cables.
- **Obj.3.** Explore economic and environmental aspects of power generation and distribution, including grid integration of renewable energy sources.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Illustrate the concepts of power system components and its associated terms.
- **CO2.** Classify different types of power generation.
- **CO3.** Analyze performances of power system.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Generation Transmission and Distribution 4L**
Introduction to Thermal, Hydro-Electric, Nuclear, Solar and Wind Power Generation. Basic concept of electrical supply system. Introduction to Smart Grid.

**Module 2: Mechanical Design of Overhead Transmission Line 6L**
Design of Conductors, Line supports: Towers, Poles, Insulators: Types, Voltage distribution across a suspension insulator string, String efficiency, arching shield and rings, Methods of improving voltage distribution across Insulator strings, Electrical tests on line Insulators Sag, Tension and Clearance, Effect of Wind and Ice on Sag, Stringing Chart Dampers.

**Module 3: Electrical Design of Overhead Transmission Line 8L**
Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phases' symmetrical and unsymmetrical configurations. Skin Effect, Proximity Effect, Bundle conductors. Transposition. Concept of GMD and GMR. Influence of Earth on conductor capacitance.

**Module 4: Corona 3L**
Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.

**Module 5: Cables 5L**
Types of cables, cable components, capacitance of single core and 3 core cables, dielectric stress,

optimum cable thickness, grading, dielectric loss and loss angle.

**Module 6: Performance of Lines** **8L**

Short, medium (nominal T, π) and long lines and their representation. Calculation of ABCD constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.

**Module 7: Tariff** **2L**

Variable Load on Power Stations. Introduction of Tariff, different types of tariff. Indian Electricity Rule – 1956 and 2003: General Introduction.

**Text Books:**

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power System Engineering, Nagrath & Kothery, TMH
3. Elements of Power System Analysis, C.L. Wadhwa, New Age International.
4. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors
5. Principles of Power System, V. K. Mehta and Rohit Mehta, S. Chand.

**Reference Books:**

1. Electric Power Transmission & Distribution, S. Sivanagaraju, S. Satyanarayana, Pearson Education.
2. A Text book on Power System Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.
3. Power System Protection and Switchgear, Badri Ram, TMH
4. Electric Power Distribution System Engineering, 2nd Edition, T. Gonen, CRC Press.
5. www.powermin.nic.in/acts notification/pdf/ier1956.pdf.

**Course Name: Renewable Energy Systems**
**Course Code: EE503**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Knowledge in Basic electronics, Fundamental Concept of Electrical Machines, Mathematics, Physics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide a comprehensive understanding of various renewable energy sources such as solar, wind, biomass, hydro, geothermal, and ocean energy.
- **Obj.2.** Analyze the working principles, design aspects, and performance characteristics of renewable energy conversion systems.
- **Obj.3.** Evaluate the technical and economic feasibility of renewable energy systems for different applications.
- **Obj.4.** Understand the challenges and solutions for integrating renewable energy into existing power grids, including storage systems and smart grid concepts.
- **Obj.5.** Promote awareness of environmental, social, and regulatory issues related to sustainable energy development.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Identify the fundamental principle solar and wind power generation.
- **CO2.** Classify different features of solar cells and wind generators.
- **CO3.** Apply solar and wind power integration with existing network

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Solar Radiation 6L**

The sun to earth transaction of solar energy, Study of wavelength of solar radiation spectra, Spectrum of electromagnetic radiation, Concept of extra-terrestrial radiation, solar constant, air mass, beam, diffused and total solar radiation, Spectral distribution of solar spectrum, Solar geometry covering all parameter related to the position of the sun with respect to observer; Instruments for measurement of solar energy (Pyranometer/Pyrheliometer/ sunshine recorder/Lux meter), Depletion of solar radiation – absorption, scattering; beam radiation, diffuse and Global radiation; measurement of solar radiation; solar time – local apparent time (LAT) .

**Module 2: Solar photovoltaic System 8L**

P-N junction, Space charge region, Energy band Diagram, P-N junction potential, width of depletion region, carrier movements and current densities, generation of photovoltage, light generated current, I-V equation of solar cells, Solar cell characteristics, Losses in solar cells, Design specification of solar cells, Types of solar cells, Solar PV module and array, Shading impact: Bypass diode, blocking diode, Maximum Power Point Tracking (MPPT) algorithms, Converter Control.

**Module 3: Solar Thermal Power Generation 6L**

Principles of heat and mass transfer, Basic of Solar Thermal Conversion, Efficiency and Testing of flat plate collectors, Analysis of Parabolic trough, central receivers, parabolic dish collectors, Concept of solar pond, solar water heater, solar passive heating and cooling system, Solar industrial heating system, solar refrigeration and air conditioning, solar cookers, solar furnaces, solar green house, solar dryer, solar distillation.

**Module 4: Introduction to Wind Power 8L**

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind Turbine Aerodynamics, Wind Turbine Types and their construction, Major applications of Wind Power, Environmental Aspects of wind power, merits and demerits, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters.

**Module 5: Different configurations of Solar and Wind Power 8L**

Standalone PV system configurations (with different types of loads e.g. DC, with battery and DC, AC/DC, battery and AC/DC), Grid connected system without energy storage, Load characteristics, Applications of PV System: Direct coupled, Grid connected, Stand alone, Hybrid system, PV System Economics. Constant Speed Constant Frequency (CSCF), Variable Speed Constant Frequency System (VSCF), Variable Speed Variable Frequency System (VSVF).

**Text Books:**

1. C. S. Solanki Solar Photovoltaics, PHI Learning, 2011
2. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.
3. J N Roy, D.N Bose,Photo Voltaic Science And Technology, Cambridge University,Press (2018)
4. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.
5. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.

**Reference Books:**

1. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.
2. J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.
3. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005.

**Course Name: Introduction to Machine Learning**
**Course Code: CS(EE)501**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Knowledge in Data Structure, Design and Analysis of Algorithms, Statistics, Artificial Intelligence.

**Course Objectives:** The objectives of this course are

- **Obj.1.** To provide an overview of many concepts, techniques, and algorithms in machine learning related to classification and regression problems.
- **Obj.2.** To give the student the basic ideas and intuition behind modern machine learning methods as well as a bit more formal understanding of how, why, and when they work.
- **Obj.3.** The underlying theme in the course is statistical inference as it provides the foundation for most of the methods covered.
- **Obj.4.** Make use of Data sets in implementing the machine learning algorithms.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Recognize the characteristics of machine learning that make it useful to real-world problems.
- **CO2.** Characterize machine learning algorithms as supervised, semi- supervised, and unsupervised.
- **CO3.** Be able to use support vector machines.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Basics of Linear Algebra** **8L**

Introduction to Machine Learning, linear classification, perceptron update rule, Perceptron convergence, generalization, Maximum margin classification, Classification errors, regularization.

**Module 2: Logistic regression** **9L**

Linear regression, estimator bias and variance, active learning, Active learning, non-linear predictions, Regression/Classification Basic methods: Distance-based methods, Nearest Neighbors, Decision Trees, Kernel regression, kernel optimization, Model selection criteria, Description length, feature selection, expectation maximization.

**Module 3: Classification** **10L**

Classification problems; decision boundaries; nearest neighbor methods, Probability and classification, Naive Bayes, Bayes' Rule and Naive Bayes Model, Hidden Markov models (HMMs), Bayesian networks, Learning Bayesian networks, Logistic regression, online gradient descent, neural network, support vector machine (SVM), kernel ridge regression.

**Module 4: Introduction to Deep Learning 9L**

Definition, Need of Deep Learning, Different Techniques: ANN, CNN, Recursive Neural Deep Model, Framework: Tensorflow, Tensorflow light.

**Text Books:**

1. Machine Learning. Tom Mitchell. First Edition, McGraw-Hill.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3. Machine Learning by Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson.

**Reference Books:**

1. Simon Haykin, Neural Networks and Learning Machines Third Edition, Pearson Publisher.
2. Christopher M. Bishop, Pattern Recognition and Machine Learning (Information Science andStatistics), Springer, 2006.
3. Pattern Classification. Richard Duda, Peter Hart and David Stock. Second Edition Wiley Interscience.

**Course Name: Discrete and Non-Linear Control Systems**
**Course Code: PE(EE)501A**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Basic knowledge of Control Systems and Signals & Systems.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Build a strong foundation in discrete-time and nonlinear control concepts and trends.
- **Obj.2.** Model discrete-time and nonlinear systems using state-space, transfer function, and describing function methods.
- **Obj.3.** Analyse stability and performance using Jury's test, phase-plane, Lyapunov, and Z-transform techniques.
- **Obj.4.** Evaluate digital compensators and state-feedback controllers for stability, transient response, and steady-state accuracy.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Apply fundamental concepts and modelling approaches (state-space, transfer function, describing function) to develop mathematical models of discrete-time and nonlinear control systems.
- **CO2.** Analyse the stability and performance of discrete-time and nonlinear systems using suitable approach.
- **CO3.** Evaluate the effectiveness of digital compensators and state-feedback controllers in achieving.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction & Review 6L**
Review of Control Concepts: Modelling, time-domain and frequency-domain methods.
Classification of Systems: Continuous vs. discrete systems, Linear vs. Nonlinear systems.
Computer-Based Control: History, evolution, modern trends, and industrial applications.
State-Space Modelling (Continuous-Time): Concepts of state, state variables, and state models, Conversion of linear differential equations/transfer functions into state models, Concepts of controllability and observability.

**Module 2: Discrete-Time Control Systems 16L**
Basics of discrete-time Control Systems: Introduction to digital control systems and comparison with analog systems; discrete representation of continuous systems, Sample and Hold circuit, Mathematical modeling of sample and hold circuit.
Sampling and Quantization: Effects of sampling and quantization; aliasing and anti-aliasing filters; choice of sampling frequency (Nyquist criterion).
Mathematical Modeling of Discrete Time System: Z-Transform, Inverse Z-Transform, Properties of Z-Transform and it's application for discrete-time system analysis, Pulse Transfer Function of open-loop systems, Pulse Transfer Function of closed-loop systems, State-Space Modeling of

Discrete-Time Systems, solution of discrete time state equations and controllability and observability in discrete time systems.
Stability analysis of discrete systems: Mapping from s-plane to z-plane, stability and damping in the z-domain, Jury's stability test.
Introduction to Digital Controllers & Compensators: State-Feedback Controller Design -pole placement. Lead, Lag, Lead-Lag Compensators – basic concept and purpose. Digital PID Controllers – overview of P, PI, PD, PID; applications in discrete-time control.

**Module 3: Non-Linear Control Systems 14L**

Introduction to Non-Linear Systems: Introduction, Features of Linear and Non Linear Systems, Types of non-linearity, Common nonlinearities in control systems, Typical Examples, Concept of phase portraits – Singular points – Limit cycles.
Describing Function Analysis: Describing function fundamentals, Describing functions of common nonlinearities, Describing function analysis of nonlinear systems, Limit cycles, Stability of Oscillations.
Lyapunov Stability Analysis: Stability Concepts, Equilibrium Points, BIBO and Asymptotic Stability, Lyapunov theory, Lyapunov's Direct method, Simple problem
Phase Plane Analysis: Construction of phase portrait, Concepts of phase plane analysis, Phase plane analysis of simple linear system and nonlinear system.

**Text Books:**

1. I.J. Nagrath & M. Gopal, Control Systems Engineering, New Age International, 5th Edition, 2007.
2. Hassan K. Khalil, Nonlinear Control, Pearson Prentice Hall, 1st Edition, 2014.
3. M. Gopal, Digital Control and State Variable Methods, 2nd Edition, TMH.
4. Katsuhiko Ogata, Discrete-Time Control Systems, 2nd Edition, Pearson/PHI, 1995.

**Reference Books:**

1. Katsuhiko Ogata, Modern Control Engineering, PHI Learning Pvt. Ltd.
2. B.C. Kuo, Digital Control System, Oxford University Press.
3. C.H. Houpis, Digital Control Systems, McGraw Hill International.
4. Franklin, Powell & Workman, Digital Control of Dynamic Systems, Addison Wesley.
5. Goodwin, Control System Design, Pearson Education.

**Course Name: Digital Signal Processing**
**Course Code: PE(EE)501B**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Circuit Theory, various signals and systems, Laplace Transform, Z-Transform, knowledge of arithmetic of complex numbers and elementary calculus

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the fundamentals of discrete-time signals and systems, including time-domain and frequency-domain analysis.
- **Obj.2.** Develop the ability to design and analyze digital filters, both Finite Impulse Response (FIR) and Infinite Impulse Response (IIR).
- **Obj.3.** Familiarize students with key DSP tools such as the Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), and Z-transform.
- **Obj.4.** Enable practical understanding of DSP implementation, including real-time processing and the use of DSP processors and software tools.
- **Obj.5.** Expose students to real-world applications of DSP in areas like audio and speech processing, communications, biomedical signal processing, and control systems.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Interpret the properties of discrete time signals in time domain and frequency domain.
- **CO2.** Demonstrate the transform- domain signal and analyze the frequency response.
- **CO3.** Design and implement IIR filtering operations with the real time constraints.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Discrete-time Signals and Systems 6L**

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences, periodic, energy, power, unit-sample, unit step, unit ramp and complex exponentials, arithmetic operations on sequences, impulse response, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.

**Module 2: Z-Transform 6L**

Definition, mapping between s-plane and Z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples and exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z-transform, initial value theorem, Perseval’s relation, inverse Z-transform by contour integration, power series and partial fraction expansions with examples and exercises.

**Module 3: Frequency Analysis of Signals and Systems 5L**
DTFT- Frequency domain sampling - DFT-Properties-Frequency analysis of signals using DFT-FFT Algorithm-Radix-2 FFT algorithms-Applications of FFT.

**Module 4: Theory and Design of Analog Filters 4L**
Design techniques for analog low pass filter –Butterworth and Chebyshev approximations, frequency transformation, Properties.

**Module 5: Design of IIR Digital Filters 4L**
IIR filter design – Bilinear and Impulse Invariant Transformation techniques – Spectral transformation of digital filters.

**Module 6: Design of FIR Digital Filters 4L**
FIR Filter Design - Phase and group delay - Design characteristics of FIR filters with linear phase – Frequency response of linear phase FIR filters – Design of FIR filters using Rectangular, Hamming, Hanning, Bartlett and Blackmann window functions.

**Module 7: Realization of Digital Filters 3L**
Direct Forms I and II, Cascade, Parallel and Lattice structures.

**Module 8: Digital Signal Processors 4L**
General-purpose digital signal processors - Fixed point and floating-point DSP - Finite word length effects - MAC, filter operation in different DSP architectures - typical implementation of DSP algorithms.

**Text Books:**


1. John G. Proakis, D.G. Manolakis and D.Sharma, “Digital Signal Processing Principles, Algorithms and Applications”, 4th edition, Pearson Education, 2012.
2. Sanjit K. Mitra, “Digital Signal Processing”, 4th edition, TMH, 2013.
3. P. Rameshbabu, “Digital Signal Processing”, Scitech Publications (India).
4. S.Salivahanan, A.Vallabraj & C. Gnanapriya, “Digital Signal Processing”, TMH Publishing Co.
5. A. Nagoor Kani, “Digital Signal Processing”, McGraw Hill.


**Reference Books:**


1. Oppenhiem V.A.V and Schaffer R.W, “Discrete – time Signal Processing”, 3rd edition, Pearson new international edition, 2014.
2. Sophocles J. Orfanidis, “Introduction to Signal Processing” 2nd edition, Prentice Hall, Inc, 2010.
3. Chi-Tsong Chen, “Digital Signal Processing; Spectral Computation and Filter Design”, Oxford University Press.

**Course Name: Embedded Systems**
**Course Code: PE(EE)501C**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Digital Electronics, Microprocessor and Microcontrollers

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide a solid foundation in embedded system architecture, including microcontrollers, memory, and I/O interfacing.
- **Obj.2.** Develop programming skills for embedded systems, particularly using assembly language and high-level languages like C/C++.
- **Obj.3.** Enable students to design and implement real-time embedded applications, including interrupt handling, timers, and peripheral interfacing.
- **Obj.4.** Introduce real-time operating systems (RTOS) concepts and their use in scheduling, multitasking, and resource management.
- **Obj.5.** Expose students to embedded system development tools, simulation, debugging techniques, and hardware-software co-design.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Illustrate with concepts related to the fundamental principles of embedded systems design, explain the process and apply it.
- **CO2.** Apply knowledge of the advanced Embedded technology both for hardware and software.
- **CO3.** Analyze Hardware/Software design techniques for microcontroller-based embedded systems and apply techniques in design problems.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction to Embedded System 12L**

Basics of Embedded computer Systems, Microprocessor and Microcontroller difference, Hardware architecture and software components of embedded system List of various applications [Mobile phones, RFID, WISENET, Robotics, Biomedical Applications, Brain machine interface etc.], Difference between embedded computer systems and general-purpose computer Systems. Characteristics of embedded systems, Classifications of embedded system.

**Module 2: Hardware Software Co-Design 14L**

Co-Design Types: Microprocessors/Microcontrollers/DSP based Design, FPGA/ASIC/pSOC based Design, Hybrid Design. Methodology: i) System specifications; ii) co-specifications of hardware and software; iii) System Design Languages (capturing the specification in a single Description); iv) System modelling/simulation; v) Partitioning (optimizing hardware/software partition); vi) Co-verification (simulation interaction between custom hardware and processor), Co-implementation; vii) Embedded Systems Design development cycle.

**Module 3: Real Time Operating System (RTOS) 10L**

Introduction, Types, Process Management, Memory Management, Interrupt in RTOS, Task scheduling, Basic design using RTOS; Basic idea of Hardware and Software testing in Embedded Systems. Programming concepts and embedded programming in C.

**Text Books:**

1. Embedded system Design: Peter Marwedel, Springer
2. Embedded Systems - Raj Kamal
3. Embedded Systems - K. Shibu

**Reference Books:**

1. M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, "The8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson Education, 2007.
2. R. Kamal, "Embedded System", McGraw Hill Education, 2009.
3. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004. R18 B. Tech EE Page 111 of 128.

**Course Name: Electrical Machines – II Lab**
**Course Code: EE591**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concepts of Electrical Machines - II.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Reinforce theoretical concepts learned in Electrical Machines – II through hands-on experiments.
- **Obj.2.** Develop the ability to conduct experiments, record data, and analyze performance characteristics of various AC machines.
- **Obj.3.** Understand the control and operational behavior of synchronous and induction machines under different load conditions.
- **Obj.4.** Promote safe and effective use of electrical laboratory equipment.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Perform different tests on Three-Phase A.C. Generators, Synchronous Motors and Single-Phase Induction Motor.
- **CO2.** Interpret the observed result using theoretical knowledge and hence calculate unknown parameters.

**CO-PO Mapping:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | - | 3 | - | - | - | - | 3 | 2 | - |
| **CO2** | 2 | - | - | 3 | - | - | - | - | 3 | 2 | - |

## ***List of Experiments***†

**Group A: Three-Phase Induction Machine**

1. Separation of losses in three-phase Induction Motor.
2. Load test of a three-phase wound rotor Induction Motor
3. Speed control of three-phase Induction Motor by V/f constant.
4. To study the performance of Three-Phase Induction generator.
5. Circle diagram of a three-phase Induction Motor.

**Group B: Synchronous Machine**

6. To observe the effect of excitation and speed on induced e.m.f of a three-phase alternator and plot the O.C.C. of the alternator.
7. Determination of regulation of Synchronous machine by Synchronous Impedance method.
8. To determine the direct axis resistance [$X_d$] and quadrature reactance [$X_q$] of a 3-phase synchronous machine by slip test.
9. Parallel operation of three-phase Synchronous generators / existing supply system.
10. V-curve of Synchronous motor.

**Group C: Low HP Motors**

11. Identification of different types of low HP motors.
12. Determination of equivalent circuit parameters of a single-phase Induction motor.
13. Load test on single-phase Induction motor to obtain the performance characteristics.

† Maximum Three experiments to be conducted from each group.

14. To study the effect of capacitor on the starting and running condition of a Single-Phase Induction motor and to determine the method of reversing the direction of rotation.
15. Load Test on Universal Motor.

Other than above experiments, one innovative experiment has to be conducted in the laboratory.

**Course Name: Power Systems Lab**
**Course Code: EE591**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concepts of Power System.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Familiarize students with various components of power systems, including transmission lines.
- **Obj.2.** Develop practical skills in performing experiments related to Dielectric strength and breakdown voltage.
- **Obj.3.** Promote proficiency in using industry-standard software tools (e.g., MATLAB/Simulink, PSCAD, ETAP) for power system modeling and analysis.
- **Obj.4.** Emphasize the importance of system safety, reliability, and efficiency in the generation, transmission, and distribution of electric power.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Demonstrate performance of transmission line and distribution line.
- **CO2.** Construct line support for a particular transmission line.
- **CO3.** Evaluate different methods of active and reactive power control.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Draw the schematic diagram of structure of power system and power transmission line and symbol of electrical equipment.
2. Simulation of DC distribution by network analyzer.
3. Measurement of earth resistance by earth-tester.
4. Measurement of dielectric strength of insulating oil.
5. Measurement of dielectric strength of solid insulating material.
6. Different parameter calculation by power circle diagram.
7. Study of different types of insulator.
8. Determination of the generalized constants A, B, C, D of long transmission line.
9. Active and reactive power control of alternator.
10. Study and analysis of an electrical transmission line circuit with the help of software.
11. Dielectric constant tan-delta, resistivity test of transformer oil.
12. Any innovative experiment according to knowledge of Power System

**Course Name: Introduction to Machine Learning Lab**
**Course Code: CS(EE)591**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concepts of Data Structure, Design and Analysis of Algorithms, Statistics, Artificial Intelligence.

**Course Objectives:** The objectives of this course are to

**Obj.1.** Make use of Data sets in implementing the machine learning algorithms.
**Obj.2.** Implement the machine learning concepts and algorithms in any suitable language of choice.

**Course Outcomes:** After successful completion of the course, student will be able to

**CO1.** Demonstrate the implementation procedures for the machine learning algorithms.
**CO2.** Design Java/Python programs for various Learning algorithms.
**CO3.** Apply appropriate data sets to the Machine Learning algorithms.
**CO4.** Identify and apply Machine Learning algorithms to solve real world problems.

**CO-PO Mapping:**

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

## ***List of Experiments***

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
5. Write a program to implement the naive Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6. Assuming a set of documents that need to be classified, use the naive Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/ API.
8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
9. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set.

Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.

10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

<table>
<tr><th colspan="11">3rd Year 6th Semester</th></tr>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Broad Category</th><th rowspan="2">Category</th><th rowspan="2">Paper Code</th><th rowspan="2">Subject</th><th colspan="4">Contact Hours/Week</th><th rowspan="2">Credit Points</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>Total</th></tr>
<tr><th colspan="10">A. Theory</th></tr>
<tr><td>1</td><td>ENGG</td><td>Major</td><td>EE601</td><td>Electric Drives and PLC</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>2</td><td>ENGG</td><td>Major</td><td>EE602</td><td>Power System Protection</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>3</td><td>ENGG</td><td>Major</td><td>EE603</td><td>Electric and Hybrid Vehicle</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">ENGG</td><td rowspan="3">Major</td><td rowspan="3">PE(EE)601</td><td>A. Power System Operation and Control</td><td rowspan="3">3</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">3</td><td rowspan="3">3</td></tr>
<tr><td>B. Power Quality and FACTS</td></tr>
<tr><td>C. Energy Storage Technologies</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">ENGG</td><td rowspan="3">Minor</td><td rowspan="3">OE(EE)601</td><td>A. Database Management System</td><td rowspan="3">3</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">3</td><td rowspan="3">3</td></tr>
<tr><td>B. Computer Architecture and Network</td></tr>
<tr><td>C. Cloud Computing</td></tr>
<tr><th colspan="10">B. Practical</th></tr>
<tr><td>6</td><td>ENGG</td><td>Major</td><td>EE691</td><td>Electric Drives and PLC Lab</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td>7</td><td>ENGG</td><td>Major</td><td>EE692</td><td>Power System Protection Lab</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td>8</td><td>ENGG</td><td>Major</td><td>EE693</td><td>Electric and Hybrid Vehicle Lab</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td rowspan="3">9</td><td rowspan="3">ENGG</td><td rowspan="3">Minor</td><td rowspan="3">OE(EE)691</td><td>A. Database Management System Lab</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">3</td><td rowspan="3">3</td><td rowspan="3">1.5</td></tr>
<tr><td>B. Computer Architecture and Network Lab</td></tr>
<tr><td>C. Cloud Computing Lab</td></tr>
<tr><td>10</td><td>HUM</td><td>Ability Enhancement Courses</td><td>HU(EE)691</td><td>Soft Skill and Aptitude</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><th colspan="10">C. Sessional</th></tr>
<tr><td>11</td><td>PROJ</td><td>Project</td><td>PR681</td><td>Major Project - I</td><td>0</td><td>0</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>12</td><td>PROJ</td><td>Internship</td><td>PR682‡</td><td>Industrial Training / Internship</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>13</td><td>PROJ</td><td>Skill Enhancement Course</td><td>PR683</td><td>Seminar on Industrial Training / Internship</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><th colspan="8">Total for Theory, Practical and Sessional</th><th>30</th><th>30.5</th></tr>
</table>

‡ Industrial Training/Internship is to be completed before 6th Semester Examination and the credit will be given subjected to submission of Reports and Certificates.

**Course Name: Electric Drives and PLC**
**Course Code: EE601**
**Contact: 3L: 0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of components of electrical machines and power electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the basic concepts of electric drives, their components, characteristics, and applications.
- **Obj.2.** Develop the ability to analyse the performance of DC and AC drives under different loading conditions.
- **Obj.3.** To design and select suitable electric drives for specific industrial applications.
- **Obj.4.** Integrate electric drives with PLCs for industrial automation tasks.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Demonstrate the concept, characteristics, application fields and development, trend of electric motor required for a Power Drives System
- **CO2.** Illustrate different types of braking and speed-control of electric motors for various applications.
- **CO3.** Analyse the converter fed motor under different torque/speed conditions.
- **CO4.** Apply of PLC for various kinds of drive operations

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Fundamental Concept of Electric Drive** **3L**

Definition of electric drive, type of drives; Speed torque characteristic of driven unit/loads, Concept of Multi-quadrant operation, Classification and components of load torque, Equivalent value of drive parameters for loads with rotational and translational motion.

**Module 2: Electric Braking** **3L**

Electric Braking of DC motor during lowering of loads and stopping, Regenerative braking, AC and DC rheostatic braking.

**Module 3: Selection of motor power rating (concept only)** **4L**

Thermal model of motor for heating and cooling (equation and problems), classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, Load equalization (concept only)

**Module 4: DC Motors Drives** **6L**

Starting of DC motor for shunt and Series motors, Ward-Leonard System, Single phase and three phases controlled DC drives (two quadrant operation and steady state analysis), Dual converter control of DC drives. Two and Four quadrant DC motor drive.

**Module 5: Induction Motor Drives** **5L**

Review of three phase Induction Motor analysis and performance, Stator voltage control, V/f Controlled induction motors, Slip power recovery, CSI fed induction motor drives

**Module 6: Synchronous Motor Drives** **6L**

Synchronous machine variable speed drive, Variable frequency control, Sinusoidal SPM machine drives, synchronous reluctance machine drives, wound field synchronous motor drive, Load-commutated Synchronous Motor Drives, Model of PMSM.

**Module 7: Introduction to PLC** **5L**

Concept of PLC, Building blocks of PLC, Functions of various blocks, limitations of relays. Advantages of PLCs over electromagnetic relays, PLC manufacturer etc.

**Module 8: Applications of PLCs** **4L**

Ladder Logic programing, some applications-On-off control, Sequential starting of motors, Motor in forward and reverse direction, Filling of Bottles.

**Text Books:**

1. G. K. Dubey, Fundamentals of Electrical Drives, Narosa, 2001.
2. R. Krishnan, Electric Motor Drives: Modeling, Analysis and Control, PHI-India, 2005.
3. N. K. De and P. K. Sen, Electric Drives, Prentice Hall of India Private Limited, 2006.
4. S. K. Pillai, A First Course on Electrical Drives, New Age International.
5. Overview of Industrial Process Automation, KLS Sharma, Elsevier, 2011
6. Automation Made Easy, P. G. Martin & H. Gregory, ISA, 2009

**Reference Books:**

1. B. K. Bose, ―Modern Power Electronics and AC Drives, Pearson Education Asia, 2003
2. Industrial Automation, Circuit Design and components, D W Pessen
3. S. B. Dewan, G. R. Slemon and A. Straughen, "Power Semiconductor Drives", John Wiley and Sons, New York 1984
4. Springer Handbook of Automation

**Course Name: Power System Protection**
**Course Code: EE602**
**Contact: 3L: 0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of components of electrical machines and power systems.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the need and functions of a protective system in electrical power networks.
- **Obj.2.** Explain working principles of circuit breakers, relays, and other protective devices.
- **Obj.3.** Develop ability to select and maintain suitable switchgear for different power system components.
- **Obj.4.** Apply protection schemes for transmission lines, transformers, alternators, motors, and busbars.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Describe the basic elements of a protective system and classify faults in power systems.
- **CO2.** Explain working principles of circuit breakers, fuses, relays, and switchgear.
- **CO3.** Analyze and apply protection schemes for transmission lines, transformers, alternators, motors, and busbars.
- **CO4.** Application of over-voltage protection and insulation coordination in power systems.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Elements of Protection** **5L**
Need of protective system, functions of protective elements, types and causes of faults, backup protection, protective transformers: CTs and PTs (construction, connection, specifications), current limiting reactors and neutral earthing methods.

**Module 2: Circuit Interrupting Devices** **6L**
Interrupting devices, sequence of operation and interlocking, Fuses: types, characteristics, testing and applications, Isolators, circuit breakers: arc phenomena and extinction, Oil, Air-Break, Air-Blast, SF6 and Vacuum CBs, Auto-reclosure, resistance switching, HVDC CBs.

**Module 3: Protective Relays** **6L**
Need, classification and selection of relays, Electromagnetic, thermal, directional, distance, negative phase sequence relays, Static relays and microprocessor-based relays, Relay settings, testing, and maintenance.

**Module 4: Protection of Transmission Line and Feeder** **7L**
Over-current, earth-fault, overload, differential, carrier-aided schemes, impedance protection, auto-

reclosing, protection of parallel feeders, ring mains and busbars.

**Module 5: Protection of Transformer, Alternator, Motor and Busbar 7L**

Over-current, percentage differential, restricted earth fault protection, inrush phenomenon and Buchholz relay protection, protection of alternators, motors, and differential busbar protection.

**Module 6: Over Voltage Protection 5L**

Causes of over voltages and methods of reduction, Lightning arresters: construction, characteristics and applications, Insulation coordination and Basic Impulse Insulation Level (BIL).

**Text Books:**

1. Paithankar Y.G. and Bhide S.R., Fundamentals of Power System Protection, PHI, New Delhi.
2. Ram B. and Vishwakarma D.N., Power System Protection and Switchgear, TMH, New Delhi.
3. Uppal S.L., Electrical Power, Khanna Publications.
4. Mehta V.K., Electrical Power System, S. Chand Publications.
5. Rao S.S., Switchgear and Protection, Khanna Publications, New Delhi.

**Reference Books:**

1. Ravindranath B. and M. Chander, Power System Protection and Switchgear, Wiley Eastern Ltd, Delhi.
2. Gupta J.B., Switchgear and Protection, Katariya Publications, New Delhi.
3. Wadhwa C.L., Art and Science of Protective Relaying, Wiley.
4. Mason C.R., Protective Relaying: Principles and Applications, Wiley.

**Course Name: Electric and Hybrid Vehicles**
**Course Code: EE603**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Power Electronics and Electric Drives.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the fundamental concepts, configurations, and parameters of Electric Vehicles (EVs) to build a solid foundation of EV technology.
- **Obj.2.** Develop the ability to analyse electric propulsion systems, associated motors, and power electronic converters used in EV applications.
- **Obj.3.** Provide insights into the design, operation, and control of various EV motor drives and their integration with power electronics.
- **Obj.4.** Familiarize students with hybrid vehicle configurations, energy storage systems, and different charging methods to enable effective deployment of EVs.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Identify EV concepts, EV configurations and various EV parameters for better understanding of the EV technology.
- **CO2.** Analyse the EV propulsion system and electric motors for vehicular applications & power electronics converters required for their control.
- **CO3.** Analyse DC motor & induction motor drives and discuss methods for controlling them.
- **CO4.** Elaborate various hybrid electric vehicle configurations and Identify different energy sources used in EV and analyse the various methods used in charging these energy sources.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction** **6L**

Past, Present & Future of EV and Hybrid Vehicles, Current Major Issues, Advanced Electric and Hybrid drive vehicle technology, Comparison of EV, Hybrid EV, and IC Engine vehicles. Components of Hybrid Electric Vehicle, Economic and environmental impacts of Electric and Hybrid vehicles: Comparative study of vehicles for economic and environmental aspects. In-wheel drives, EV and HEV Parameters: Weight, size, force, energy & performance parameters.

**Module 2: Dynamics of Electric and Hybrid Vehicles** **8L**

General description of vehicle movement. Choice of electric and hybrid propulsion systems, block diagram of EV and HEV propulsion system. Factors affecting vehicle motion – vehicle resistance, tires ground adhesion, rolling resistance, aerodynamic drag, equation of grading resistance, dynamic equation. Drive train configurations for EVs and HEVs, automobile power train, classification of vehicle power plants, need of gear box. Concept of EV/HEV motors, classification of EV/HEV motors, single motor and multi-motor configurations, fixed & variable geared transmission, in-wheel motor configuration.

**Module 3: Required Power Electronics & Control 6L**

Comparison of EV and HEV power devices, introduction to power electronics converters for EV and HEV applications. Four-quadrant DC chopper, three-phase full bridge voltage-fed inverter, soft-switching converters, comparison of hard-switching and soft-switching converters, three-phase voltage-fed resonance DC link inverter. Hybrid vehicle–specific power converter and controller requirements.

**Module 4: EV and HEV Motor Drives 8L**

PMSM and BLDC drives for EVs and HEVs: dynamic modelling, torque equations, control methods, machine sizing, current, voltage and speed limits, extending constant power speed range, current control methods. Role of induction and switched reluctance motors in HEVs. Integration of hybrid propulsion motor drives with energy management systems.

**Module 5: Energy Sources & Charging 8L**

Different Batteries, Fuel Cells, and Ultra-capacitors used in EVs and HEVs. Battery characteristics (Discharging & Charging), Battery Management System and Charge Balancing. Hybrid energy storage in HEVs (battery + ultracapacitor/fuel cell). Battery Chargers: Conductive (basic charger circuits), arrangement of an off-board conductive charger, standard power levels of conductive chargers. Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Fast Charging Station. Role of regenerative braking and energy recuperation in EVs and HEVs.

**Text Books:**

1. A.K. Babu, Electric & Hybrid Vehicles, Khanna Publishing House, New Delhi (Ed. 2018).
2. Ehsani, M. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press.
3. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York, 2001.
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

**Reference Books:**

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. David Andrea, “Battery Management System for Large Lithium -Ion Battery Packs”, Artech house, 2010.
3. Chris Mi, *Modern Electric Vehicle Technology and Design*, Wiley-IEEE Press (2021).

**Course Name: Power System Operation and Control**
**Course Code: PE(EE)601A**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Basic Electrical Engineering, Engineering Mathematics, Power System

**Course Objectives:** The objectives of this course are to

- **Obj.1.** To understand the structure and operation of the Indian power grid, including the roles of load dispatch centres.
- **Obj.2.** To analyse load frequency control and voltage regulation techniques for single and multi-area power systems.
- **Obj.3.** To apply knowledge of economic dispatch and unit commitment for optimal power system operation.
- **Obj.4.** To explore computer-based control, monitoring systems, and reactive power management in modern power systems.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Explain the fundamentals of power system operation and control
- **CO2.** Differentiate load frequency control and voltage regulation methods for single-area and two-area power systems
- **CO3.** Choose different economic dispatch and unit commitment techniques to optimize power system operation considering constraints
- **CO4.** Construct the operation of computer-based control systems, SCADA, and reactive power management devices in power system monitoring and control

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction to Power System Operation and Control 6L**

Overview of the Indian power system – structure, operation, and challenges, Roles, responsibilities, and operational hierarchy of load dispatch centres, Necessity and methods of maintaining system voltage and frequency within permissible limits, Relationship between real power and frequency reactive power and voltage control strategies and mechanisms, Analysis of daily, weekly, and seasonal load patterns, impact on system operation, Principles and objectives of economic and secure dispatch, load forecasting and scheduling, Basic concepts of turbine speed governors, dynamic modelling and control, Characteristics and behaviour of generators under varying load conditions, Regulation and control of generators operating in parallel load sharing and stability considerations

**Module 2: Load Frequency Control (LFC) 6L**

Static and dynamic analysis of uncontrolled and controlled systems, Tie-line modelling and control strategies, block diagram representation, Analysis of Static and Dynamic Behaviour in Two-Area Load Frequency Control Systems, Concept, implementation, and analysis of frequency bias in interconnected systems

**Module 3: Reactive Power and Voltage Control** **8L**

Fundamentals and sources of reactive power in power system, Need for control and impact on voltage stability, Principles and function of Automatic Voltage Regulator (AVR), brushless AC excitation system, block diagram representation of AVR loop, Dynamic and Static Response Analysis of AVR Loop, Voltage Profile and Regulation in Transmission Networks, Techniques for maintaining voltage profile, tap-changing transformers, Static Var Compensators (SVC: TCR + TSC), and STATCOM for voltage regulation

**Module 4: Power System Economic Operation and Control** **8L**

Formulation and objectives of economic dispatch in power systems, Input-output relationships, incremental cost curve analysis, Economic dispatch without transmission losses, impact of transmission losses on dispatch, Constraints involved in Unit Commitment (UC), operational and system constraint, Priority list method for solving the unit commitment problem

**Module 5: Computer Control and Monitoring of Power Systems** **8L**

Importance and benefits of automation in power system operation, Concept, roles, and key functions of energy control centres, Phasor Measurement Unit (PMU): Applications in system monitoring and data acquisition, Overview of hardware used in power system control and monitoring, Functions and architecture of Supervisory Control and Data Acquisition (SCADA) and Energy Management Systems (EMS). State Estimation in Power Systems: Problem formulation, types of measurements, and handling measurement errors

**Text Books:**

1. Modern Power System Analysis by I. J. Nagrath and D. P. Kothari.
2. S. Sivinagaraju and G. Sreenivasan "Power System Operation and Control" Pearson Publications
3. Power System Stability and Control by Prabha Kundur
4. Abhijit Chakrabarti and Sunita Halder, "Power System Analysis Operation and Control", PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

**Reference Books:**

1. Power System Operation by Allen J. Wood and Bruce F. Wollenberg
2. Dr. K, Uma Rao "Power System Operation and Control". Wiley Publications
3. Power System Control and Stability by Paul M. Anderson and A. A. Fouad
4. Economic Operation of Power Systems by J. Wood and B. Wollenberg
5. Power System SCADA and Smart Grids by Mini S. Thomas and John D. McDonald
6. Power System State Estimation by A. Abur and A. G. Exposito

**Course Name: Power Quality and FACTS**
**Course Code: PE(EE)601B**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Power Systems, Control Systems, Power Electronics

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the characteristics of AC transmission and the impact of shunt and series reactive compensation.
- **Obj.2.** Acquire an understanding of the working principles and operating characteristics of FACTS devices.
- **Obj.3.** Develop a fundamental understanding of power quality concepts.
- **Obj.4.** Explore the operating principles of devices used to enhance power quality.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Explain the performance and behaviour of uncompensated AC transmission lines to understand their limitations in power transfer and stability.
- **CO2.** Distinguish the working principles, configurations, and operating characteristics of various FACTS devices used for reactive power control and voltage regulation.
- **CO3.** Select FACTS devices to enhance power flow control, improve voltage stability, and support overall system performance
- **CO4.** Construct key power quality issues in distribution systems by appropriate compensation and control techniques using DSTATCOM, DVR, and UPQC.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Transmission Lines and Series/Shunt Reactive Power Compensation 4L**
Fundamentals of AC Transmission, Analysis of Uncompensated AC Transmission Lines, Passive Reactive Power Compensation Techniques, Midpoint Shunt and Series Compensation of AC Transmission Lines, Comparison Between Series and Shunt Compensation

**Module 2: Thyristor-based Flexible AC Transmission Controllers (FACTS) 6L**
Overview and Characteristics of Thyristor-based FACTS Devices, Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor, Single Pole Single Throw (SPST) Switch, Configurations and Modes of Operation of SVC and TCSC, Harmonics and Control Techniques for SVC and TCSC, Fault Current Limiter

**Module 3: Voltage Source Converter (VSC) Based FACTS Controllers 8L**
Introduction to Voltage Source Converters (VSC), Six-Pulse VSC, Multi-Pulse, and Multi-Level Converters, Pulse-Width Modulation Techniques for VSCs, Selective Harmonic Elimination, Sinusoidal PWM, and Space Vector Modulation, STATCOM: Operating Principle and Reactive Power Control (Type I and Type II Controllers), Static Synchronous Series Compensator (SSSC):

Principle of Operation and Control, Unified Power Flow Controller (UPFC): Principle of Operation and Control, Interphase Power Flow Controller: Working Principle, Other FACTS Devices: GTO Controlled Series Compensator

**Module 4: Application of FACTS 4L**

Application of FACTS Devices for Power Flow Control and Stability Improvement, Simulation of Power Swing Damping in a Single-Machine Infinite Bus System Using TCSC, Simulation of Transmission Mid-Point Voltage Regulation Using STATCOM

**Module 5: Power Quality Problems in Distribution Systems 4L**

Power Quality Issues in Distribution Systems, Transient and Steady-State Variations in Voltage and Frequency, Voltage Unbalance, Sags, Swells, and Interruptions, Waveform Distortions: Harmonics, Noise, Notching, DC Offsets, and Fluctuations, Flicker and Its Measurement, Equipment Tolerance: CBEMA Curve

**Module 6: DSTATCOM and Shunt Active Filters 5L**

Reactive Power Compensation Using DSTATCOM, Harmonics and Unbalance Mitigation in Distribution Systems with DSTATCOM and Shunt Active Filters, Synchronous Reference Frame Extraction of Reference Currents, Current Control Techniques for DSTATCOM

**Module 7: Dynamic Voltage Restorer and Unified Power Quality Conditioner 5L**

Voltage Sag and Swell Mitigation Using Dynamic Voltage Restorer (DVR), Working Principle and Control Strategies of DVR, Series Active Filtering Techniques, Unified Power Quality Conditioner (UPQC): Working Principle, Capabilities and Control Strategies of UPQC

**Text Books:**

1. FACTS Controllers in Power Transmission and Distribution, N K. R. Padiyar, New Age International (P) Ltd. 2007.
2. FACTS Controllers in Power Transmission and Distribution by K.R. Padiyar
3. Flexible AC Transmission Systems (FACTS) by Narain G. Hingorani
4. Power Quality in Power Systems and Electrical Machines by Ewald F. Fuchs and Mohammad A.S. Masoum
5. Active Power Filters by Hirofumi Akagi
6. Electrical Power Quality by Surya Santoso

**Reference Books:**

1. Understanding FACTS: Concepts and Technology of FACTS Systems, N. G. Hingorani and L. Gyugyi Wiley-IEEE Press, 1999.
2. Reactive Power Control in Electric Systems, T. J. E. Miller, John Wiley and Sons, New York, 1983.
3. Electrical Power Systems Quality", R. C. Dugan, McGraw Hill Education, 2012.
4. Electric Power Quality, G. T. Heydt, Stars in a Circle Publications, 1991
5. Understanding Power Quality Problems by Math Bollen
6. Power Quality Enhancement Using Custom Power Devices by Arindam Ghosh and Gerard Ledwich
7. Understanding Power Quality Problems by Math H. J. Bollen
8. Power Quality in Power Systems by Ewald Fuchs
9. Electrical Power Systems Quality by Roger C. Dugan

**Course Name: Energy Storage Technologies**
**Course Code: PE(EE)601C**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Basic Electrochemistry, Power Electronics, Power Systems

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce the scope, need, and opportunities of energy storage systems in modern power and transportation sectors.
- **Obj.2.** Develop an understanding of different storage technologies including thermal, chemical, electromagnetic, and electrochemical systems.
- **Obj.3.** Provide insights into the design, performance, and application of batteries, supercapacitors, and fuel cells.
- **Obj.4.** Familiarize students with battery design for transportation applications and challenges of battery management, safety, and recycling.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Describe the fundamental concepts, scope, and importance of energy storage systems in various applications.
- **CO2.** Explain the working principles, characteristics, and limitations of thermal, chemical, electromagnetic, and electrochemical storage systems.
- **CO3.** Analyse the performance of different battery chemistries, supercapacitors, and fuel cells for electric vehicle and grid applications.
- **CO4.** Evaluate battery design, charging methods, safety issues, and recycling approaches for sustainable energy storage solutions.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction** **9L**

Necessity of energy storage, different types of energy storage, mechanical, chemical, electrical, electrochemical, biological, magnetic, electromagnetic, thermal, comparison of energy storage technologies

**Module 2: Energy Storage Systems** **9L**

Thermal Energy storage-sensible and latent heat, phase change materials, Energy and exergy analysis of thermal energy storage, Electrical Energy storage-super-capacitors, Magnetic Energy storage Superconducting systems, Mechanical-Pumped hydro, flywheels and pressurized air energy storage, Chemical-Hydrogen production and storage, Principle of direct energy conversion using fuel cells, thermodynamics of fuel cells, Types of fuel cells, Fuel cell performance, Electrochemical Energy Storage Battery, primary, secondary and flow batteries.

**Module 3: Needs for Electrical Energy Storage 10L**
Emerging needs for EES, more renewable energy-less fossil fuel, Smart Grid uses - the roles of electrical energy storage technologies-the roles from the viewpoint of a utility-the roles from the viewpoint of consumers-the roles from the viewpoint of generators of renewable energy.

**Module 4: Types of Electrical Energy Storage systems 3L**
Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), super charging stations, Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

**Module 5: Design and Applications of Electrical Energy Storage 5L**
Renewable energy storage-Battery sizing and stand-alone applications, stationary (Power Grid application), Small scale application-Portable storage systems and medical devices, Mobile storage Applications- Electric vehicles (EVs), types of EVs, batteries and fuel cells, future technologies, hybrid systems for energy storage.

**Text Books:**

1. Energy Storage - Technologies and Applications by Ahmed Faheem Zobaa, InTech
2. Fundamentals of Energy Storage by J. Jensen and B. Sorenson, Wiley-Interscalene, NewYork,
3. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer.

**Reference Books:**

1. Thermal energy storage: Systems and Applications by Dincer I. and Rosen M. A., Wileypub.
2. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer.
3. Electric & Hybrid Vehicles by G. Pistoia, Elsevier B. V.
4. Fuel cell Fundamentals by R. O' Hayre, S. Cha, W. Colella and F. B. Prinz, Wiley Pub.

**Course Name: Database Management System**
**Course Code: OE(EE)601A**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Mathematics, Data Structure, Operating System.

**Course Objectives:** The objectives of this course are to

**Obj.1.** Understand fundamental concepts of database systems, data models, and database architectures.
**Obj.2.** Develop skills to design and implement relational databases using entity-relationship modeling and SQL.
**Obj.3.** Apply normalization, transaction management, concurrency control, and recovery techniques for efficient database design.
**Obj.4.** Analyze, evaluate, and optimize database performance using indexing, query optimization, and physical storage concepts.

**Course Outcomes:** After successful completion of the course, student will be able to

**CO1.** Explain fundamental elements of a database management system, compare the basic concepts of relational data model, entity-relationship model, file organization and use appropriate index structure.
**CO2.** Apply efficient query optimization techniques, suitable transaction management, concurrency control mechanism and recovery management techniques
**CO3.** Evaluate a database design and improve the design by normalization
**CO4.** Design entity-relationship diagrams to represent simple database application scenarios, translate entity-relationship diagrams into relational tables, populate a relational database and formulate SQL queries on the data.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction** **6L**
Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

**Module 2: Entity-Relationship Model** **5L**
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

**Module 3: Relational Model** **5L**
Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

**Module 4: SQL and Integrity Constraints 7L**
Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Sub queries, Database security application development using SQL, Stored procedures and triggers.

**Module 5: Relational Database Design 4L**
Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF.

**Module 6: Internals of RDBMS 4L**
Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.

**Module 7: File Organization & Index Structures 5L**
File & Record Concept, placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.

**Text Books:**

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.

**Reference Books:**

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems (3/e), McGraw Hill.
2. Peter Rob and Carlos Coronel, Database Systesm-Design, Implementation and Management (7/e), Cengage Learning.

**Course Name: Computer Architecture and Network**
**Course Code: OE(EE)601B**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Mathematics, Basic Computing, Digital Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce students to the fundamental principles of computer organization and design.
- **Obj.2.** Analyze the performance of different CPU architectures and memory systems.
- **Obj.3.** Familiarize students with the concepts and models of computer networks.
- **Obj.4.** Enable students to apply their knowledge to solve basic problems in networking and system design.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Explain the fundamental concepts of computer architecture and network organization, including the functional units of a computer and the layers of the OSI and TCP/IP models.
- **CO2.** Analyze the performance of a computer system based on metrics like clock speed, instruction count, and memory access time.
- **CO3.** Design a basic computer system and a simple network topology, selecting appropriate components and protocols.
- **CO4.** Evaluate and recommend the optimal hardware and network solutions for specific application requirements, justifying the choices based on performance, cost, and efficiency.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Basic Computer Architecture 6L**

Introduction to computer organization and architecture, functional units, Von Neumann architecture, instruction formats, addressing modes, instruction cycle, types of buses and their operations, introduction to microprogrammed control and hardwired control.

**Module 2: CPU Design and Performance 10L**

CPU organization, registers, ALU, control unit, introduction to pipelining, pipeline hazards (data, control, structural), handling hazards, instruction-level parallelism, performance metrics, clock rate, CPI (cycles per instruction), MIPS, Amdahl's Law.

**Module 3: Memory System Design 8L**

The memory hierarchy, cache memory, main memory, secondary storage, cache mapping techniques, direct mapping, associative mapping, set-associative mapping, cache write policies, write-through, write-back, virtual memory, page tables, TLB.

**Module 4: Introduction to Computer Networks 6L**

Fundamentals of data communication, network topologies (bus, star, ring), types of networks (LAN, WAN, MAN), the OSI model, all seven layers, the TCP/IP model, comparison with the OSI model, key protocols.

**Module 5: Network Protocols and Devices 6L**

Network Layer, IP addressing (IPv4, IPv6), routing algorithms, Transport Layer, TCP and UDP protocols, flow control, congestion control, network devices, hubs, switches, routers, gateways.

**Text Books:**

1. W. Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education.
2. D. A. Patterson and J. L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann.
3. A. S. Tanenbaum, Computer Networks, Pearson Education.
4. Behrouz A. Forouzan, Data Communications and Networking, McGraw-Hill Education.

**Reference Books:**

1. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
2. Andrew S. Tanenbaum and David J. Wetherall, Computer Networks, Pearson.

**Course Name: Cloud Computing**
**Course Code: OE(EE)601C**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Programming Fundamentals, Computer Networks, Operating Systems, Database Management Systems.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the fundamental concepts, architecture, and characteristics of cloud computing and virtualization.
- **Obj.2.** Analyze cloud service models (SaaS, PaaS, IaaS) and deployment models (public, private, community, hybrid).
- **Obj.3.** Apply cloud simulators and virtualization tools, such as CloudSim, GreenCloud, and VMware, for practical cloud-based scenarios.
- **Obj.4.** Evaluate cloud solutions, identify challenges, and assess security, scalability, and performance considerations.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Recall and describe the basics of cloud computing, virtualization, and essential cloud characteristics.
- **CO2.** Explain and analyze cloud service and deployment models, including SaaS, PaaS, IaaS, and hybrid clouds.
- **CO3.** Apply cloud simulators like CloudSim, GreenCloud, and VMware tools to create and manage virtual machines and simulate cloud scenarios.
- **CO4.** Evaluate cloud adoption challenges, security concerns, performance metrics, and propose optimized cloud solutions.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Cloud Computing Overview** **6L**

Origins of Cloud computing, Cloud components, Essential characteristics, On-demand self-service, Broad network access, Location independent resource pooling, Rapid elasticity, Measured service, Comparing cloud providers with traditional IT service providers, Roots of cloud computing.

**Module 2: Cloud Insights** **8L**

Architectural influences, High-performance computing, Utility and Enterprise grid computing, Cloud scenarios – Benefits: scalability, simplicity, vendors, security, Limitations – Sensitive information, Application development, security level of third party, security benefits, Regularity issues: Government policies.

**Module 3: Cloud Architecture – Layers and Models** **8L**

Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption. Cloud deployment model: Public clouds – Private clouds – Community clouds - Hybrid clouds - Advantages of Cloud computing.

**Module 4: Cloud Simulators – CloudSim and GreenCloud 6L**
Introduction to Simulator, understanding CloudSim simulator, CloudSim Architectureb(User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to GreenCloud.

**Module 5: Introduction to VMWare Simulator 8L**
Basics of VMWare, advantages of VMware virtualization, using Vmware workstation, creating virtual machines-understanding virtual machines, create a new virtual machine on local host, cloning virtual machines, virtualize a physical machine, starting and stopping a virtual machine.

**Text Books:**

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2011.
2. Thomas Erl, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2013.
3. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Distributed and Cloud Computing, Morgan Kaufmann, 2012.
4. George Reese, Cloud Application Architectures, O'Reilly, 2009.

**Reference Books:**

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, McGraw Hill, 2010.
2. Barrie Sosinsky, Cloud Computing Bible, Wiley, 2011.
3. Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi, Mastering Cloud Computing, McGraw Hill, 2013.

**Course Name: Electric Drives and PLC Lab**
**Course Code: EE691**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Concept of Electric Circuit, Electrical machines and power electronics

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Impart knowledge on the operation of power electronic converters for DC and AC motor control.
- **Obj.2.** Develop skills in analyzing motor characteristics under various loading conditions.
- **Obj.3.** Familiarize students with the implementation of Programmable Logic Controller (PLC) in electric drive applications.
- **Obj.4.** Encourage problem-solving through simulation and hardware-based experiments on drives.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Demonstrate the operation of power electronic converters for controlling the speed of DC and AC motors
- **CO2.** Apply power electronic converters for motor speed control.
- **CO3.** Analyse the characteristics of electric motors for different type of loads.
- **CO4.** Implement the basic working of Programmable Logic Controller (PLC) in Electric Drives

**CO-PO Mapping:**

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

**List of Experiments:**

1. Study of Thyristor controlled DC Drive using MATLAB/PSIM.
2. Study of Chopper fed DC Drive using MATLAB/PSIM.
3. Study of AC Single phase motor-speed control using TRIAC.
4. PWM inverter fed 3-phase Induction motor control using PSPICE/MATLAB/PSIM Software.
5. VSI/CSI Induction motor Drive analysis using PSPICE/MATLAB/PSIM Software
6. Study of V/F control operation of 3-phase Induction motor Drives.
7. Regenerative braking operation for DC or AC motor-study using software/hardware.
8. Dynamic braking operation for DC or AC motor-study using software/ hardware.
9. AC and DC Drive Applications using PLC
10. Introduction to PLC and ladder logic implementation
11. PC/ PLC based forward/reverse motion control operation of Induction motor.
12. Innovative experiments.

**Course Name: Power System Protection Lab**
**Course Code: EE692**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Electrical Circuit Analysis, Electrical Machines, Power Systems.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide hands-on training in testing electromechanical and numerical relays.
- **Obj.2.** Enable students to configure and verify protection schemes for electrical power equipment.
- **Obj.3.** Develop skills in simulating faults and analyzing protective relay performance.
- **Obj.4.** Enhance competence in selecting appropriate protection strategies for real-world scenarios.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Carry out standard on-site and laboratory tests on electromechanical and static relays (time-delay, over-current, polarity/ratio and magnetization tests on CTs/PTs), record measurements and interpret results.
- **CO2.** Configure, operate and test protection relays (undervoltage, earth-fault, Micom/numerical differential relays); verify settings and trip logic on hardware and IEDs.
- **CO3.** Model and simulate protection schemes for transformers, generators, motors and transmission lines (distance relays, fault location, power swing analysis) using PSCAD/EMTDC or MATLAB/Simulink and analyze the outcomes.
- **CO4.** Select and justify appropriate protection schemes and relay settings for given power system scenarios; prepare clear technical reports and present findings.

**CO-PO Mapping:**

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

**List of Experiments:**

1. Study on (i) on load Time Delay Relay (ii) off load Time Delay Relay
2. Polarity, Ratio and Magnetization Characteristics Test of CT & PT
3. Testing on (i) Under Voltage Relay and (ii) Earth Fault Relay
4. Study of Transformer Protection by Simulation
5. Study of Generator Protection by Simulation
6. Study of Motor Protection by Micom Relay and Simulation.
7. Study of Different Characteristics of Over Current Relay.
8. Study of numerical type differential relay.
9. Study of transmission line fault detection, classification and location estimation using distance relays by simulating different faults on the WSCC 9-bus test power system through PSCAD/EMTDC software or MATLAB/Simulink.
10. Study of Power Swing and its impact on distance relaying-based transmission line protection scheme through PSCAD/EMTDC software or MATLAB/Simulink.

**Course Name: Electric and Hybrid Vehicle Lab**
**Course Code: EE693**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Electrical Machines, Power Electronics, Electric Drives, Automobile Basics.

**Course Objectives:** The objectives of this course are to

**Obj.1.** Introduce students to propulsion systems and control techniques used in EVs.
**Obj.2.** Develop practical understanding of battery charging/discharging and vehicle-to-grid concepts.
**Obj.3.** Analyze speed–torque characteristics and four-quadrant operation of EV drives.
**Obj.4.** Train students in simulation and hardware implementation of closed-loop motor control.
**Obj.5.** Expose students to performance evaluation of EV components under different operating modes.

**Course Outcomes:** After successful completion of the course, student will be able to

**CO1.** Demonstrate the operation and control of propulsion motors (IM, PMSM) and drives used in Electric Vehicles under different operating modes.
**CO2.** Apply battery charging/discharging techniques (G2V and V2G) and analyse system behaviour under different operating conditions.
**CO3.** Analyse speed–torque characteristics, four-quadrant operation, and performance parameters (speed, current, voltage, power) of EV propulsion systems.
**CO4.** Implement and evaluate closed-loop motor control techniques (V/F, Field-Oriented Control, throttle-based control) using modern simulation and hardware tools.

**CO-PO Mapping:**

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

**List of Experiments:**

1. Introduction to power electronics based electric vehicle system.
2. Constant current mode of discharging/charging of EV Battery to the three-phase grid (Vehicle to Grid) and (Grid to Vehicle).
3. Open loop and close loop speed control of EV induction motor drive (V/F) in both clockwise and anti-clockwise direction.
4. Field oriented control of EV PMSM motor drive in both clockwise and anti-clock wise direction.
5. Create your own speed profile and run the propulsion motor (EV IM and EV PMSM) and analyse the speed profile, voltage, current, and power of the motor
6. Run the propulsion motor by throttle paddle and analyse the speed, voltage, current, power of the system.
7. Testing and analysis and propulsion motor loading at different speed and torque condition.
   a) Constant speed VS constant torque
   b) Constant speed VS variable torque
   c) Changing speed VS constant torque
8. Study of four quadrant operation of propulsion motor and analyse all the parameters like

voltage, current, speed, toque, and power flow.

a) Forward motoring mode
b) Forward braking mode
c) Reverse motoring mode

9. Reverse braking mode

**Course Name: Database Management System Lab**
**Course Code: OE(EE)691A**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Knowledge about the basics of electronics and basic concepts in logic design, basic knowledge of data structure and programming concept.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce relational database concepts and schema design.
- **Obj.2.** Develop competency in SQL and PL/SQL for data definition, manipulation, and control.
- **Obj.3.** Familiarize students with advanced features such as cursors, triggers, and procedures.
- **Obj.4.** Enable application development using database connectivity with frontend tools.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Design and implement a database schema for a given problem-domain
- **CO2.** Create and maintain tables using PL/SQL Course Outcome
- **CO3.** Populate and query a database
- **CO4.** Application development using PL/SQL & frontend tools

**CO-PO Mapping:**

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

**List of Experiments:**

1. Study of Backend Tool – Oracle.
2. Data Definition Language (DDL) commands in RDBMS.
3. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
4. High-level language extension with Cursors.
5. High level language extension with Triggers
6. Procedures and Functions.
7. Embedded SQL.
8. Database design using E-R model and Normalization.
9. Mini project (Application Development using Oracle and Visual Basic)
    - i. Inventory Control System.
    - ii. Material Requirement Processing
    - iii. Hospital Management System
    - iv. Railway Reservation System
    - v. Personal Information System
    - vi. Web Based User Identification System
    - vii. Time-table Management System

**Text Books:**

1. ORACLE PL/SQL by example. Benjamin Rosenzweig, Elena Silvestrova, Pearson Education 3rd Edition.

**Reference Books:**

1. ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc- Graw Hill.
2. SQL & PL/SQL for Oracle 10g, Black Book, Dr. P. S. Deshpande.

**Course Name: Computer Architecture and Network Lab**
**Course Code: OE(EE)691B**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Basic Computer Architecture and Operating System.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Provide practical knowledge of CPU architecture, instruction cycles, and memory organization.
- **Obj.2.** Train students in implementing and analyzing processor functions and pipeline hazards.
- **Obj.3.** Familiarize with the setup, configuration, and analysis of computer networks.
- **Obj.4.** Develop skills in network application design using socket programming and simulators.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Demonstrate fundamental components of computer architecture including instruction cycle, addressing modes, and bus operations through software/hardware tools.
- **CO2.** Implement and analyze CPU functions (ALU operations, registers, pipelining, hazards) and memory hierarchy mechanisms (cache, virtual memory) using simulators.
- **CO3.** Configure and analyze computer networks through setup of IP addressing, subnetting, and implementation of data link and transport layer protocols.
- **CO4.** Design and implement network applications and services (sockets, client-server programming, protocol simulation) for effective communication.

**CO-PO Mapping:**

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

**List of Experiments:**

1. Study of instruction cycle, instruction formats, and addressing modes using a CPU simulator (e.g., MARIE / RISC-V).
2. Implementation of ALU operations (arithmetic & logic) and observation of register transfers.
3. Simulation of control unit design – Hardwired vs. Microprogrammed control.
4. Pipelining and hazards: Demonstration of data, control, and structural hazards using a pipeline simulator.
5. Cache memory and virtual memory simulation – mapping techniques (direct, associative, set-associative) and page table/TLB.
6. Network device setup and IP configuration (NIC installation, LAN connectivity, subnetting).
7. Network configuration commands in Windows/Linux environments.
8. Topology design and simulation using Packet Tracer/NS2/NS3.
9. Implementation of error detection and flow control protocols (CRC, Stop & Wait, Sliding Window).
10. Socket programming (TCP and UDP) for client–server communication and simple

applications.

**Text Books:**


1. B. A. Forouzan – Data Communications and Networking (5th Ed.) – TMH
2. W. Stallings – Computer Organization and Architecture – Pearson/PHI
3. W. Stallings – Data and Computer Communications (5th Ed.) – Pearson/PHI


**Reference Books:**


1. A. S. Tanenbaum – Computer Networks (4th Ed.) – Pearson/PHI
2. M. Mano – Computer System Architecture – Pearson
3. Black – Data & Computer Communication – PHI
4. Zheng & Akhtar – Network for Computer Scientists & Engineers – OUP

**Course Name: Cloud Computing Lab**
**Course Code: OE(EE)691C**
**Contact: 0L:0T:3P**
**Credit: 1.5**

**Prerequisite:** Operating System, Computer Networks, Virtualization Concepts, and Basic Programming.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce cloud computing environments, virtualization, and service models.
- **Obj.2.** Provide skills in configuring and using cloud platforms for computation and storage.
- **Obj.3.** Analyze performance, scalability, and monitoring in cloud environments.
- **Obj.4.** Develop and deploy cloud-based applications using APIs and container technologies.
- **Obj.5.** Encourage teamwork and problem-solving through end-to-end cloud project deployment.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Demonstrate the setup and use of cloud platforms, virtualization tools, and basic cloud services.
- **CO2.** Apply cloud service models (IaaS, PaaS, SaaS) for solving computational and storage problems.
- **CO3.** Analyze performance, scalability, and resource management in cloud environments using monitoring tools.
- **CO4.** Develop and deploy applications using cloud APIs and services for real-time use cases.

**CO-PO Mapping:**

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

**List of Experiments:**

1. Setup of VMware/VirtualBox/KVM; create and configure virtual machines.
2. Install and configure OpenStack/CloudStack/Eucalyptus on local infrastructure.
3. Demonstration of IaaS, PaaS, and SaaS with examples.
4. Configure object/block storage (e.g., AWS S3, Google Cloud Storage, or OpenStack Swift).
5. Auto-scaling instances on AWS/Azure/OpenStack.
6. Use tools like CloudWatch/Prometheus to monitor CPU, memory, and network usage.
7. Simulation of load balancing and task allocation.
8. Deploy a Web Application on a cloud platform using PaaS (e.g., Heroku/AWS Elastic Beanstalk/Google App Engine).
9. Setup of Docker containers and Kubernetes cluster deployment.
10. Deploy a mini end-to-end cloud solution (e.g., online file storage system, e-commerce web app with DB backend).

**Text Books:**

1. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi – Mastering Cloud Computing

– McGraw Hill.
2. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra – Distributed and Cloud Computing – Elsevier.

**Reference Books:**

1. Thomas Erl – Cloud Computing: Concepts, Technology & Architecture – Pearson.
2. George Reese – Cloud Application Architectures – O'Reilly.
3. Gautam Shroff – Enterprise Cloud Computing – Cambridge University Press.

<table>
<tr><th colspan="10">4th Year 7th Semester</th></tr>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Broad Category</th><th rowspan="2">Category</th><th rowspan="2">Paper Code</th><th rowspan="2">Subject</th><th colspan="4">Contact Hours/Week</th><th rowspan="2">Credit Points</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>Total</th></tr>
<tr><th colspan="10">A. Theory</th></tr>
<tr><td>1</td><td>ENGG</td><td>Major</td><td>EE701</td><td>Introduction to Smart Grid</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">ENGG</td><td rowspan="3">Major</td><td rowspan="3">PE(EE)701</td><td>A. Energy Conservation and Audit</td><td rowspan="3">3</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">3</td><td rowspan="3">3</td></tr>
<tr><td>B. HVDC Transmission Systems</td></tr>
<tr><td>C. Power Generation Economics</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">ENGG</td><td rowspan="3">Minor</td><td rowspan="3">OE(EE)701</td><td>A. Robotics and Drone Technology</td><td rowspan="3">3</td><td rowspan="3">0</td><td rowspan="3">0</td><td rowspan="3">3</td><td rowspan="3">3</td></tr>
<tr><td>B. Bio-Medical Instrumentation</td></tr>
<tr><td>C. Digital Image Processing</td></tr>
<tr><td>4</td><td>ENGG</td><td>Skill Enhancement Courses</td><td>HU(EE)701</td><td>Industrial Management</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><th colspan="10">B. Sessional</th></tr>
<tr><td>5</td><td>PROJ</td><td>Project</td><td>PR781</td><td>Major Project - II</td><td>0</td><td>0</td><td>0</td><td>0</td><td>8</td></tr>
<tr><td colspan="8">Total for Theory, Practical and Sessional</td><td>12</td><td>20</td></tr>
</table>

**Course Name: Introduction to Smart Grid**
**Course Code: EE701**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Power System and Power Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.6.** Provide an understanding of the evolution, necessity, and policies driving smart grid development.
- **Obj.7.** Introduce smart grid components, communication systems, and measurement technologies.
- **Obj.8.** Develop the ability to analyze, model, and evaluate smart grid performance and operation.
- **Obj.9.** Promote awareness of cybersecurity, islanding, and protection strategies in modern grids.
- **Obj.10.** Encourage application of smart grid concepts through simulation and case studies.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Describe the necessity and evolution of smart grid with policies.
- **CO2.** Apply theoretical concepts for analyzing the performance of the grid.
- **CO3.** Understand Smart Grid design, operation and control.
- **CO4.** Discuss on two-way power flow of distribution system.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Smart Grid Architectural Designs** **4L**
Introduction. Evolution of electric Grid, Need for smart grid, difference between Conventional grid and smart grid, General View of the Smart Grid Market Drivers, Functions of Smart Grid Components, present development and international policies in smart grid.

**Module 2: Smart Grid Communications and Measurement Technology** **5L**
Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) , Smart Meters , Smart Appliances, Advanced Metering Infrastructure (AMI), Micro grid and Smart Grid Comparison.

**Module 3: Performance Analysis Tools for Smart Grid Design** **6L**
Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, types, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design Contingency Studies for the Smart Grid.

**Module 4: Information Security and Communication Technology for Smart Grid 6L**

Data communication, switching techniques, communication channels, HAN, NAN, WAN, Bluetooth, Zigbee, GPS, Wi-Fi based communication, Wireless mesh network, Basic of cloud computing and cyber security for smart grid, Broadband over power line(BPL).

**Module 5: Islanding & Smart Grid Protection 4L**

Islanding Detection Techniques, Smart Grid Protection, Digital relays for Smart Grid Protection.

**Module 6: Operation and control 5L**

Modelling of Storage Devices, Modelling of DC Smart Grid components, Operation and control of DC Microgrid, Operation and control of AC Microgrid, Operation and control of AC-DC hybrid Microgrid.

**Module 7: Smart Grid Case Study 6L**

Simulation and Case study of AC Microgrid, Simulation and Case study of DC Microgrid, Simulation and Case Study of AC-DC Hybrid Microgrid, Demand side management of Smart Grid, Demand response analysis of Smart Grid.

**Text Books:**

1. James momoh, "Smart grid fundamentals of design and analysis, IEEE Press, a john wiley & sons, inc., publication, 2012.
2. Bernd M. Buchholz, Zbigniew Styczynski, Smart grid fundamentals and Technologies Electricity Networks, Springer, Heidelberg New York Dordrecht London, 2014.

**Reference Books:**

1. Janaka Ekanayake, Nick Jenkis, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Smard grid technology and applications, Wiley, 2012.
2. Stuart Borlase Smart grid: Infrastructure, Technology and solutions, CRC Press 2012.

**Paper Name: Energy Conservation and Audit**
**Paper Code: PE(EE)701A**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Concept of Electrical Machines, Power System and Power Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Impart knowledge on energy conservation principles and their impact on sustainability.
- **Obj.2.** Introduce methods of energy auditing, life cycle costing, and economic evaluation of energy systems.
- **Obj.3.** Develop competence in analyzing energy use in electrical machines, drives, and lighting systems.
- **Obj.4.** Enable understanding of demand-side management techniques and regulatory frameworks.
- **Obj.5.** Highlight the role of smart grid and modern technologies in energy efficiency.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Learn about Energy Conservation and its benefits
- **CO2.** Learn Life Cycle costing of Electrical Appliances
- **CO3.** Learn about Energy auditing
- **CO4.** Learn about Supply and Demand Side Management
- **CO5.** Learn about the role of Smart Grid and Energy Control Centers.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Energy Conservation and Environment** **6L**

Electricity Act 2003, Integrated Energy Policy. Energy and environment, Air pollution, Climate change, United Nations Framework Convention on climate change (UNFCCC), Montreal Protocol, Kyoto Protocol, Clean Development Mechanism (CDM), CDM methodology and Procedures, Sustainable development.

**Module 2:** **10L**

***Electrical Systems (2L):*** Supply & Demand Side, Economic operation, Input-Output curves, Electricity tariff types; Case Study 1;
***Cogeneration (2L):*** Types and Schemes;
***Energy auditing (5L):*** Load profiling; Case Study 2; Necessity of Energy audit, Types of energy audit, Energy audit instruments; Case Study 3; Energy Conservation Act-2001 and its features, Notification Under the act, Designated agencies, Schemes of Bureau of Energy Efficiency (BEE); Intervals of EA regulation;
***Energy Economics (1L):*** Economic assessment and Economic methods for specific energy

analysis; Case study 4

**Module 3: 9L**

***Electric Motors & Energy Conservation (5L):*** Energy efficient controls and starting efficiency -Electric Motors; Energy efficient /high efficient Motors; Case study 5; Load Matching and selection of motors; Case Study 6; Variable speed drives; Case study 7; Pumps and Fans-Efficient Control strategies; Case study 8;

***Electric loads & Energy conservation measures (4L):*** Air conditioning & Refrigeration, Cold storage-Types-Optimal operation-case study 9; Electric water heating-Geysers-Solar Water Heaters-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process.

**Module 4: Electrical Demand Side Management (DSM) 7L**

Reactive Power management-Capacitor Sizing-Degree of Compensation; Case study 10; Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling -Case study 11; Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study 12;

**Module 5: 4L**

***Smart Grid Technologies in Energy Conservation (2L):*** Plug In Hybrid Electric Vehicles (PHEV); Microgrids; Home Energy Management Systems (HEMS); Electrical Energy Storage Technologies;
***Computer Controls (2L):*** Hardware, Software-EMS

**Text Books:**

1. Leon K. Kirchmayer, “Economic Operation of power system”, Wiley India Pvt Ltd, July 2010.
2. Timothy J. E. Miller, “Reactive power control in electric systems”, Wiley edition, August 2010
3. Albert Thumann, P.W, Plant Engineers and Managers Guide to Energy Conservation” TWI Press Inc, Terre Haute, 9th edition, 2008
4. Turner, Wayne C., “Energy Management Handbook”, Lilburn, The Fairmont Press, 2001
5. Anthony J. Pansini, Kenneth D. Smalling, “Guide to Electric Load Management”, Pennwell Pub,1998
6. Albert Thumann, “Handbook of Energy Audits”, Fairmont Pr; 5th edition,1998
7. Howard E. Jordan, “Energy-Efficient Electric Motors and Their Applications”, Plenum Pub Corp; 2nd edition 1994

**Reference Books:**

1. Jean-Claude Sabonnadi Are, “Low emission power generation technologies and energy management”, John Wiley & Sons, August 2010
2. Ursula Eicker, “Low energy cooling for sustainable buildings”, John Wiley & Sons, August 2010
3. Francois, Leveque, “Transport pricing of electricity networks”, Springer 2003.
4. Giovanni Petrecca, “Industrial Energy Management: Principles and Applications”, The Kluwer international series -207,1999 Springer 2000.
5. Parasiliti F., P. Bertoldi, “Energy Efficiency in motor driven systems”, Springer, 2003.
6. Donald R. W., “Energy Efficiency Manual”, Energy Institute Press,2000
7. Petrecca, Giovanni, “Industrial Energy Management”, Springer 1993
8. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities”, IEEE Inc, USA.,1985
9. NESCAP-Guide Book on Promotion of Sustainable Energy Consumption

**Paper Name: HVDC Transmission Systems**
**Paper Code: PE(EE)701B**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisites:** Concept of Power System and Power Electronics.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Familiarize students with HVDC technology, configurations, and applications.
- **Obj.2.** Develop the ability to analyze HVDC converters, control methods, and system operations.
- **Obj.3.** Understand harmonic generation, filtering techniques, and power quality issues in HVDC systems.
- **Obj.4.** Gain knowledge of fault scenarios and protection schemes in HVDC networks.
- **Obj.5.** Provide exposure to multiterminal HVDC and modern FACTS-integrated transmission systems.

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

- **CO1.** Describe HVDC converters and HVDC transmission.
- **CO2.** Formulate and solve mathematical problems related to rectifier and inverter control methods and learn about different control schemes as well as starting and stopping of DC links.
- **CO3.** Analyze the different harmonics generated by the converters and their variation with the change in firing angles.
- **CO4.** Distinguish the nature of faults on the converters and their protection schemes.
- **CO5.** Demonstrate the existing HVDC systems along with MTDC systems and modern transmission system.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction** **4L**

Introduction of DC power transmission technology, comparison of AC and DC transmission, limitation of HVDC transmission, reliability of HVDC systems, application of DC transmission, description of DC transmission system, planning for HVDC transmission, modern trends in DC transmission.

**Module 2: Analysis of HDVC Converters** **3L**

Choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics, Characteristics of a twelve pulse converter, detailed analysis of converters.

**Module 3: Control of HVDC Converter and Systems** **5L**

Necessity of control of a DC link, rectifier control, compounding of rectifiers, power reversal of DC link, voltage dependent current order limit(VDCOL) characteristics of the converter, inverter extinction angle control, pulse phase control, starting and stopping of DC link, constant power control, control scheme of HVDC converters.

**Module 4: Harmonics and Filters 6L**

Generation of harmonics by converters, characteristics of harmonics on DC side, characteristics of current harmonics, characteristic variation of harmonic currents with variation of firing angle and overlap angle, effect of control mode on harmonics, non-characteristic harmonic. Harmonic model and equivalent circuit, use of filter, filter configuration, design of band-pass and high pass filter, protection of filters, DC filters, power line communication and RI noise, filters with voltage source converter HDVC schemes.

**Module 5: Fault and Protection Schemes in HVDC Systems 3L**

Nature and types of faults, faults on AC side of the converter stations, converter faults, fault on DC side of the systems, protection against over currents and over voltages, protection of filter units.

**Module 6: Multiterminal HVDC Systems 3L**

Types of multiterminal (MTDC) systems, parallel operation aspect of MTDC Series and shunt devices and principle of operation and control, UPFC and IPFC, modelling of FACTS devices for power system studies.

**Text Books:**

1. S. Kamakshaiah and V. Kamaraju, "HVDC Transmission", Tata McGraw Hill Education.
2. K. R. Padiyar, "HVDC Power Transmission System", Wiley Eastern Limited.
3. J. Arrillaga, "High Voltage Direct Current Transmission", The Institution of Electrical Engineers.

**Reference Books:**

1. Prabha Kundur, "Power System Stability and Control", McGraw Hill.
2. Abhijit Chakrabarti and Sunita Halder, "Power System Analysis: Operation and Control", PHI Learning Pvt. Ltd.

**Paper Name: Power Generation Economics**
**Paper Code: PE(EE)701C**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisites:** Concept of Power Systems and Renewable Energy Systems.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Analyze the costs associated with different types of power generation, such as thermal, hydro, and nuclear.
- **Obj.2.** Understand and apply different types of tariffs, including block rate, flat rate, and two-part tariffs.
- **Obj.3.** Apply unit commitment and economic dispatch techniques to optimize power system operation.
- **Obj.4.** Understand state estimation methods and load forecasting techniques to ensure reliable and efficient power system operation.

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

- **CO1.** Analyze the cost of power generation from thermal, hydro, and nuclear sources, and understand the concept of load factor, plant capacity factor, and diversity factor.
- **CO2.** Apply different types of tariffs, such as block rate, flat rate, two-part, maximum demand, and power factor tariffs, and understand subsidization and cross-subsidization.
- **CO3.** Identify constraints in unit commitment, such as spinning reserve, thermal unit constraints, and hydro constraints, and apply solution methods to optimize unit commitment.
- **CO4.** Apply transmission loss formulae and computational methods in economic load scheduling, and understand state estimation methods and load forecasting techniques in power systems.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Economics of Generation** **7L**

Cost of power generation- Thermal, Hydro and Nuclear. Types of Consumers in a distribution system Domestic, Commercial, Industrial etc. Concept of load factor, plant capacity factor, plant use factor, diversity factor, demand factor. Choice of size and number of generation units.

**Module 2: Tariff** **7L**

Block rate, flat rate, two part, maximum demand, Power factor and three part tariffs. Subsidization and Cross subsidization. Availability tariff of generation companies. Pool tariff of transmission companies. Availability based tariff (ABT).

**Module 3: Unit Commitment** **7L**

Constraints in Unit Commitment, Spinning reserve, Thermal unit constraints, Hydro constraints, Must run, Fuel constraints. Unit commitment solution methods.

**Module 4: Economic Dispatch** **10L**

Transmission loss formulae and its application in economic load scheduling.
Computational methods in economic load scheduling. Active and reactive power optimization.

**Module 5: State Estimation and load forecasting in power system** **6L**

Introduction, state estimation methods, concept of load forecasting, load forecasting technique and application in power system.

**Text Books:**

1. Economic operation of Power System, L.K. Kirchmayar John Wiely, Newyork.
2. Power system Analysis, operation & control, Chakrabarty & Haldar, 2nd edition, PHI.3. Modern power system analysis, D.P. Kothari & I.J. Nagtrath, Tata McGraw Hill.

**Reference Books:**

1. Power generation operation & control, A.J. Wood & B.F. Wollenberg, Wiley India.
2. Operation and control in power system, P.S.R. Murthy, BSP Publication.

**Paper Name: Robotics and Drone Technology**
**Paper Code: OE(EE)701A**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisites:** Concept of Power Systems and Renewable Energy Systems.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Understand the fundamentals of robotics and drones, including architecture and components.
- **Obj.2.** Learn robot and drone dynamics, control principles, and flight/locomotion mechanisms.
- **Obj.3.** Study the role of sensors, actuators, and power systems.
- **Obj.4.** Explore communication, navigation, and programming platforms.
- **Obj.5.** Apply knowledge through laboratory exercises and mini-projects.
- **Obj.6.** Examine real-world applications and future trends in robotics and drone technology.

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

- **CO1.** Describe the architecture and components of robots and drones
- **CO2.** Analyze dynamics and control of robotic and drone systems
- **CO3.** Explain sensor technologies, actuators, and integration challenges
- **CO4.** Implement communication and navigation systems

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Introduction to Robotics and Drones 6L**

History and evolution of robotics & drones, Classification: types of robots (industrial, service, mobile) and drones (fixed-wing, rotary-wing, hybrid), Core components: structure, motors, ESC, batteries, controllers, Applications in industry, defence, agriculture, healthcare, and energy

**Module 2: Dynamics and Control 6L**

Fundamentals of robot kinematics and dynamics, Aerodynamics of drones: lift, thrust, drag, weight, Stability and control (pitch, roll, yaw for drones; DOF for robots), Control systems: PID, adaptive, and AI-based approaches

**Module 3: Sensors, Actuators, and Power Systems 6L**

Sensors: IMU, GPS, LIDAR, Cameras, Proximity, Force, Temperature, Actuators: Brushless motors, Servos, Linear actuators, Sensor fusion techniques (Kalman filter basics), Power systems: batteries, fuel cells, hybrid power for robotics & drones

**Module 4: Communication and Navigation Systems 6L**

Communication protocols: RF, WiFi, Bluetooth, 4G/5G, Telemetry and control link for drones, Robotic navigation: SLAM (Simultaneous Localization and Mapping) basics, GPS-based navigation, autonomous path planning.

**Module 5: Programming and Simulation 6L**

Programming platforms: ROS (Robot Operating System), DroneKit, MATLAB/Simulink, Basics of motion control programming, Simulation tools: Gazebo, PX4 SITL, Mission Planner, Safety, regulations, and ethical considerations

**Module 6: Applications and Future Trends 6L**

Applications: robotics in manufacturing, drones in agriculture, surveillance, logistics, healthcare, Advanced concepts: swarm robotics, AI-driven autonomy, human-robot interaction, BVLOS drones, Challenges: energy efficiency, safety, cybersecurity, ethics.

**Text Books:**

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 4th Edition, 2018.
2. Maja J. Matarić, The Robotics Primer, MIT Press, 2007.
3. Francis Markham, David Roberts, Drone Theory: UAV Fundamentals and Applications, Routledge, 2020.
4. Robert C. Nelson, Flight Stability and Automatic Control, McGraw Hill, 2nd Edition, 2019.

**Reference Books:**

1. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer, 2017.
2. Siegwart, Nourbakhsh, and Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 3rd Edition, 2011.
3. Antonio Barrientos et al., Fundamentals of Robotics and Drones, CRC Press, 2021.
4. Thomas Bräunl, Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems, Springer, 3rd Edition, 2020.
5. Michael S. Branicky et al., Unmanned Aircraft Systems: UAVS Design, Development and Deployment, Wiley, 2021.
6. Brett Hoffstadt, Success with Drones in Civil Engineering and Surveying, McGraw Hill, 2016.

**Paper Name: Bio-Medical Instrumentation**
**Paper Code: OE(EE)701B**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisites:** Basic Electrical Engg, Basic principles of sensing, measurement and transduction.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Introduce an fundamentals of transducers as applicable to physiology
- **Obj.2.** Explore the human body parameter measurements setups
- **Obj.3.** Make the students understand the basic concepts of forensic techniques.
- **Obj.4.** Give basic ideas about how multimedia evidences are useful in crime investigation.

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

- **CO1.** Describe the physiology of biomedical system.
- **CO2.** Measure biomedical and physiological information.
- **CO3.** Discuss the application of Electrical & Electronics in diagnostics.
- **CO4.** Acquaintance with the Electrical Isolation and Safety Standards in the biomedical system

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Physiology and transducers** **6L**

Cell and its structure, Resting and Action Potential, Nervous system: Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, Cardiovascular system, respiratory system, Basic components of a biomedical system.

**Module 2: Electro – Physiological measurements** **10L**

Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes, Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier. ECG, EEG, EMG,Lead systems and recording methods, typical waveforms. Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters of biomedical equipment.

**Module 3: Non-electrical parameter measurements** **6L**

Measurement of blood pressure, Cardiac output, Heart rate, Heart sound Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers : pH of blood, measurement of blood pCO2, pO2, finger-tip oximeter, Standard HL7.

**Module 4: Medical Imaging and LASER Application** **8L**

Radiographic and fluoroscopic techniques, X rays, Computer tomography, Mammography, MRI, Ultrasonography, Endoscopy, Thermography, Different types of biotelemetry systems and patient monitoring. LASER- Principle of LASER operation and its characteristics. Types of LASERs – Pulsed Ruby LASER, Nd-YAG LASER – Helium-Neon LASER– $CO_2$ LASER – Semiconductor Laser and their biomedical application.

**Module 5: Electrical Isolation and Safety Standards 6L**

Optical & Electrical Isolation Techniques, Leakage Currents in Medical Devices, Grounding & Protection Mechanisms, Standards for Biomedical Equipment Safety : IEC 60601 (Medical Electrical Equipment Standard), FDA Regulations for Medical Devices, Electromagnetic Interference (EMI) & Electromagnetic Compatibility (EMC).

**Text Books:**


1. Cromwell L – Biomedical Instrumentation and Measurement, Pearson
2. Khandpur R.S., Hand book of Biomedical Instrumentation, Tata McGraw Hill
3. Webster J S – Medical Instrumentation – Application and Design
4. Astor B R – Introduction to Biomedical Instrumentation and Measurement, McMillan.
5. Chatterjee Miller – Biomedical Instrumentation, Cengage Learning

**Paper Name: Digital Image Processing**
**Paper Code: OE(EE)701C**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisite:** Digital Signal Processing.

**Course Objectives:** The objectives of this course are to

- **Obj.1.** Familiarize students with the fundamentals of digital image representation and transforms.
- **Obj.2.** Provide knowledge of image enhancement techniques in both spatial and frequency domains.
- **Obj.3.** Develop competence in image compression, segmentation, and edge detection methods.
- **Obj.4.** Impart understanding of image security, encryption, and watermarking techniques.
- **Obj.5.** Encourage application of image processing algorithms in engineering and real-world problems.

**Course Outcomes:** After successful completion of the course, student will be able to

- **CO1.** Familiarize with Digital Image characteristics, its representation in different domain.
- **CO2.** Analyze digital image enhancement techniques in spatial and frequency domain.
- **CO3.** Analyze the performance of image compression, segmentation and security.
- **CO4.** Apply image processing algorithms in different applications and solve problems.

**CO-PO Mapping:**

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

## ***Course Content***

**Module 1: Digital Imaging Fundamentals and Transform of Digital Images 10L**

***Digital Imaging Fundamentals:*** Basic idea of Digital image, Pixel, Mathematical operation of Digital Image, Sampling, Quantization, application of digital Image Processing.

***Transform of Digital Images:*** Importance of Digital Image Transform, Fourier Transform of Digital Image (DFT), Inverse Fourier Transform (IDFT), Application of Digital Image Transform in different area

**Module 2: Digital Image Enhancement 9L**

Importance of Digital Image enhancement, enhancement in spatial and frequency domain, Bit plane slicing, Histogram, Histogram Equalization, Mean and Median filtering in Digital Images, Frequency domain filtering in Digital Images – LPF, HPF and BPF.

**Module 3: Digital Image Compression 10L**

Importance of Digital Image Compression, Types of Image Compression, example of lossless and lossy compression, Image compression standards, Compression in spatial domain, compression using Huffman coding, Filter Bank analysis Segmentation of Digital Images: Importance and applications of Image Segmentation, Thresholding, Segmentation based on Region Growing, Watershed algorithm. Edge detection in Digital Image Processing: Importance of Edge detection in Digital Image Processing, Types of Edge Detection, Mathematical Equation of each operator.

**Module 4: Security in Digital Image Processing 7L**

Importance of Digital Image Security, Watermarking, Image encryption in spatial and frequency domain, Steganography. Application of Artificial Intelligence/ Machine Learning in Image and Video Processing

**Text Books:**

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.
2. S. Annadurai, R. Shanmugalakshmi, "Fundamentals of Digital Image Processing", Pearson Education, 2006
3. Digital Video processing, A Murat Tekalp, Prentice Hall

**Reference Books:**

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
2. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.
3. Willliam K Pratt, "Digital Image Processing", John Willey, 2002.
4. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", First Edition, PHI Learning Pvt. Ltd., 2011.

**Paper Name: Industrial Management**
**Paper Code: HU(EE)701**
**Contact: 3L:0T:0P**
**Total Contact Hours: 36**
**Credit: 3**

**Prerequisites:** Mathematics, English

**Course Objective:**

- **Obj.1.** Provide knowledge of management principles, organizational behavior, and industrial structure.
- **Obj.2.** Introduce financial management, project planning, and operations strategies in industries.
- **Obj.3.** Develop decision-making, leadership, and communication skills in engineering management.
- **Obj.4.** Enable understanding of human resource management, industrial relations, and ethics.
- **Obj.5.** Prepare students for managerial roles in technical and industrial environments.

**Course Outcome:** After completion of this course students will be able to

- **CO1.** Explain and describe various technology-based business models and the dynamics of value creation, value proposition, and value capture in industrial enterprises.
- **CO2.** Select, interpret and use different costing techniques as a basis for decisions in various business situations.
- **CO3.** Understand the basic principles of financial accounting and reporting.
- **CO4.** Produce and interpret an industrial company's Annual Statement, at a basic level.
- **CO5.** Describe the operations of an industrial enterprise from various perspectives, and analyze its basic strengths and weaknesses based on concepts from the field of Industrial Management.
- **CO6.** Explain how the industrial company markets and price it's products considering GST.

## ***<u>Course Content</u>***

**Module 1: Introduction to Accounting** **10L**

Important Definitions, Basic concepts and conventions, Types of Accounts with Golden Rule of Accounting, Journal, Ledger and Trial Balance, Preparation of Trading Account, Profit & Loss A/C and Balance Sheet for business organizations.

**Module 2: Financial Management** **12L**

***Introduction to Financial Management:***
Introduction, Definition and concept, scope, objective, functions of Finance Manager.
***Ratio Analysis:***
Definition, Objectives, Advantages & Disadvantages, Classification of Ratios: Liquidity ratios, Capital Structure ratios, Activity ratios & Profitability Ratios.
***Capital Budgeting:***
Nature of Investment Decision, Importance of Capital Budgeting, capital budgeting process, Investment criteria, payback period, Rate of return, cash flow, discounting cash flow NPV method and IRR method, Benefit cost ratio, ARR.

**Module 3: Cost Accounting and Budget 8L**

***Cost Accounting:***

Introduction to cost accounting-Cost Centre, Cost unit, Elements of costs, Statement of cost or cost sheet, Marginal cost & C-V-P analysis with BEC.

***Budget and Budgetary Control:***

Concepts of Budget, Budgeting and budgetary control, advantages, disadvantages, uses, Master Budget, Zero Based Budget, Cash budget, Flexible budget.

**Module 4: Working capital management 6L**

Introduction-working capital concept-financing working capital-importance of working capital-management of working capital-working capital cycle- management of different components of working capital-working capital forecast.

**Text Books:**

1. Financial Management, Khan & Jain, S. Chand
2. Management Accounting, Khan & Jain, S. Chand
3. Modern Accountancy, Haniff & Mukherjee, TMH

**Reference Books:**

1. An Introduction to Accountancy, S.N.Maheswari, Vikas publication
2. Cost Accounting: Theory and Practices, B. Banerjee, PHI
3. Financial Management, IM Pandey, Vikas