AC-01-Item No. 2.0, 2.4, 3.0 & 3.4 dated 29th April 2024

Agnel Charities

# Fr. C. Rodrigues Institute of Technology

Sector 9A, Vashi, Navi Mumbai, 400703, Maharashtra, India

www.fcrit.ac.in

## An Autonomous Institute Affiliated to the University of Mumbai

**Department of Electrical Engineering**

**Curriculum Structure FY to B.Tech**

**&**

**First, Second and Third Year Syllabus**

**Prepared by: Board of Studies for Electrical Engineering**

**Approved by: Academic Council of Fr. C. Rodrigues Institute of Technology**

**Effective from: 2024-25**

**Revision: 2024.1**

# PREAMBLE-DEAN ACADEMICS

*Accelerating Towards Excellence: Unveiling a New Era in Education*

Dear Students, Faculty, and Stakeholders,

It is with great pleasure and anticipation that we introduce the newly designed curriculum for autonomy at Agnel Charities' Fr. C. Rodrigues Institute of Technology. This pioneering initiative aims to revolutionize engineering education, ensuring our graduates are equipped with not only technical prowess but also the holistic skills necessary for thriving in today's dynamic professional landscape.

1. **Purpose of Autonomy:** Our commitment to autonomy is rooted in the imperative to bridge the gap between academia and industry. We envision education as a catalyst for individual growth, fostering self-sustainability and enhancing employability. Through our curriculum, westrive to nurture engineers who not only excel in their fields but also contribute meaningfullyto society.

2. **Curriculum Design: A Top-to-Down Approach:** Our curriculum is meticulously crafted with a top-to-down approach, encompassing all 12 attributes of Program Outcomes mandated by regulatory bodies. Emphasizing a blend of theoretical knowledge and practical application, it is designed to cultivate well-rounded professionals capable of tackling real-world challenges with confidence and competence.

3. **Alignment with National Education Policy-2020:** In adherence to the guidelines laid out in the National Education Policy-2020, our curriculum embodies a multidisciplinary approach, offering a diverse array of core and elective courses. It integrates hands-on learning experiences such as mini and major projects, skill-based labs, and one-semester internships to nurture innovation and problem-solving skills. Additionally, the inclusion of value-added courses, honours, and minors ensures a comprehensive educational journey tailored toindividual interests and aspirations.

4. **Opportunities for Teachers in Innovation:** We recognize the pivotal role of our faculty in shaping the educational experience. Our curriculum provides ample opportunities for teachers to innovate in teaching-learning methodologies and evaluation techniques. Throughcontinuous professional development programs and collaborative platforms, we empower our educators to experiment with innovative pedagogies, leverage technology for enhanced learning outcomes, and implement novel assessment strategies. By fostering a culture of innovation among our faculty, we aim to enrich the learning experience and inspire a passion for lifelong learning among our students.

As we embark on this transformative journey, we invite all stakeholders to join us in shaping the futureof engineering education. Together, let us strive towards excellence, innovation, and societal impact.

Sincerely,

**Dean of Academics Agnel Charities' Fr. C. Rodrigues Institute of Technology**

# PREAMBLE- BOS CHAIRPERSON

Established in 1994, the Electrical Engineering department, provides comprehensive programs spanning undergraduate, postgraduate, and Ph. D levels. Comprising a team of highly qualified and experienced faculty, the department distinguishes itself through its cutting-edge facilities such as the Renewable Laboratory, Protection Laboratory, Power Electronics, Drives and Control System Laboratory. Additionally, the program has received accreditation thrice in 2005, 2012, and 2018, maintaining its validity to date. Furthermore, the institute is scheduled to transition to autonomy from the academic year 2024-25.

The scheme and syllabus of the Department of Electrical Engineering under autonomy are centred entirely on fostering the development of learners and cultivating the essential attributes that graduates should possess. When crafting the curriculum, two primary considerations are taken into account: the essential domain knowledge, skill sets, and tools required for the diverse career paths available to contemporary Electrical engineers and the 12 attributes of Program Outcomes mandated by regulatory bodies. The NBA-SAR January 2016 serves as a benchmark for shaping the learning outcomes within each module of the syllabus. Electrical engineering curriculum is structured to cover a range of core areas and specialized topics, ensuring that graduates are well-equipped to tackle the challenges of the modern world.

National Educational Policy-2020 guidelines are considered as reference while designing the curriculum. It incorporates practical learning opportunities like mini projects and major projects, skills-based labs, and internships to foster creativity and problem-solving abilities. Furthermore, offering value-added courses, honours programs, and minors ensures a well-rounded educational experience that caters to students' unique interests and goals.

The curriculum offers abundant chances for educators to pioneer teaching methods and assessment approaches, with the goal of enriching students' learning experiences and cultivating a lifelong passion for learning.

With a strong foundation in electrical engineering principles and specialized knowledge in key areas, graduates of our program are well-prepared to make significant contributions to the field and drive innovation in technology.

As we embark on this transformative journey, we invite all stakeholders to join us in shaping the future of Electrical Engineering education.

**BOS Chairperson,**
**Department of Electrical Engineering.**

# Contents

## A. Abbreviations

| | |
|---|---|
| AEC | Ability Enhancement Course |
| AU | Audit Course |
| BSC | Basic Science Course including Mathematics |
| BSL | Basic Science Laboratory Course |
| ELC | Experiential Learning Course |
| ESC | Engineering Sciences Course |
| ESL | Engineering Sciences Laboratory Course |
| HMC | Honours or Minor Core Course |
| HML | Honours or Minor Laboratory |
| HMP | Honours or Minor Mini Project |
| HSS | Humanities Social Sciences and Management Course |
| IKS | Indian Knowledge System Course |
| INT | Internship |
| L | Lecture |
| LBC | Laboratory Course |
| LLC | Liberal Learning Course |
| MDM | Multidisciplinary Minor Course |
| MDL | Multidisciplinary Laboratory Course |
| MJP | Major Project |
| MNP | Mini Project |
| OEC | Open Elective Course |
| P | Practical |
| PCC | Program Core Course |
| PEC | Program Elective Course |
| RPC | Research Project Coursework |
| RPR | Research Project |
| SBL | Skill Based Laboratory |
| SEC | Skill Enhancement Course |
| T | Tutorial |
| VEC | Value Education Course |

**B. Credit Structure**

| 1. B. Tech in Electrical Engineering | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Course** | **Semester-wise Credit Distribution** | | | | | | | | | **FCRIT Credit Distribution** | **DTE Credit Distribution** |
| | **I** | **II** | **III** | **IV** | **V** | **VI** | **VII** | **VIII** | **Total** | | |
| **Basic Science Course (BSC)** | 08 | 08 | -- | -- | -- | -- | -- | -- | **16** | **18** | **14-18** |
| **Basic Science Laboratory Course (BSL)** | 01 | 01 | -- | -- | -- | -- | -- | -- | **02** | | |
| **Engineering Science Course (ESC)** | 05 | 02 | -- | -- | -- | -- | -- | -- | **07** | **16** | **12-16** |
| **Engineering Science Laboratory Course (ESL)** | 04 | 05 | -- | -- | -- | -- | -- | -- | **09** | | |
| **Program Core Course (PCC)** | -- | -- | 14 | 13 | 06 | 03 | 03 | -- | **39** | **50** | **44-56** |
| **Laboratory Course (LBC)** | -- | -- | 02 | 03 | 02 | 02 | 02 | -- | **11** | | |
| **Program Elective (PEC)** | -- | -- | -- | -- | 03 | 03 | 06 | 03 | **15** | **15** | **20** |
| **Multidisciplinary Minor (MDM)** | -- | -- | 03 | 03 | 03 | 04 | — | -- | **13** | **13** | **14** |
| **Multidisciplinary Laboratory Course (MDL)†** | -- | -- | -- | -- | 01 | -- | -- | -- | **01** | **01** | |
| **Open Elective (OEC)** | -- | -- | -- | -- | -- | -- | 03 | 03 | **06** | **06** | **08** |
| **Skill Enhancement Course (SEC)** | 01 | 01 | -- | -- | -- | -- | -- | -- | **02** | **08** | **08** |
| **Skill Based Laboratory (SBL)** | -- | -- | 02 | 02 | -- | 02 | -- | -- | **06** | | |
| **Ability Enhancement Course (AEC)** | -- | 03 | -- | -- | 02 | -- | -- | -- | **05** | **05** | **04** |
| **Humanities Social Sciences and Management (HSS)** | -- | -- | 02 | -- | 02 | -- | 02 | -- | **06** | **06** | **04** |
| **Indian Knowledge System (IKS)** | -- | 02 | -- | -- | -- | -- | -- | -- | **02** | **02** | **02** |
| **Value Education Course (VEC)** | 02 | -- | -- | 02 | -- | -- | -- | -- | **04** | **04** | **04** |
| **Experiential Learning Course (ELC)** | -- | -- | -- | -- | -- | 02 | -- | -- | **02** | **02** | **04** |
| **Mini Project (MNP)** | -- | -- | 01 | 01 | 01 | 01 | -- | -- | **04** | **10** | **04** |
| **Major Project (MJP)** | -- | -- | -- | -- | -- | -- | 02 | 04 | **06** | | |
| **Internship (INT)** | -- | -- | -- | -- | -- | -- | -- | 08 | **08** | **08** | **12** |
| **Liberal Learning Course (LLC)** | -- | -- | -- | -- | -- | 02 | -- | --- | **02** | **02** | **04** |
| **Total Credits** | **21** | **22** | **24** | **24** | **20** | **19** | **18** | **18** | **166** | **166** | **160-176** |

**† NOTE: The Multidisciplinary Laboratory Course can be moved to the sixth semester if the department prefers**

## C Curriculum Structure and Examination Scheme for B. Tech in Electrical Engineering

**(FY and SY with Effect from AY 2024-2025)**
**Curriculum Structure – FY Semester-I**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **BSC101** | Engineering Mathematics I | 3 | -- | 1 | 3 | -- | 1 | 4 |
| **BSC102** | Engineering Physics-I | 2 | -- | -- | 2 | -- | -- | 2 |
| **BSC103** | Engineering Chemistry-I | 2 | -- | -- | 2 | -- | -- | 2 |
| **ESC101** | Engineering Mechanics | 3 | -- | -- | 3 | -- | -- | 3 |
| **ESC102** | Basic Electrical Engineering | 2 | -- | -- | 2 | -- | -- | 2 |
| **BSL101** | Engineering Physics-I Laboratory | -- | 1 | -- | -- | 0.5 | -- | 0.5 |
| **BSL102** | Engineering Chemistry-I Laboratory | -- | 1 | -- | -- | 0.5 | -- | 0.5 |
| **ESL101** | Engineering Mechanics Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **ESL102** | Basic Electrical Engineering Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **ESL103** | Programming Laboratory-I (C) | -- | 2*+2 | -- | -- | 2 | -- | 2 |
| **SEC101** | Basic Workshop Practice-I | -- | 2 | -- | -- | 1 | -- | 1 |
| **VEC101** | Universal Human Values | 2 | -- | -- | 2 | -- | -- | 2 |
| | **Total** | **14** | **12** | **1** | **14** | **6** | **1** | **21** |

*** Instructions should be conducted for the entire class.**

**NOTE 1: Compulsory Non-Credit Activities: Participation and/or coordination of co-curricular and extra-curricular events at the Institute or Department level is mandatory for all students from semesters 1 to 8 as part of non-credit liberal education. Please consult the department's Curriculum Book for more information. These activities do not yield credits. Upon successful participation or organization of activities, a certificate will be awarded at the conclusion of semester 8.**

**NOTE 2: Please note that during semesters 1 to 8 some of the non-technical courses such as Humanities Social Sciences and Management (HSSM), Open Electives (OE), Value Education Course (VEC), and Liberal Learning Course (LLC) may be conducted either online synchronously or asynchronously. For more information, please consult the curriculum book of your respective department.**

## Examination Scheme – FY Semester-I

| Course Code | Course Name | Examination Scheme | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | | |
| **BSC101** | Engineering Mathematics-I | 20+25@ | 30 | 50 | 1.5 | 2 | 125 | |
| **BSC102** | Engineering Physics-I | 15 | 20 | 40 | 1.0 | 1.5 | 75 | |
| **BSC103** | Engineering Chemistry-I | 15 | 20 | 40 | 1.0 | 1.5 | 75 | |
| **ESC101** | Engineering Mechanics | 20 | 30 | 50 | 1.5 | 2 | 100 | |
| **ESC102** | Basic Electrical Engineering | 15 | 20 | 40 | 1.0 | 1.5 | 75 | |
| **BSL101** | Engineering Physics-I Laboratory | 25 | -- | -- | -- | -- | 25 | |
| **BSL102** | Engineering Chemistry-I Laboratory | 25 | -- | -- | -- | -- | 25 | |
| **ESL101** | Engineering Mechanics Laboratory | 25 | -- | -- | -- | -- | 25 | |
| **ESL102** | Basic Electrical Engineering Laboratory | 25 | -- | 25 | -- | -- | 50 | |
| **ESL103** | Programming Laboratory-I (C) | 50 | -- | 50 | -- | -- | 100 | |
| **SEC101** | Basic Workshop Practice-I | 50 | -- | -- | -- | -- | 50 | |
| **VEC101** | Universal Human Values | 50 | -- | -- | -- | -- | 50 | |
| | **Total** | **360** | **120** | **295** | -- | **--** | **775** | |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.**

**@For continuous assessment of tutorials.**

## Curriculum Structure – FY Semester-II

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **BSC204** | Engineering Mathematics-II | 3 | -- | 1 | 3 | -- | 1 | 4 |
| **BSC205** | Engineering Physics-II | 2 | -- | -- | 2 | -- | -- | 2 |
| **BSC206** | Engineering Chemistry-II | 2 | -- | -- | 2 | -- | -- | 2 |
| **AEC201** | Professional Communication and Ethics-I | 2 | 2 | -- | 2 | 1 | -- | 3 |
| **ESC203** | Basic Electronics Engineering | 2 | -- | -- | 2 | -- | -- | 2 |
| **BSL203** | Engineering Physics-II Laboratory | -- | 1 | -- | -- | 0.5 | -- | 0.5 |
| **BSL204** | Engineering Chemistry-II Laboratory | -- | 1 | -- | -- | 0.5 | -- | 0.5 |
| **ESL204** | Engineering Graphics Laboratory | -- | 2*+2 | -- | -- | 2 | -- | 2 |
| **ESL205** | Programming Laboratory-II (Java) | -- | 2*+2 | -- | -- | 2 | -- | 2 |
| **ESL206** | Basic Electronics Engineering Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **SEC202** | Basic Workshop Practice-II | -- | 2 | -- | -- | 1 | -- | 1 |
| **IKS201** | Indian Knowledge System | 2 | -- | -- | 2 | -- | -- | 2 |
| | Total | **13** | **16** | **1** | **13** | **8** | **1** | **22** |

*** Instructions should be conducted for the entire class.**

### Examination Scheme – FY Semester-II

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **BSC204** | Engineering Mathematics-II | 20+25@ | 30 | 50 | 1.5 | 2 | 125 |
| **BSC205** | Engineering Physics-II | 15 | 20 | 40 | 1.0 | 1.5 | 75 |
| **BSC206** | Engineering Chemistry-II | 15 | 20 | 40 | 1.0 | 1.5 | 75 |
| **AEC201** | Professional Communication and Ethics-I | 50 | -- | -- | -- | -- | 50 |
| **ESC203** | Basic Electronics Engineering | 15 | 20 | 40 | 1.0 | 1.5 | 75 |
| **BSL203** | Engineering Physics-II Laboratory | 25 | -- | -- | -- | -- | 25 |
| **BSL204** | Engineering Chemistry-II Laboratory | 25 | -- | -- | -- | -- | 25 |
| **ESL204** | Engineering Graphics Laboratory | 50 | -- | 50 | -- | -- | 100 |
| **ESL205** | Programming Laboratory-II (Java) | 50 | -- | 50 | -- | -- | 100 |
| **ESL206** | Basic Electronics Engineering Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **SEC202** | Basic Workshop Practice-II | 50 | -- | -- | -- | -- | 50 |
| **IKS201** | Indian Knowledge System | 50 | -- | -- | -- | -- | 50 |
| | **Total** | **415** | **90** | **295** | **--** | **--** | **800** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.**

**@For continuous assessment of tutorials.**

## Curriculum Structure – SY Semester-III

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **EEPCC301** | Engineering Mathematics-III | 3 | -- | 1 | 3 | -- | 1 | 4 |
| **EEPCC302** | Circuit and Signal Analysis | 3 | -- | 1 | 3 | -- | 1 | 4 |
| **EEPCC303** | Elements of Power System | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEPCC304** | Renewable Sources and Energy Storage | 3 | -- | -- | 3 | -- | -- | 3 |
| **XXMDM301Y#** | -- | 3 | -- | -- | 3 | -- | -- | 3 |
| **EELBC301** | Electronics Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EELBC302** | Electrical System Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EESBL301** | Python Laboratory | -- | 4 | -- | -- | 2 | -- | 2 |
| **EEMNP301** | Mini Project-1A | -- | 3 | -- | -- | 1 | -- | 1 |
| **HSS301** | Product Design | 2 | -- | -- | 2 | -- | -- | 2 |
| | **Total** | **17** | **11** | **2** | **17** | **5** | **2** | **24** |

**#Four theory courses ( Three 3-credit courses and one 4-credit course) and one laboratory course (1 credit) offered by other department has to be taken by electrical students, to complete the 14 credit requirements for MDM.**

**Examination Scheme – SY Semester-III**

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **EEPCC301** | Engineering Mathematics-III | 20+25@ | 30 | 50 | 1.5 | 2 | 125 |
| **EEPCC302** | Circuit and Signal Analysis | 20+25@ | 30 | 50 | 1.5 | 2 | 125 |
| **EEPCC303** | Elements of Power System | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPCC304** | Renewable Sources and Energy Storage | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **XXMDM301Y** | -- | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EELBC301** | Electronics Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EELBC302** | Electrical System Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EESBL301** | Python Laboratory | 50 | -- | 50 | -- | -- | 100 |
| **EEMNP301** | Mini Project-1A | 50 | -- | -- | -- | -- | 50 |
| **HSS301** | Product Design | 50 | -- | -- | -- | -- | 50 |
| | **Total** | **350** | **150** | **350** | -- | -- | **850** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.**

**@For continuous assessment of tutorials.**

**Curriculum Structure – SY Semester-IV**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **EEPCC405** | Engineering Mathematics-IV | 3 | -- | 1 | 3 | -- | 1 | 4 |
| **EEPCC406** | Control System | 3 | | -- | 3 | -- | -- | 3 |
| **EEPCC407** | Power Electronics | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEPCC408** | Power System Engineering | 3 | -- | -- | 3 | -- | -- | 3 |
| **XXMDM402Y** | -- | 3 | -- | -- | 3 | -- | -- | 3 |
| **EELBC403** | Power Electronics Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EELBC404** | Control System Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EELBC405** | Measurement and Instruments Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EESBL402** | PCB Fabrication and Circuit Testing Laboratory | -- | 4 | -- | -- | 2 | -- | 2 |
| **EEMNP402** | Mini Project – 1B | -- | 3 | -- | -- | 1 | -- | 1 |
| **VEC402** | Environment and Sustainability | 2 | -- | -- | 2 | -- | -- | 2 |
| | **Total** | **17** | **13** | **1** | **17** | **6** | **1** | **24** |

### Examination Scheme – SY Semester-IV

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **EEPCC405** | Engineering Mathematics-IV | 20+25@ | 30 | 50 | 1.5 | 2 | 125 |
| **EEPCC406** | Control System | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPCC407** | Power Electronics | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPCC408** | Power System Engineering | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **XXMDM402 Y** | -- | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EELBC403** | Power Electronics Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EELBC404** | Control System Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EELBC405** | Measurement and Instruments Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EESBL402** | PCB Fabrication and Circuit Testing Laboratory | 50 | -- | 50 | -- | -- | 100 |
| **EEMNP402** | Mini Project – 1B | 50 | -- | 50 | -- | -- | 100 |
| **VEC402** | Environment and Sustainability | 50 | -- | -- | -- | -- | 50 |
| | **Total** | **350** | **150** | **425** | -- | -- | **925** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.**

**@For continuous assessment of tutorials.**

## Curriculum Structure – TY Semester-V

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **EEPCC509** | Electrical Machines | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEPCC510** | Protection and Switchgear | 3 | -- | -- | 3 | -- | -- | 3 |
| **XXMDM503Y** | -- | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEPEC501Y** | Program Elective Course-I | 3 | -- | -- | 3 | -- | -- | 3 |
| **EELBC506** | Switchgear and Safety Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EELBC507** | Electrical Machines Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **XXMDL501Y** | -- | -- | 2 | -- | -- | 1 | -- | 1 |
| **AEC502** | Professional Communication and Ethics-II | 1 | 2 | -- | 1 | 1 | -- | 2 |
| **EEMNP503** | Mini Project-2A | -- | 3 | -- | -- | 1 | -- | 1 |
| **HSS502** | Entrepreneurship | 2 | -- | -- | 2 | -- | -- | 2 |
| | **Total** | **15** | **11** | **--** | **15** | **5** | **--** | **20** |

**NOTE: Students who choose not to pursue Honours or Minor are welcome to register for the initial two courses of the fifth and sixth semesters' Honours or Minor track in 'Audit' mode (AU). This allows them to explore the course material without the expectation of earning a letter grade. Upon fulfilling the requirements in 'Audit' mode, their participation will be acknowledged on the grade sheet. Audit courses are excluded from grade point averages and have no impact on SGPI/CGPI calculations. For more information on Honours and Minor track courses, please refer to the Institute Handbook for Honours/Minor/Honours in Research degree programs.**

**Program Elective Course-I:**

Students should take one PE from the following list of Program Elective Course- I.

| **Course Code** | **Program Elective Course-I** |
|---|---|
| EEPEC5011 | Advanced Power Electronics |
| EEPEC5012 | Engineering Electromagnetics |
| EEPEC5013 | Electric Vehicle Technology |

## Examination Scheme – TY Semester-V

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **EEPCC509** | Electrical Machines | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPCC510** | Protection and Switchgear | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **XXMDM503Y** | -- | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPEC501Y** | Program Elective Course-I | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EELBC506** | Switchgear and Safety Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EELBC507** | Electrical Machines Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **XXMDL501Y** | -- | 25 | -- | 25 | -- | -- | 50 |
| **AEC502** | Professional Communication and Ethics-II | 50 | -- | -- | -- | -- | 50 |
| **EEMNP503** | Mini Project-2A | 50 | -- | -- | -- | -- | 50 |
| **HSS502** | Entrepreneurship | 50 | -- | -- | -- | -- | 50 |
| | **Total** | **305** | **120** | **275** | -- | -- | **700** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.**

## Curriculum Structure – TY Semester-VI

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **EEPCC611** | Drives and Control | 3 | | -- | 3 | -- | -- | 3 |
| **XXMDM604Y** | -- | 4 | | -- | 4 | -- | -- | 4 |
| **EEPEC602Y** | Program Elective Course-II | 3 | -- | -- | 3 | -- | -- | 3 |
| **EELBC608** | Drives and Control Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EELBC609** | Electrical Software Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EESBL603** | Industrial Automation Laboratory | -- | 4 | -- | -- | 2 | -- | 2 |
| **EEMNP604** | Mini Project-2B | -- | 3 | -- | -- | 1 | -- | 1 |
| **ELC601** | Research Methodology | 2 | -- | -- | 2 | -- | -- | 2 |
| **LLC601Y*** | Liberal Learning Course | 2 | -- | -- | 2 | -- | -- | 2 |
| | Total | **14** | **11** | **--** | **14** | **5** | **--** | **19** |

**NOTE: Students who choose not to pursue Honours or Minor are welcome to register for the initial two courses of the fifth and sixth semesters' Honours or Minor track in 'Audit' mode (AU). This allows them to explore the course material without the expectation of earning a letter grade. Upon fulfilling the requirements in 'Audit' mode, their participation will be acknowledged on the grade sheet. Audit courses are excluded from grade point averages and have no impact on SGPI/CGPI calculations. For more information on Honours and Minor track courses, please refer to the Institute Handbook for Honours/Minor/Honours in Research degree prorams.**

***Liberal Learning Course:**

Every student should take Liberal Learning Course for Semester VI. Students can take this course from the following list of Liberal Learning Courses.

| Liberal Learning Courses | |
|---|---|
| **Course Code** | **Course Name** |
| LLC6011 | Art of Living |
| LLC6012 | Yoga and Meditation |
| LLC6013 | Health and Wellness |
| LLC6014 | Diet and Nutrition |
| LLC6015 | Personality Development |

**Program Elective Course-II:**

Students should take one PE from the following list of Program Elective Course- II.

| Course Code | Program Elective Course-II |
|---|---|
| EEPEC6021 | Lighting System Design |
| EEPEC6022 | High Voltage DC transmission |
| EEPEC6023 | Advanced Control System |

**Examination Scheme – TY Semester-VI**

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem. Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **EEPCC611** | Drives and Control | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **XXMDM604Y** | -- | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPEC602Y** | Program Elective Course-II | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EELBC608** | Drives and Control Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EELBC609** | Electrical Software Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EESBL603** | Industrial Automation Laboratory | 50 | -- | 50 | -- | -- | 100 |
| **EEMNP604** | Mini Project-2B | 50 | -- | 50 | -- | -- | 100 |
| **ELC601** | Research Methodology | 50 | -- | -- | -- | -- | 50 |
| **LLC601Y*** | Liberal Learning Course | 50 | -- | -- | -- | -- | 50 |
| | **Total** | **310** | **90** | **300** | -- | -- | **700** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.**

## Curriculum Structure – B. Tech Semester-VII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **EEPCC712** | Electrical Systems Design and Auditing | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEPEC703Y** | Program Elective Course-III | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEPEC704Y** | Program Elective Course-IV | 3 | -- | -- | 3 | -- | -- | 3 |
| **OEC701Y** | Open elective Course –I | 3 | -- | -- | 3 | -- | -- | 3 |
| **EELBC710** | Electrical System Design and Audit Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EELBC711** | Applied Power Electronics Laboratory | -- | 2 | -- | -- | 1 | -- | 1 |
| **EEMJP701** | Major Project A | -- | 6 | -- | -- | 2 | -- | 2 |
| **HSS703** | Financial Planning | 2 | -- | -- | 2 | -- | -- | 2 |
| | **Total** | **14** | **10** | **--** | **14** | **4** | **--** | **18** |

**Program Elective Course-III:**

Students should take one PE from the following list of Program Elective Course- III.

| **Course Code** | **Program Elective Course-III** |
|---|---|
| EEPEC7031 | Power System Operation and Control |
| EEPEC7032 | Digital VLSI Design |
| EEPEC7033 | Automation and Control |

**Program Elective Course-IV:**

Students should take one PE from the following list of Program Elective Course- IV.

| **Course Code** | **Program Elective Course-III** |
|---|---|
| EEPEC7041 | Smart Power System |
| EEPEC7042 | Power Quality and FACTS |
| EEPEC7043 | Artificial Intelligence in Renewable Energy System |

**Open Elective Course - I**

Every student is required to take one Open Elective Course-I for Semester VII. Students can take this course from the following list of Open Elective Course-I.

| Course Code | Open Elective Course-I |
|---|---|
| OEC7011 | Product Lifecycle Management |
| OEC7012 | Reliability Engineering |
| OEC7013 | Management Information System |
| OEC7014 | Design of Experiments |
| OEC7015 | Operation Research |
| OEC7016[@@] | Cyber Security and Laws |
| OEC7017 | Disaster Management and Mitigation Measures |
| OEC7018 | Energy Audit and Management |
| OEC7019 | Development Engineering |

[@@] Students opting for Honours/Minor degree in Cybersecurity or relevant domain need to select other Open Elective.

**Examination Scheme – B. Tech Semester-VII**

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **EEPCC712** | Electrical Systems Design and Auditing | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPEC703Y** | Program Elective Course-III | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEPEC704Y** | Program Elective Course-IV | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **OEC701Y** | Open elective Course –I | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EELBC710** | Electrical System Design and Audit Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EELBC711** | Applied Power Electronics Laboratory | 25 | -- | 25 | -- | -- | 50 |
| **EEMJP701** | Major Project A | 50 | -- | -- | -- | -- | 50 |
| **HSS703** | Financial Planning | 50 | -- | -- | -- | -- | 50 |
| | **Total** | **230** | **120** | **250** | -- | -- | **600** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for both theory and laboratory courses.**

## Curriculum Structure – B. Tech Semester-VIII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **EEPEC805Y** | | 3 | -- | -- | 3 | -- | -- | 3 |
| **OEC802Y** | | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEMJP802** | Major Project-B | -- | 12 | -- | -- | 4 | -- | 4 |
| **INT801** | Internship~ | -- | -- | -- | -- | 8 | -- | 8 |
| | **Total** | **6** | **12** | **--** | **6** | **12** | **--** | **18** |
| **~ Students have the opportunity to engage in a three-month internship within industry, research organizations, foreign universities, or internal internship for research and product development during the 8th semester, provided they meet the semester requirements and receive approval from the institute.** | | | | | | | | |

**Program Elective Course-V:**

Students should take one PE from the following list of Program Elective Course- V.

| Course Code | Program Elective Course-V |
|---|---|
| EEPEC8051 | Power Electronics and Control |
| EEPEC8052 | Advanced Power System |
| EEPEC8053 | Microgrid and Smart Grid |

**Open Elective Course -II**

Every student is required to take one Open Elective Course-II for Semester VIII. Students can take this course from the following list of Open Elective Course-II.

| Course Code | Open Elective Course-II |
|---|---|
| OEC8021 | Project Management |
| OEC8022 | Finance Management |
| OEC8023 | Entrepreneurship Development and Management |
| OEC8024 | Human Resource Management |
| OEC8025 | Professional Ethics and CSR |
| OEC8026 | Circular Economy |
| OEC8027 | IPR and Patenting |
| OEC8028 | Digital Business Management |
| OEC8029 | Environmental Management |

**Examination Scheme – B. Tech Semester-VIII**

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **EEPEC805Y** | | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **OEC802Y** | | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEMJP802** | Major Project-B | 50 | -- | 50 | -- | -- | 100 |
| **INT801** | Internship | 50 | -- | 50 | -- | -- | 100 |
| | **Total** | **140** | **60** | **200** | -- | -- | **400** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for theory, laboratory, and internship courses.**

**NOTE: Please note that due to the internship requirement in the 8th semester, theory courses during this semester will be conducted either online synchronously or asynchronously. For more information, please consult the curriculum book of your respective department.**

**D. Multidisciplinary Minor Courses Offered by the Department for the Other Program Students**

**Curriculum Structure for MDM Courses**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | P | T | L | P | T | Total |
| **EEMDM301** | Industrial Electronics | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEMDM402** | Measurements and Control | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEMDM503** | Electrical Drives and Control | 3 | -- | -- | 3 | -- | -- | 3 |
| **EEMDL601** | Automation & AI | -- | 2 | -- | -- | 1 | -- | 1 |
| **EEMDM604** | Automation and Artificial Inteligence | 4 | -- | -- | 4 | -- | -- | 4 |
| | **Total** | **13** | **2** | **--** | **13** | **1** | **--** | **14** |

**Examination Scheme for MDM Courses**

| Course Code | Course Name | Examination Scheme | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | In-Semester Assessment$ | | End Sem Exam (ESE) | Exam Duration for Theory (in Hrs) | | |
| | | Continuous Assessment | Mid-Sem Exam | | Mid-Sem | End-Sem | |
| **EEMDM301** | Industrial Electronics | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEMDM402** | Measurements and Control | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEMDM503** | Electrical Drives and Control | 20 | 30 | 50 | 1.5 | 2 | 100 |
| **EEMDL601** | Automation & AI | 25 | -- | 25 | -- | -- | 50 |
| **EEMDM604** | Automation and Artificial Inteligence | 20 | 30 | 50 | 1.5 | 2 | 100 |
| | **Total** | **105** | **120** | **225** | -- | -- | **450** |

**$Please refer to the Curriculum Book of respective departments for guidelines on in-semester assessments for theory, laboratory, and internship courses.**

**E. Honours, Minor, and Honours in Reseach Degree Program**

**The Honours, Minor, and Honours in Research degree programs aim to empower students by offering specialized courses/research internships or projects in emerging fields of their interest, thus enhancing their proficiency in those areas. Students who achieve a CGPI of 7.5 or higher by the end of the fourth semester are eligible to pursue an additional 18 credits from the fifth to eighth semesters to qualify for a B. Tech degree with Honours, Minor, or Honours in Research designation. Students need to refer to the Institute level Handbook for Honours/Minor/Honours in Research Degree Programs for further details.**

# F. Syllabi
# First Year

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| BSC | BSC101 | ENGINEERING MATHEMATICS-I | 03+01* |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 + 25* | 30 | 50 | 1.5 | 2 | 125 |

*For Tutorial

**Pre-requisite:**

1. Differentiation of function of a single variable.
2. Types of matrices and their basic operations.
3. Vector Algebra.

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis

**Course Objectives:**

1. To provide the basic knowledge of the concepts of Mathematics applicable to the field of engineering.
2. To build a mathematical foundation of the methodology required for solving application based problems in the field of engineering.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>Mathematics is the fundamental step which creates a solid foundation for all Applied fields of Engineering. Professional Engineering applications have Mathematics as an integral part of their evolution. For example: Formulation in Mathematics to various engineering field using case study.<br>Application of matrices in control systems, wireless signals and computer graphics, Introduction to function of several variables to apply in Marginal rate of technical substitution, Elasticity of substitution, Use the concept of vector differentiation into Fluid Mechanics.<br>Hence, Formulation Based Mathematics is a fundamental requisite to all fields of Engineering for analyzing their performances. | **01** |
| **01.** | **Matrices - I**<br>***Learning Objective:***<br>*Learner will be able to*<br>• *Analyze and interpret the basic fundamentals of matrices.*<br>• *Determine the rank of a matrix by applying the concepts of elementary transformation of a matrix.* | **7-9** |

| | | |
|---|---|---|
| | **Contents:**<br>Type of Matrices and Properties, Symmetric, Skew-Symmetric, Orthogonal Matrices, Complex Matrix, Hermitian, skew-Hermitian, Unitary Matrices, Rank of a Matrix, Elementary transformation, Normal Form, Echelon Form. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Identify the correct procedure to express a square matrix as the sum of a Symmetric and Skew-Symmetric Matrix. (PI:2.1.1 & 2.2.3)*<br>*LO 1.2: Identify the correct procedure to express a square matrix as the sum of a Hermitian and Skew-Hermitian Matrix. (PI:2.1.1 & 2.2.3)*<br>*LO 1.3: Use elementary transformations to determine the rank of a matrix by finding its normal form. (PI:1.1.1 & 1.2.1 )* | |
| **02.** | **Matrices - II**<br>***Learning Objective:***<br>*Learner will be able to*<br>• *Analyze the differences between homogeneous and non-homogeneous simultaneous equations*<br>• *Apply these concepts to find their solutions, if they exist.* | **5-7** |
| | **Contents:**<br>Solution of system of Linear Equations, Condition for consistency of Non-Homogeneous Equations, Condition for consistency of Homogeneous Equations, Row Vector and Column Vector, Linearly dependence and Independence of vectors, Linear Combination of Vectors | |
| | ***Self-Learning Topics:***<br>***Coding Theory*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO.2.1: Identify homogeneous and non-homogeneous simultaneous equations, express them into matrix form and use appropriate method to solve them. (PI-2.1.1 & 2.2.3)*<br>*LO.2.2: Interpret & use the concept of rank to determine whether a given vector is linearly dependent or linearly independent (PI-1.1.1 & 1.2.1)* | |
| **03.** | **Matrices - III** | **6-8** |
| | ***Learning Objective:***<br>*Learner will be able to*<br>• *Analyze the differences between homogeneous and non-homogeneous simultaneous equations*<br>• *Apply these concepts to find their solutions, if they exist.* | |
| | **Contents:**<br>Introduction to Eigen Values, Characteristic equation, Characteristic roots & Eigen vectors.<br>Finding Eigen values and Eigen vectors for different types of Matrices: Non Symmetric Matrices with non-repeated Eigen Values, Non Symmetric Matrices with Repeated Eigen Values, Symmetric Matrices with non-repeated Eigen Values, Symmetric Matrices with Repeated Eigen Values<br>Cayley-Hamilton Theorem (Without proof), Statement and verification, Function of square matrix as an application. | |
| | ***Self-Learning Topics:***<br>*Singular value Decomposition* | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Apply fundamentals of determinant to find Eigen Values and Eigen Vectors. (PI-1.1.1 & 1.2.1)*<br>*LO 3.2: Analyze, identify and use Cramer's Rule/homogeneous equation to determine Eigen vectors for corresponding Eigen values. ( PI-2.1.3 & 2.2.4 )* | |
| **04.** | **Differential Calculus of Several Variables-I**<br>***Learning Objectives:***<br>*Analyse the fundamentals of Differentiations of functions of two or more independent variables and apply this concept in function of functions, composite functions and implicit functions.* | **7-9** |
| | **Contents:**<br>Introduction to Partial Differentiation, Geometrical meaning of $\frac{\partial u}{\partial x}$ & $\frac{\partial u}{\partial y}$ Partial derivatives of first and higher order, Differentiation of function of function, Differentiation of composite function. | |
| | ***Self-Learning Topics:***<br>*Jacobian of two and Three variable* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Identify the basic concepts of partial differentiation (PD) with the prerequisite of differentiation of function of a single variable and apply suitable procedure to partially differentiate a function of several variables. (PI-2.2.3 & 2.1.3)*<br>*LO 4.2: Apply the suitable method to solve a particular problem from the set of different types of learned functions. (PI-1.1.1 & 1.2.1)* | |
| **05.** | **Differential Calculus of Several Variables-II**<br>***Learning Objective/s:***<br>• *Apply the concept of PD to solve problems by using Euler 's Theorem on Homogeneous functions with two independent variables.*<br>• *Analyse the learned concept of PD and apply it to find maxima and minima of functions of two variables* | **5-7** |
| | **Contents:**<br>Homogeneous functions, Euler's Theorem on Homogeneous functions with two Independent variables(With Proof), Deductions from Euler's Theorem, Maxima and Minima of a function of two independent variables. | |
| | ***Self-Learning Topics:***<br>*Euler's Theorem on Homogeneous functions with three Independent variables* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Apply Euler's Theorem to solve problems based on homogeneous function of two variables. (PI-1.1.1 & 1.2.1)*<br>*LO 5.2: Identify the conditions for maxima and minima of functions of two variables and determine it. (PI-2.1.3 & 2.2.3)* | |
| **06.** | **Vector Differentiation** | **7-9** |
| | ***Learning Objective/s:***<br>*Analyze the fundamentals of Gradient of scalar point function, Divergence & Curl of a vector point function and apply it to verify whether the field is irrotational or solenoidal.* | |

| | | |
|---|---|---|
| | **Contents:**<br>Scalar and Vector point function, Differentiation of vector, Level surface, Gradient of scalar point function and its properties, Vector differential operator, geometrical meaning of $\nabla\emptyset$, directional derivative Divergence of a vector point function, Curl of a vector point function. | |
| | ***Self-Learning Topics:***<br>*Tangent and normal to the surface, angle between two surfaces at a common point* | |
| | ***Learning Outcomes:*** | |
| | *A learner will be able to*<br>*LO 6.1: Apply fundamentals of vector algebra and differentiation of several variables to evaluate Gradient, Divergence & Curl. (PI-1.1.1 & 1.2.1)*<br>*LO 6.2: Identify whether the given vector field is irrational or solenoidal and solve the problem by identifying the appropriate procedure. (PI-2.1.3 & 2.2.3).* | |
| | **Course Conclusion** | **01** |
| **Total** | | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.1 | Apply mathematical techniques as calculus/algebra to solve problems. |
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 2.1.1 | Articulate problem statements and identify objectives. |
| 2.1.3 | Identify the mathematical knowledge that applies to a given problem. |
| 2.2.3 | Identify existing processes/solution methods for solving the Problems. |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |

**Course Outcomes:** A learner will be able to -

1. Apply the concept of rank of a matrix to find the solution of homogeneous and non-homogeneous system of equations by analyzing their consistency.
   ( *LO 1.1, LO 1.2, LO 1.3, LO 2.1, LO 2.2*)
2. Analyse the characteristic equation to determine the Eigen value, Eigen vector, also function of a matrix by applying Cayley-Hamilton theorem. (*LO 3.1, LO 3.2*)
3. Implement the fundamentals of partial differentiation to evaluate the maxima and minima of functions of several variables. ( *LO 4.1, LO 4.2, LO 5.1, LO 5.2*)
4. Apply the concepts of Gradient, Divergence, and Curl in order to analyse and state the two types of fields, Irrotational and Solenoidal( *LO 6.1, LO 6.2*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSC101.1 | 3 | 3 | | | | | | | | | |
| BSC101.2 | 3 | 3 | | | | | | | | | |
| BSC101.3 | 3 | 3 | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSC101.4 | 3 | 3 | | | | | | | | | |
| **Average** | 3 | 3 | | | | | | | | | |

**Text Books :**

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication, forty fourth Edition, 2021
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, Tenth Edition, 2011.

**Reference Books :**

1. Engineering Mathematics by Srimanta Pal and Subodh, C. Bhunia, Oxford University Press, First Edition, 2015
2. Engineering Mathematics by P. Sivaramakrishna Das and C. Vijayakumari, Pearson, First Edition, 2017

**IN-SEMESTER ASSESSMENT (75 MARKS)**

**1. Continuous Assessment - Theory-(20 Marks)**

1. Numerical Assignments (Minimum 20 problems): 5 marks
2. Class test based on above Numerical assignment: 5 marks
3. Team – Pair - Solo: 5 marks
4. Regularity and active participation: 5 marks

**2. Continuous Assessment – Tutorial -(25 Marks)**

1. Tutorials: 20 Marks
   Students must be encouraged to write at least 6 class tutorials. Each tutorial carries 20 Marks. Average will be taken of all six tutorials out of 20 marks.
2. Regularity and active participation: 5 marks

**4. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| BSC | BSC102 | Engineering Physics-I | 02 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 15 | 20 | 40 | 1 | 1.5 | 75 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer and The World

**Course Objectives:**

1. To provide the Basic knowledge on the concepts of physics pertaining to the field of engineering.
2. To build a foundation to the methodology necessary for solving problems by applying the knowledge of physics in the field of engineering

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction** | **01** |
| **01.** | **Interference in Thin Film and Diffraction**<br>***Learning Objective:***<br>*•To apply the basic concept of interference and diffraction phenomena in various measurements*<br>*•To identify the principles of interference and diffraction to solve practical problems.* | **6-8** |
| | **Contents:**<br>Interference: Interference by division of amplitude; Interference in thin film of constant thickness: Application in Anti-reflecting films. Wedge shaped film: Newton's rings - Diameters of dark Newton's rings; Applications in determination of refractive index of liquid. Diffraction: Diffraction Grating, Diffraction due to grating; Resolving power of a grating; Applications of diffraction grating; Determination of wavelength of light using plane transmission grating. | |
| | ***Self-Learning Topics:***<br>*Origin of colours in thin film, Diameters of Bright Newton's rings, Determination of wavelength of incident light using Newton's rings experiment.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to* | |

| | | |
|---|---|---|
| | *LO 1.1: diagrammatically represent the mechanism of thin film interference and diffraction and write the parameters required for their application. (P.I.- 1.2.1)*<br>*LO 1.2: interpret the interference and diffraction phenomena in real life examples. (P.I.- 1.2.1)*<br>*LO 1.3: solve problems using the concepts of thin film interference and diffraction. (P.I.- 1.2.2)*<br>*LO 1.4: identify the parameters which defines the quality of a grating. (P.I.- 2.1.2)*<br>*LO 1.5: derive the expressions for various parameters and conditions of maxima and minima of intensity of a problem using the concepts of interference and diffraction. (P.I.- 2.1.3)* | |
| **02.** | **LASER**<br>***Learning Objective:***<br>• *To apply knowledge of absorption and emission in production of laser.*<br>• *To identify the use of lasers in technical fields and associate the impact of laser applications in environment and societal context.* | **3-5** |
| | **Contents:**<br>Laser: Stimulated emission and multiplication process; Population inversion; Pumping; Metastable state: Resonant cavity; Helium Neon laser: Principle, construction and working; Nd:YAG laser: Principle, construction and working; Applications of LASER. | |
| | ***Self-Learning Topics:*** *Spontaneous emission, Methods of Pumping, Advantages, disadvantages and limitations of He-Ne and Nd:YAG laser.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: state various parameters and phenomena related to lasers and their importance in LASER production. (P.I.-1.2.1)*<br>*LO 2.2: identify different types of lasers in terms of principle, construction and working (P.I.-2.2.3)*<br>*LO 2.3: identify the industrial and medical applications of laser. (P.I.-6.1.1)*<br>*LO 2.4: state the disadvantages and limitations of using lasers in public. (P.I.-6.1.2)* | |
| **03.** | ***Fiber Optics***<br>***Learning Objective:***<br>*•To apply knowledge of optical phenomena in propagation of light through optical fibre.*<br>*•To analyze the role of optical fibre in fibre optics communication.*<br>*•To associate the use of fibre optics communication in societal issues and identify the principle of fibre optics to solve engineering problem.* | **3-5** |
| | **Contents:**<br>Optical Fibre; Numerical aperture; Angle of acceptance; V-number; Types of optical fibres; Numerical aperture for step index fibre; Fibre optic communication system. | |
| | ***Self-Learning Topics:*** *Critical angle, Fractional index change, Modes of propagation.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to* | |

| | | |
|---|---|---|
| | *LO 3.1: state various parameters related to the optical fibre and its application in fibre optics. (P.I.-1.2.1)*<br>*LO 3.2: solve problems on optical fibre using the concepts and basic formulae. (P.I.- 1.2.2)*<br>*LO 3.3: identify different types of optical fibre in terms of its relevant parameters. (P.I.-2.1.2)*<br>*LO 3.4: derive the expressions for various parameters relevant to fibre optics. (P.I.-2.1.3)*<br>*LO 3.5: apply the concept of optical fibre in fibre optic communication system. (P.I.- 6.1.1)* | |
| **04.** | ***Semiconductor Physics***<br>***Learning Objectives:***<br>*•To apply the fundamental knowledge of band gap in semiconductors*<br>*•To evaluate the concept of fermi level in semiconductor for solving problems.* | **4-6** |
| | **Contents:**<br>Energy bands in semiconductor; Direct & indirect band gap semiconductor; Determination of energy band gap in semiconductor. Fermi level; Fermi Dirac distribution, Fermi level in intrinsic semiconductors, Fermi level in extrinsic semiconductors: Effect of temperature and impurity concentration on fermi level in extrinsic semiconductors, Significance of Fermi level. | |
| | ***Self-Learning Topics:*** *Effect of temperature on fermi level in P-type semiconductor, Effect of impurity concentration on fermi level in N-type semiconductors, p-n junction diode.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: state various parameters which defines a semiconductor and its applications of devices. (P.I.-1.2.1)*<br>*LO 4.2: solve the problems involving fermi level. (P.I.-1.2.2)*<br>*LO 4.3: identify the types of semiconductors based on band gap and Interpret the applications of semiconductors based on its band gap property. (P.I.-2.1.2)*<br>*LO 4.4: sketch the effect of temperature and impurities on fermi level of semiconductor. (P.I.-2.1.3)* | |
| **05.** | **Semiconductor Devices**<br>***Learning Objective/s:***<br>*•To apply the fundamental knowledge of semiconductor in various semiconductor devices.*<br>*•To assess the applicability of semiconductor devices in different societal issues.*<br>*•To identify impact of semiconductor devices in society in terms of sustainability.* | **3-5** |
| | **Contents:**<br>Semiconductor Devices: Hall sensor: Principle, construction, working and application; Semiconductor laser: Principle, construction, working and application; Solar cell: Principle, construction, working and | |

| | | |
|---|---|---|
| | application. Importance of semiconductor devices in terms of sustainability. | |
| | ***Self-Learning Topics:*** *Light Emitting Diode (LED), Photodiode.* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: state the principles of various semiconductor devices and their applications. (P.I.-1.2.1)*<br>*LO 5.2: use the semiconductor devices for various measurements. (P.I.-2.1.3)*<br>*LO 5.3: analyse Semiconductor devices in terms of their principle, construction, working. (P.I.-2.2.3)* | |
| **06.** | **Superconductors**<br>***Learning Objective/s:***<br>*•To summarize the properties of superconductors.*<br>*•To evaluate practical problems using the principles of superconductors.*<br>*•To apply the concept of superconductors in MAGLEV train.* | **3-5** |
| | **Contents:**<br>Superconductivity, critical temperature, critical magnetic field, Meissner effect; Type I and Type II superconductors; Applications of superconductor in MAGLEV. | |
| | ***Self-Learning Topics:***<br>*High temperature superconductor and its importance*. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: recall different parameters, phenomena related to superconductor and its importance in superconductor and MAGLEV. (P.I.-1.2.1)*<br>*LO 6.2: solve problems on superconductor using the concepts and basic formulae. (P.I.-1.2.2)*<br>*LO 6.3: identify the type of superconductors in terms of various parameters. (P.I.-2.1.2)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of physics to an engineering problem. |
| 1.2.2 | Apply the formulae derived from the concept to solve engineering problem. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.

6.1.1 Identify and describe various role of science particularly as pertains to protection of the public and public interest at global, regional and local level.

6.1.2 Identify and explain the limitations in the usage of devices for public.

## Course Outcomes:

A learner will be able to -

1. Apply the fundamental knowledge of optical phenomena to analyse the relevant basic engineering problems and draw the conclusions. (*LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.5*)
2. apply to use the fundamental knowledge of semiconductor physics to identify the various parameters to solve the problem. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4*)
3. apply the knowledge of Laser, fiber optics for health and safety issues by analyzing their properties and parameters. (*LO 2.1, LO2.1, LO 2.3, LO 2.4, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5*)
4. identify the role and impact of the semiconductor devices and superconductors by knowing their applications. (*LO 5.1, LO5.2, LO 5.3, LO 6.1, LO 6.2, LO 6.3*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSC102.1 | 3 | 3 | | | | | | | | | |
| BSC102.2 | 3 | 3 | | | | | | | | | |
| BSC102.3 | 3 | | | | | 3 | | | | | |
| BSC102.4 | 3 | 3 | | | | | | | | | |
| **Average** | 3 | 3 | | | | 3 | | | | | |

**Text Books :**

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar Revised Edition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat Rai Publications.

**Reference Books :**

1. Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley
2. Optics, Ajoy Ghatak, Seventh Edition, 2020, Tata McGraw Hill
3. Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley
4. A textbook of Optics - N. Subramanyam, Brijlal and Avadhanulu, 23rd Edition, 2006, S.Chand Publishing.

**Other Resources :**

1. Online physics library, California State University:-Web link- https://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web link- www.physics.rutgers.edu
3. NPTEL Course: Fundamentals of semiconductor devices, by Prof. Digbijoy N. Nath, IISc Bangalore:- Web link- https://nptel.ac.in/courses/108108122

**IN-SEMESTER ASSESSMENT (35 MARKS)**

**1. Continuous Assessment - Theory-(15 Marks)**

1. MCQ test: 4 marks
2. Class test: 4 marks
3. Open book test/Open notes test: 4 marks
4. Regularity and active participation: 3 marks

**2. Mid Semester Exam (20 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (40 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| BSC | BSC103 | ENGINEERING CHEMISTRY- I | 02 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 15 | 20 | 40 | 1 | 1.5 | 75 |

**Pre-requisite:**

1. Nil

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6 -The engineer and the world

**Course Objectives:**

1. To enable the students to apply the laws of chemistry to an engineering problem.
2. To enable the students to appreciate material properties and their engineering applications.
3. To enable the students to analyze and select the most appropriate engineering material
4. To acknowledge the current developments in the field of nanotechnology, energy storage systems and green chemistry for sustainable development.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>Engineering chemistry provides the fundamental understanding of materials, substances and processes that engineers need to design, develop and manufacture products and systems. | **01** |
| **01.** | **Green Chemistry**<br>***Learning Objective:***<br>*To state the principles of green chemistry and apply them in the synthesis of various industrially important chemical substances and drugs in order to exhibit the social and environmental impact of chemical industry practices for the sustainable design and development.* | **4-6** |
| | **Contents:**<br>Introduction, 12 principles of green chemistry with examples as Conventional and green synthesis of carbaryl and ibuprofen, adipic acid and Indigo with special emphasis on bioenzymes. Numericals on atom economy. Carbon Sequestering and Carbon Credit.<br>Green solvents:- water as green solvent, supercritical solvents and DMC. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics:***<br>***Latest research areas in the field of green chemistry.*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 : State the principles green chemistry. (1.3.1)*<br>*LO 1.2: Identify the hazards involved in the conventional industrial chemical reactions in order to protect health and environment. (6.1.1)*<br>*LO 1.3: Synthesize drugs, chemical pesticides and industrial precursors using green chemistry principles as standard guidelines. (2.2.3) (6.2.1)*<br>*LO 1.4: Analyze Bhopal gas tragedy reaction (2.1.3)*<br>*LO 1.5: Apply the concept of green solvents in chemical industries for the sustainable development, (6.1.2)*<br>*LO 1.6: Use the concept of Carbon Sequestering and Carbon Credit to assess public health and environment. (6.1.1)*<br>*LO 1.7:* Calculate atom economy of the given reaction. (1.2.2) | |
| **02.** | **Water quality management** | **4-6** |
| | ***Learning Objective:***<br>*To analyze the quality of water and use the modern methods of water treatment and to understand the impact of water pollution in order to practice the sustainable water quality management.* | |
| | **Contents:**<br>Quality of water: Boiler troubles (Scale and Sludge, Boiler Corrosion, Caustic Embrittlement) Hardness and its types and numericals. Determination of hardness by EDTA method and Numericals.<br>Membrane filtration technology: - Ion exchange and reverse osmosis. Numericals based on ion exchange method.<br>Water pollution: - Water quality indices- BOD and COD with numericals. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Classify the impurities of water into various types of hardness. (2.1.3)*<br>*LO 2.2: Analyze different types of hardness in water using numerical problems (2.1.3)*<br>*LO 2.3: Identify the effect of hard water in boiler and other chemical industries for assessing the public safety. (6.1.1)*<br>*LO 2.4: Calculate the various types of hardness in water sample using EDTA method. (1.2.2)*<br>*LO 2.5: Apply various water treatments for assessing the public health (6.1.1)*<br>*LO 2.6: Identify and estimate water quality indices to control pollution of water (6.1.2)*<br>*LO 2.7: Calculate BOD and COD of sewage sample (1.2.2)* | |
| **03.** | **Science of Corrosion** | **4-6** |
| | ***Learning Objective:***<br>*To identify the different types of corrosion using the theories of electrochemistry and suggest the corrosion control methods for the same in Industry.* | |

| | | |
|---|---|---|
| | **Contents:**<br>Introduction to corrosion, mechanism of dry corrosion – Oxidation corrosion, Pilling Bedworth rule and wet Corrosion-Mechanisms of wet corrosion, Types of wet corrosion (galvanic, differential aeration, stress and Intergranular corrosion).<br>Methods of prevention of Corrosion- cathodic protection (Sacrificial, impressed current) Protective coatings- Metallic coatings (tinning and galvanizing). | |
| | ***Self-Learning Topics:***<br>*Factors affecting rate of corrosion-size of electrodes, passivity, position of metal in galvanic series and polarization.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Define corrosion and its types. (1.3.1)*<br>*LO 3.2: State the mechanism of oxidation corrosion. (1.3.1)*<br>*LO 3.3: Define the role of oxide layers in deciding the rate of corrosion. (1.3.1)*<br>*LO 3.4: State and Apply the Pilling Bedworth rule to predict corrosion resistance of metals and alloys. (1.2.1) (1.3.1)*<br>*LO 3.5: state the conditions for wet corrosion (1.2.1)*<br>*LO 3.6: State the mechanisms of wet corrosion with the help of diagram and reactions. (1.3.1)*<br>*LO 3.7: State different types wet corrosion with the help of examples. (1.3.1)*<br>*LO 3.8: Apply the various protection methods for safety of metallic equipment and structures. (6.1.1)*<br>*LO 3.9: Apply the metallic coatings on various metal surfaces for protection of machine health. (6.1.1)* | |
| **04.** | **Introduction to Thermodynamics** | **4-6** |
| | ***Learning Objectives:***<br>***To state the fundamentals of thermodynamics and apply them in engineering.*** | |
| | **Contents:**<br>Concepts of system, types of systems, surroundings. Extensive and intensive properties, Macroscopic and microscopic approach, heat and work, Thermodynamic equilibrium, reversible and irreversible process, First law of thermodynamics – internal energy and enthalpy. Applications of thermodynamics in engineering. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Define a system, surroundings and variables. (1.3.1)*<br>*LO 4.2: State first law of thermodynamics (1.2.1)*<br>*LO 4.3: Apply first law of thermodynamics for calculation of work done or heat evolved. (1.2.2)*<br>*LO 4.4: To show energy conversion in different forms. (1.3.1)*<br>*LO 4.5: To calculate the enthalpy of given chemical system. (1.2.2)*<br>*LO 4.6: To apply the concepts of thermodynamics in engineering (1.3.1)* | |

| | | |
|---|---|---|
| **05.** | **Phase Equilibria**<br>***Learning Objective/s:***<br>*To interpret the various phase transformations using thermodynamics.* | **3-5** |
| | **Contents:**<br>Gibb's Phase Rule, Terms involved with examples, One Component System (Water) and its applications, reduced Phase Rule, Two Component System (Pb- Ag), and Eutectic system: Applications in solder alloys and Numericals. | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: State and apply Gibb's phase rule equation to the given system, (1.2.1)*<br>*LO 5.2: State the terms in the Gibb's phase rule equation. (1.2.1)*<br>*LO 5.3: Draw the phase diagrams and state the salient features of the same. (1.3.1)*<br>*LO 5.4: Calculate the number of degrees of freedom for each phase in a phase diagram using phase rule equations. (1.2.2)*<br>*LO 5.5: State and apply the condensed phase rule to the eutectic alloys. (1.2.1)*<br>*LO 5.6: State the applications of eutectics in the solder alloys (1.3.1)* | |
| **06.** | **Energy from non-conventional sources** | |
| | ***Learning Objective/s:***<br>*To apply the knowledge of synthesis of non-conventional chemical fuels and deal with the challenges involved in their implementation with respect to sustainable development.* | |
| | **Contents:**<br>Synthesis and applications of Biodiesel, Hydrogen production by steam reforming of methane and electrolysis of water, challenges in hydrogen storage and transport. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: Apply the concept of transesterification for the production of biodiesel (1.3.1)*<br>*LO 6.2: Identify the properties of biodiesel as a green fuel for sustainability. (6.1.2)*<br>*LO 6.3: Synthesize hydrogen by steam reforming of methane and electrolysis of water. (2.2.3)*<br>*LO 6.4: Identify the challenges in hydrogen production, storage and transport for the benefit of society. (6.1.1)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 1.2.2 | Apply the formulae based on the concepts of engineering chemistry for solving the numerical problems. |
| 1.3.1 | Apply fundamental engineering chemistry concepts to solve engineering problems. |

2.1.3 Identify the engineering chemistry concepts to analyze the given problem
2.2.3 Identify the existing processes/ solution methods for solving the problems
6.1.1 Identify and describe the various roles of materials particularly as pertains to protection of the public and public interest at global, regional and local level.
6.1.2 Analyse the environmental aspects of engineering problems for its impact on sustainability.
6.2.1 To identify and interpret standard guidelines for various standard chemical industry practices.

**Course Outcomes:** A learner will be able to -

1. *Apply the laws of electrochemistry and thermodynamics for solving engineering problems. (LO-3.1, LO-3.2, LO-3.3, LO-3.4,LO-3.5,LO-3.6, LO-3.7, LO-3.8, LO-3.9, LO-4.1, LO-4.1, LO-4.2, LO-4.3, LO-4.4, LO-4.5, LO- 4.6, LO- 5.1, LO- 5.2, LO- 5.3, LO- 5.4, LO- 5.5, LO- 5.6, LO- 6.1, LO-6.2, LO- 6.3, LO- 6.4)*
2. *Analyze the quality of water and challenges in non-conventional energy sources for solving the real-world problems (LO-1.1, LO- 1.2, LO-1.3, LO-1.4, LO- 1.5, LO-1.6, LO-1.7, LO- 2.1, LO- 2.2, LO- 2.3, LO- 2.4, LO- 2.5, LO- 2.6, LO- 2.7, LO- 6.1, LO- 6.2, LO- 6.3, LO- 6.4)*
3. *Identify the suitable chemical product or material for the protection of environment and public health. (LO-1.1, LO- 1.2, LO-1.3,LO-1.4,LO-1.5,LO-1.6,LO-1.7, LO- 2.1, LO- 2.2, LO- 2.3,LO-2.4,LO-2.5,LO-2.6,LO- 2.7, LO-3.1, LO-3.2, LO-3.3, LO-3.4,LO-3.5,LO-3.6, LO-3.7, LO-3.8, LO-3.9, LO- 6.1, LO- 6.2, LO- 6.3, LO- 6.4)*
4. *Interpret the impact of modern chemical industrial practices and energy sources for sustainable development. (LO-1.1, LO- 1.2, LO-1.3,LO-1.4,LO-1.5,LO-1.6,LO-1.7, LO- 2.1, LO- 2.2, LO- 2.3, LO- 2.4, LO- 2.5, LO- 2.6, LO- 2.7)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSC103.1 | 3 | 2 | | | | 3 | | | | | |
| BSC103.2 | 3 | 3 | | | | 3 | | | | | |
| BSC103.3 | 3 | 3 | | | | 3 | | | | | |
| BSC103.4 | 3 | 3 | | | | 3 | | | | | |
| **Average** | 3 | 2.75 | | | | 3 | | | | | |

**Text Books :**

1. A textbook of engineering chemistry by S. Dara, 2014 edition, Chand Publication.
2. A Textbook of chemistry by Shashi Chawla, First edition, 2019, Dhanpatrai and Co.
3. Textbook of green chemistry by AK Ahluwalia, 2008, Ane Book India

**Reference Books :**

1. Engineering Chemistry by Jain and Jain, $17^{th}$ edition, 2018, Dhanpatrai Publications.
2. Engineering Chemistry by Raghupati Mukhopadhyay, First edition, 2007, New Age

3. Engineering Chemistry by Payal Joshi and Shashank Deep, First edition, 2019, Oxford

**Other Resources :**

1. Online chemistry library for open access text books: https://chem.libretexts.org

**IN-SEMESTER ASSESSMENT (35 MARKS)**

**1. Continuous Assessment - Theory-(15 Marks)**

1. Numerical Assignment/s (min 20 problems):4 Marks
2. Class test based on numerical assignment: 4 Marks
3. Article reading & summarization: 4 Marks
4. Regularity and active participation: 3 Marks

**2. Mid Semester Exam (20 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (40 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **ESC** | ESC101 | ENGINEERING MECHANICS | 03 |

| **Examination Scheme** | | | | | |
|---|---|---|---|---|---|
| **Distribution of Marks** | | | **Exam Duration (Hrs.)** | | **Total Marks** |
| **In-semester Assessment** | | **End Semester Examination (ESE)** | | | |
| **Continuous Assessment** | **Mid-Semester Exam (MSE)** | | **MSE** | **ESE** | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis

**Course Objectives:**

1. To familiarize with the concepts of force, moment, Resultant and Equilibrium of system of coplanar force.
2. To acquaint with the basic concept of friction and its application in real-life problems.
3. To understand the parameters required to quantify the Kinematics of Particle and Rigid body.
4. To understand the parameters required to quantify the Kinetics of rigid body.
5. To acquaint with basic principles of centroid and its application

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>The Engineering Mechanics Course marks the transition from physics to engineering applications. This course develops the ability to apply and analyze, which are paramount in engineering profession. | **01** |
| **01.** | ***Coplanar force System: System of Coplanar Forces***<br>***Learning Objective:***<br>*To impart the knowledge of fundamental concepts of Mathematics and Physics to analyze forces in engineering system..* | **5-7** |
| | **Contents:**<br>Classification of force systems (Concurrent, Parallel and General Force systems). Principle of Transmissibility, Composition and Resolution of Forces. Resultant of Coplanar Force Systems: Resultant of coplanar force system (Concurrent, Parallel and non- concurrent non-parallel force systems). Moment of force about a point, Couples, Varignon’s Theorem and its significance. Force couple system. | |
| | Self-Learning Topics: *Composition and Resolution of Forces.* | |

| | | |
|---|---|---|
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO 1.1: To apply fundamental engineering concepts for resolution of system of forces. (P.I.-1.3.1)*<br>*LO 1.2: Apply mechanical engineering concepts to find resultant forces acting in a system under the action of load. (PI-1.4.1)*<br>*LO 1.3: To identify unknown forces in engineering systems due to application of load. (PI-2.1.2)*<br>*LO 1.4: To apply the concepts of physics and mathematics to locate the position on resultant forces acting on a structural member in engineering application. (P.I.-2.1.3).* | |
| **02.** | **Equilibrium of Rigid Bodies in Statics. Equilibrium of Coplanar Force System:**<br>*Learning Objective:*<br>*To use fundamental concepts of engineering knowledge of equilibrium and to analyze reactions under the influence different types of loading conditions.* | **7-9** |
| | **Contents:**<br>Conditions of equilibrium for Concurrent, Parallel and General Force System (Non-Concurrent Non- Parallel forces) and Couples. Application of Equilibrium Concepts on rigid bodies in Equilibrium. Equilibrium of Beams: Different Types of Supports and Loading. Determination of reactions at supports for various types of loads including distributed system on beams. (Excluding problems on internal hinges). Friction: Concepts of Angle of Friction, Angle of Repose, Cone of Friction. Equilibrium of bodies kept on inclined plane. Application of Friction Concepts to problems involving ladders and the tipping over of bodies. | |
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO 2.1: Apply fundamental mathematical knowledge for application of equilibrium concepts on rigid bodies(P.I.-1.1.2).*<br>*LO 2.2: Apply mechanical concepts to coplanar force systems and calculate reactions in beams(P.I.-1.4.1).*<br>*LO 2.3: Apply fundamental mathematical knowledge to find frictional parameters of a rigid body (P.I.-2.1.2).*<br>*LO 2.4: Apply friction concepts to real-world scenarios involving inclined planes and ladders (P.I.-2.2.1).* | |
| **03.** | **Kinematics of Particle**<br>*Learning Objective:*<br>*Learner will be able to understand kinematics, including variable acceleration, motion curves, curvilinear motion, and projectile motion, applying concepts to real-life situations through problem-solving.* | **8-10** |
| | **Contents:**<br>Motion of particle with Variable Acceleration. Motion Curves (a-t, v- t, s-t curves). General Curvilinear Motion. Tangential and Normal | |

| | | |
|---|---|---|
| | Component of Acceleration. Projectile Motion: Trajectory Equation of Projectile. Application of the concepts of Projectile Motion in real life and related numerical. | |
| | ***Self-Learning Topics:*** *Projectile Motion Basics, Variable acceleration concept* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: apply knowledge to identify the motion of the object using the equations of motion (P.I.- 1.2.1).*<br>*LO 3.2: apply the fundamental mathematics and mechanical engineering concepts to analyze different types of motions (P.I.-1.4.1).*<br>*LO 3.3: Identify system variables to formulate trajectory equation of projectile motion (P.I.2.1.2).*<br>*LO 3.4: Apply mathematical and engineering knowledge to find motion of the object in the real life situations (P.I.-2.1.3).* | |
| **04.** | **Kinematics of Rigid Body**<br>***Learning Objectives:***<br>*To understand the parameters required to quantify the Kinematics of Particle and Rigid body*. | **5-7** |
| | **Contents:**<br>Rigid Body Motions: Translation, Rotation and General Plane motion. Kinematics of Rotation and related numerical. The concept of Instantaneous center of rotation (ICR) for the velocity. Location of ICR for 2 link mechanism. Velocity analysis of rigid body using ICR. | |
| | ***Self-Learning Topics:*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Apply engineering knowledge to identify the general plane motion(P.I.-1.3.1).*<br>*LO 4.2: Apply mathematical knowledge to find translational, rotational and general plane motion of rigid bodies(P.I.-1.4.1).*<br>*LO 4.3: Identify engineering systems and variables to find instantaneous center of rotation for link mechanism (P.I-2.2.1).*<br>*LO 4.4: Use mathematical knowledge to find general plane motion analytically. (P.I.- 2.1.3).* | |
| **05.** | **Kinetics of Particle: D'Alembert's**<br>***Learning Objective/s:***<br>*To understand the concept of kinetics of particle and the different methods to solve the engineering problems.* | **9-11** |
| | **Contents:**<br>Introduction to basic concepts of D'Alemberts Principle, Concept of Inertia force, Equations of Dynamic Equilibrium,. (Analysis limited to simple systems only.) **Work – Energy Principle:** Work Energy principle for a particle in motion. Application of Work – Energy principle to a system consists of connected masses and Springs. **Impulse – Momentum Principle:** Principle of linear Impulse and Momentum. Application of Impulse Momentum Principle to particles | |

| | | |
|---|---|---|
| | in motion. **Impact and Collisions:** Law of conservation of momentum, Coefficient of Restitution, Direct Central Impact and Oblique Central Impact. Loss of Kinetic Energy in collision of inelastic bodies. | |
| | Self-Learning Topics: *basic concepts and application in dynamic equilibrium for simple systems.* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Apply D'Alembert's Principle to analyze the particles in dynamic equilibrium, (P.I.-1.3.1)*<br>*LO 5.2: Apply mechanical engineering knowledge to use work-energy principle for mechanical systems(P.I.-1.4.1).*<br>*LO 5.3: To use mathematical knowledge, to analyze the systems using Work-Energy and Impulse-Momentum Principles(P.I.-2.1.3).*<br>*LO 5.4: To reframe complex problem in to sub problems to analyze the collisions occurring in the force system(P.I-2.2.1).* | |
| **06.** | **Centroid**<br>***Learning Objective:***<br>*To understand the importance of Centroid which can affect the stability of the objects in the real life situations.* | **3-5** |
| | **Contents:**<br>**First Moment of Area. Centroid of Composite Plane Lamina.** | |
| | ***Self-Learning Topics:***<br>*Explore methods for calculating the First Moment of Area.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: Apply fundamental knowledge to find first moment of area. (P.I.-1.1.1).*<br>*LO 6.2: Apply mechanical engineering knowledge to find centroid of composite body(P.I.-1.4.1).* | |
| | **Course Conclusion** | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| **1.1.1** | Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems. |
| **1.1.2** | Apply advanced mathematical techniques to model and solve mechanical engineering problems. |
| **1.2.1** | Apply laws of natural science to an engineering problem. |
| **1.3.1** | Apply fundamental engineering concepts to solve engineering problems. |
| **1.4.1** | Apply Mechanical engineering concepts to solve engineering problems. |
| **2.1.2** | Identify engineering systems, variables, and parameters to solve the problems |
| **2.1.3** | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| **2.2.1** | Reframe complex problems into interconnected sub problems. |

**Course Outcomes:** A learner will be able to -

1. Apply the concepts of resolution and composition of forces to find the Resultant and static equilibrium to find reactive forces with and without friction. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
2. Analyse the motion of a particle using kinematic equations. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
3. Analyse the General plane motion of a rigid body using the concepts of instantaneous Centre of Rotation to find velocity and acceleration for a link Mechanism. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Analyse the motion of a Particle using Kinetic equations. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4*)
5. Apply the concept of Centroid to locate it for a plane lamina. *(LO 6.1, LO 6.2)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESC101.1 | 3 | 3 | | | | | | | | | |
| ESC101.2 | 3 | 3 | | | | | | | | | |
| ESC101.3 | 3 | 3 | | | | | | | | | |
| ESC101.4 | 3 | 3 | | | | | | | | | |
| ESC101.5 | 2 | - | | | | | | | | | |
| **Average** | 3 | 3 | | | | | | | | | |

**Text Books :**

1. Engineering Mechanics by A K Tayal, Fourteenth Edition, 2011 Umesh Publication.
2. Engineering Mechanics by Kumar, Fourth Edition, 2017 Tata McGraw Hill
3. Engineering Mechanics by F. L. Singer, Third Edition, 1975, Harper & Raw
4. Engineering Mechanics by R. C.Hibbeler , Fourth Edition, 2017, Pearson Education

**Reference Books :**

1. Engineering Mechanics by Beer &Johnston, Fourth Edition, 1987 ,Tata McGrawHill
2. Engineering Mechanics (Statics) by Meriam and Kraige, Fourth Edition, 1999 WileyBooks
3. Engineering Mechanics by Tmoshenkos Fifth Edition,2015 , generic

**Other Resources :**

1. NPTEL Course: NOC Engineering Mechanics Statics and Dynamics by Prof. Mahesh Panchagnula offered by IIT Madras Web link- https://nptel.ac.in/courses/112/106/112106180.

**IN-SEMESTER ASSESSMENT (50 MARKS)**

**1. Continuous Assessment - Theory-(20 Marks)**

1. Numerical Assignments (minimum 20 problems): 5 Marks
2. Class Test based on similar problems which were given as an assignment: 5 Marks
3. Open book test/Open notes test: 5 Marks
4. Regularity and active participation: 5 Marks

**2. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| ESC | ESC102 | BASIC ELECTRICAL ENGINEERING | 02 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 15 | 20 | 40 | 1 | 1.5 | 75 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer and The World
4. PO8: Individual and Collaborative teamwork

**Course Objectives:**

1. To impart knowledge on fundamentals of electrical power system, conventional and non- conventional energy sources.
2. To impart knowledge on basic electrical systems, DC circuits, AC circuits, Residential Electrical System, Residential Energy Metering and Electrical Machines to solve engineering problems.
3. To introduce concept to analyze DC circuits, AC circuits.
4. To introduce safety devices incorporated in residential electrical system for professional engineering practice.

| Module | Detailed Content | Hrs |
|---|---|---|
| 00 | **Course Introduction**<br>Overview of Basic Electrical Engineering, application of Basic Electrical Engineering in Industry/real life problem. It is a foundational course designed to provide students with a comprehensive understanding of fundamental electrical concepts and principles. | 1 |
| 01. | **Introduction to Basic Electrical Systems**<br>***Learning Objective/s:***<br>*To acquire knowledge on various components of electrical powers system and compare different sources of electrical energy.* | 2-4 |
| | **Contents:**<br>Components of Electrical power System, Role of each component, Structure of electrical power system, Introduction to transformer, Conventional sources of electric energy, Renewable energy sources, Comparison of various energy sources. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics:***<br>*Comparison of conventional and nonconventional energy sources.*<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Apply the concepts of electrical engineering to understand role of each component of electrical power system. (P.I.-1.4.1)*<br>*LO1.2 Compare different sources of electrical energy using fundamental engineering concepts. (P.I.-1.3.1)* | |
| **02.** | **DC Circuits with independent sources**<br><br>***Learning Objective/s:***<br>*To apply the concepts of various theorems and laws to analyze DC circuits.*<br><br>**Contents:**<br>Ohm's Law, Kirchhoff's Laws, Star Delta transformation, Ideal and practical voltage and current sources, Mesh and Nodal Analysis, Superposition theorem, Thevenin's theorem, Maximum power transfer theorem.<br><br>***Self-Learning Topics:*** *Series and parallel connections of resistances.*<br>***Learning Outcomes:*** *A learner will be able to*<br>*LO2.1 Apply concepts of Ohm's law and Kirchoff's laws to solve DC circuits. (P.I.- 1.4.1)*<br>*LO2.2 Use concepts of star delta transformation to simplify DC circuits. (P.I.-1.3.1)*<br>*LO2.3 Apply network theorems to analyze current distribution in DC circuits. (P.I.- 2.1.3)*<br>*LO2.4 Apply the concepts of ideal and practical electrical sources to solve DC circuits using Thevenin's and Norton's theorems. (P.I.-2.1.2)* | **5-7** |
| **03.** | **AC Fundamentals**<br><br>***Learning Objective/s:***<br>*To analyze AC circuit and interpret the condition of resonance by using concepts of current, voltage, power factor and power calculation in AC circuits.*<br><br>**Contents:**<br>Single-phase AC series circuits consisting of R, L, C, RL, RC, RLC combinations, definitions -real, reactive, and apparent power. Series Resonance.<br><br>***Self-Learning Topics:*** *Parallel AC circuits.*<br><br>***Learning Outcomes:*** *A learner will be able to*<br>*LO3.1 Analyze the performance of AC circuit by calculating phase angle (power factor) between voltage and current waveform. (P.I.-2.1.2)*<br>*LO3.2 Identify condition of resonance and calculate resonant frequency by overserving current and reactance in series AC circuits. (P.I.-2.1.3)* | **5-7** |

| | | |
|---|---|---|
| **04.** | **Residential Electrical Systems**<br><br>***Learning Objective/s:***<br>*To acquire knowledge on residential electrical wiring incorporating suitable safety devices, testing and up-keeping of household electrical appliances and residential lighting system.* | **4-6** |
| | **Contents:**<br>Components of residential electrical system, Residential wiring System, load calculation, Electrical safety Devices, Fuse, MCB, ELCB, grounding issues, safety precautions, Testing of domestic appliances and up-keeping, Luminous flux, Luminous intensity, Lumination, Types of lamps in residential lighting. Case study on residential lighting. | |
| | ***Self-Learning Topics:*** *Basic requirements of electrical system.*<br><br>***Learning Outcomes:*** *A learner will be able to*<br>*LO4.1 Identify components in residential electrical system by understanding basic system requirements. (P.I.-1.3.1)*<br>*LO4.2 Test and repair domestic appliances by applying concepts of basic electrical engineering. (P.I.-1.4.1)*<br>*LO4.3 Identify safety devices for the protection of residential electrical system. (P.I.-6.1.1)*<br>*LO4.4 Conduct a case study on residential lighting in a group to demonstrate communication, conflict resolution and leadership skills. (P.I.-8.2.1)*<br>*LO4.5 Present the case study on residential lighting system design effectively as a team. (P.I.-8.3.1)* | |
| **05.** | **Introduction to Residential Energy Measurements**<br><br>***Learning Objective/s:***<br>*To acquire knowledge on residential energy metering, energy tariff and understanding the residential electricity bill.* | **2-4** |
| | **Contents:**<br>Measurement of Energy, Understanding of electricity bill, energy tariff electricity bill calculation. | |
| | ***Self-Learning Topics:*** *Types of meters used for energy metering.*<br><br>***Learning Outcomes:*** *A learner will be able to*<br>*LO5.1 Calculate the electrical energy consumed over a specified time by applying concepts of electrical engineering. (P.I.-1.4.1)*<br>*LO5.2 Determine the energy tariff by referring meter reading and government guidelines. (P.I.-1.3.1)* | |

| | | |
|---|---|---|
| **06.** | **Introduction to Electrical Machines**<br><br>***Learning Objective/s:***<br>*To identify motors for given application using concepts of construction, working and characteristics of different machines.* | **4-6** |
| | **Contents:**<br>Construction, working, characteristics and application of DC machines, Single phase Induction Motor, Servo motors, Brushless DC motor, Stepper motor. Factors to be considered for selection of motor and its rating. Selection of motors from motor and load characteristics. | |
| | ***Self-Learning Topics:*** *Working principle of electric motor.*<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO6.1 Compare and identify electrical motors for given application based on characteristics of load and motor. (P.I.-2.2.4)*<br><br>*LO6.2 Decide the rating of motor by considering factors like power, speed, torque etc. of the given application. (P.I.-2.2.3)* | |
| | **Course Conclusion** | **1** |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply Electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem. |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level. |
| 8.2.1 | Demonstrate effective communication, problem solving, and conflict resolution and leadership skills. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |

**Course Outcomes:**

Learner will be able to

1. Apply fundamental engineering concept to interpret Basic Electrical Systems, Residential Electrical System and Residential Energy Metering. ( *LO1.1, LO1.2, LO4.1, LO5.1)*
2. Apply concepts of electrical engineering to solve problems on DC circuits and AC circuits. *( LO2.1, LO2.2, LO2.3, LO2.4, LO3.1, LO3.2)*
3. Interpret and identify safety devices for professional engineering practice.( *LO4.3, LO4.4*)
4. Conduct case study on residential lighting and present it to demonstrate effective communication and problem solving. *( LO4.4, LO5.2)*
5. Identify electrical motors based on requirement of application and characteristics of motor. *(LO6.1, LO6.2, LO4.5)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESC102.1 | 3 | 3 | | | | | | | | | |
| ESC102.2 | 3 | 3 | | | | | | | | | |
| ESC102.3 | | | | | | 2 | | | | | |
| ESC102.4 | 3 | | | | | | | 3 | | | |
| ESC102.5 | | 3 | | | | | | | | | |
| Average | 3 | 3 | | | | 2 | | 3 | | | |

**Text Books:**

1. Electrical Power Systems,S.L. Uppal and Prof. Sunil S. Rao 15th Edition, Khanna Publishers
2. Basic Electrical Engineering, B.R Patil, 2nd Edition Oxford Higher Education, 2019
3. Art & Science of Utilization of electrical Energy, H Partab, Dhanpat Rai & Co., 2004.
4. Electrical and Electronic Measurements and Measuring Instruments, A K Sawhney Dhanpat Rai and Sons
5. Special Electrical Machines, E G Janardanan PHI 2014
6. Electrical Power Systems, S.L. Uppal and Prof. Sunil S. Rao, 15th Edition, Khanna Publishers

**Reference Books:**

1. Power System Engineering, D P Kothari and I J Nagrath, 3rd Edition, Mac Graw Hills,
2. Electrical Engineering Fundamentals, Vincent Del Toro, PHI Second edition, 2011
3. Utilization of Electric Power & Electric Traction, J B Gupta, 10th Edition, Dhanpat Rai and Sons 2012.
4. Electrical Engineering, B.L.Theraja Vol-I and II
5. Basic Electrical Engineering, S.N.Singh PHI, 2011

**Other Resources:**

1. NPTEL course on Basic Electrical Technology, IISc Bangalore Prof. L. Umanand https://nptelvideos.com/course.php?id=460

**IN-SEMESTER ASSESSMENT (35 Marks)**

1. **Continuous Internal Evaluation of Theory (15 Marks)**

   Numerical Assignments (minimum 20 problems): 4 Marks

   Class Test based on similar problems which were given as an assignment: 4 Marks

   Open book test/Open notes test: 4 Marks

   Regularity and active participation: 3 Marks

2. **Mid Semester Exam (20 Marks)**

   Mid semester examination will be based on 40 % to 50% of the syllabus.

**End Semester Exam (40 Marks)**

End semester will be based on the syllabus coverage upto Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **BSC-LC** | BSL101 | Engineering Physics-I Laboratory | 0.5 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| **Distribution of Marks** | | | **Exam Duration (Hrs.)** | | **Total Marks** |
| **In-semester Assessment** | | **End Semester Examination (ESE)** | | | |
| **Continuous Assessment** | **Mid-Semester Exam (MSE)** | | **MSE** | **ESE** | |
| 25 | - | - | - | - | 25 |

**Program Outcomes addressed:**

1. PO1:Engineering Knowledge
2. PO4: Conduct investigations of complex problems
3. PO8: Individual and collaborative team work
4. PO9: Communication

**Course Objectives:**

1. To demonstrate the fundamental concepts of physics and evaluate the process of an experiment/project quantitatively and qualitatively.
2. To improve the knowledge gained in the theory course.
3. To develop the abilities of measurements, observations and analyzing data.
4. To develop the experimental skill in assembling and handling laboratory instruments.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction** | **01** |
| **01.** | **Experiment 1**<br>***Learning Objective:***<br>***1. To apply the knowledge of interference of light in thin film.***<br>***2. To determine a radius of curvature of lens and write valid conclusion*** | |
| | **Contents:**<br>Newton’s Rings: Determine the radius of curvature (R) of given plano convex lens using Newton’s Rings | |
| | ***Learning Outcome:***<br>*LO 1.1: A learner will be able to*<br>*apply the concepts of interference in thin film and analyze the experimental data to calculate radius of curvature of the given plano convex lens. (P.I.1.2.1, P.I.1.2.2, P.I. 4.3.1, P.I..4.3.3)* | |
| **02.** | **Experiment 2**<br>***Learning Objective:***<br>***1. To apply the knowledge of diffraction through multiple slit.*** | **02** |

<table>
<tr><td></td><td>2. To find the wavelength of the LASER and write valid conclusion<br>Contents:<br>Diffraction through Grating: Measurement of wavelength of He-Ne laser<br>Learning Outcome:<br>LO 2.1: A learner will be able to apply the concepts of diffraction through multiple slit and analyze the experimental data to calculate wavelength of the laser source. (P.I.1.2.1, P.I.1.2.2, P.I. 4.3.1, P.I..4.3.3)</td><td></td></tr>
<tr><td>03.</td><td>Experiment 3<br>Learning Objective:<br>1. To apply the knowledge of optical fibre.<br>2. To determine the numerical aperture of an optical fibre and write the conclusion.<br>Contents:<br>Optical Fibre: Measurement of Numerical aperture.<br>Learning Outcome:<br>LO 3.1: A learner will be able to apply the knowledge of numerical aperture and analyze the experimental data to calculate numerical aperture of the given fibre. (P.I.1.2.1, P.I.1.2.2, P.I. 4.3.1, P.I..4.3.3)</td><td>02</td></tr>
<tr><td>04.</td><td>Experiment 4<br>Learning Objectives:<br>1. To apply the knowledge of Hall effect.<br>2. To determine a magnetic field using Hall effect in semiconductors<br>Contents:<br>Hall effect: Determination of magnetic field.<br>Self-Learning Topics: -<br>Learning Outcome:<br>LO 4.1: A learner will be able toapply the concept of Hall effect phenomena and analyze the experimental data to calculate magnetic field generated by electromagnet. (P.I.1.2.1, P.I.1.2.2, P.I. 4.3.1, P.I..4.3.3)</td><td>02</td></tr>
<tr><td>05.</td><td>Experiment 5<br>Learning Objective/s:<br>Contents:<br>Photodiode: Drawing the I-V characteristics of photo diode<br>Learning Outcomes:<br>LO 5.1: A learner will be able to apply the working principle of photodiode and analyze the V-I characteristic curve to draw conclusion. (P.I.1.2.1, P.I.1.2.2, P.I. 4.3.1, P.I..4.3.3)</td><td>02</td></tr>
<tr><td>06.</td><td>Course Project<br>Learning Objective/s:<br>1. To apply various concepts of physics in a project.<br>2. To develop the skill of execution of project through practical demonstration.</td><td>03</td></tr>
</table>

| | | |
|---|---|---|
| | **Contents:**<br>Selection of a project based on physics concepts, Literature survey, and Topic presentation.<br><br>***Learning Outcome:***<br>*LO 6.1 : A learner will be able to identify a project based upon the concepts of physics and present the topic effectively as a team. (P.I.1.2.1, P.I.1.2.2, P.I..8..1.2, P.I. 8.3.1, P.I. 9.1.1, P.I. 9.2.2)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **15** |

**Performance Indicators:**

**P.I. No.** **P.I. Statement**

| P.I. No. | P.I. Statement |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 1.2.2 | Apply the formulae derived from the concept to solve engineering problem. |
| 4.3.1 | Use appropriate procedures, tools and techniques to conduct experiments and collect data. |
| 4.3.3 | Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions. |
| 8.1.2. | Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective teamwork,to accomplish a goal |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |
| 9.1.1 | Produce clear, well-constructed, and well- supported written engineering documents. |
| 9.2.2 | Deliver effective oral presentations to technical and non- technical audiences. |

**Course Outcomes:** A learner will be able to -

1. A learner will be able to apply the fundamental knowledge of optical phenomena to determine various parameters through relevant experiments.(*LO 1.1, LO 2.1, LO3.1*)
2. A learner will be able to apply the fundamental knowledge of semiconductor devices to determine various parameters through relevant experiments. (*LO4.1, LO5.1*)
3. A learner will be able to apply the fundamental knowledge of physics to present proposed project work, write effective reports as a team. (*LO 6.1)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSL101.1 | 3 | | | 3 | | | | | | | |
| BSL101.2 | 3 | | | 3 | | | | | | | |
| BSL101.3 | 3 | | | 3 | | | | 3 | 3 | | |
| **Average** | 3 | | | 3 | | | | 3 | 3 | | |

**Text Books :**

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar RevisedEdition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat RaiPublications

**Reference Books :**

1. Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley
2. Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley
3. Introduction to nanotechnology, Charles P Poole and Frank J Owens, 1 st Edition, Wiley-Interscience.

**Other Resources :**

1. Online physics library, California State University:-Web linkhttps://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web linkwww.physics.rutgers.ed

**IN-SEMESTER ASSESSMENT (25 MARKS)**

1. Lab Performance: 10 Marks
2. Project (Final Report and Demonstration): 10 marks
3. Regularity and active participation: 5 marks

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| BSL | BSL102 | ENGINEERING CHEMISTRY - I LABORATORY | 0.5 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 25 | - | 25 | 25 | - | 25 |

**Pre-requisite:**

1. Nil

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO6: The engineer and the world
4. PO8: Individual and collaborative teamwork

**Course Objectives:**

1. To enable the students to utilize fundamental laboratory techniques for analysis and synthesis of chemical products.
2. To enable the students to learn various laboratory safety rules in standard laboratory practices.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>1. Laboratory familiarization<br>2. Code of conduct in chemistry laboratory<br>3. Safety and precautions to be observed in chemistry laboratory<br>4. Orientation on evaluation of laboratory performance | **01** |
| **01.** | **Experiment 1**<br>*Learning Objective/s:*<br>*To estimate the total, temporary and permanent hardness of water using EDTA method to understand its quality for industrial use.* | **02** |
| | **Contents:**<br>Estimation of Total, temporary and permanent hardness of water by EDTA method. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO-1.1 Analyse the quality of the industrial water by calculating the total hardness using complexometric titration method. (1.3.1), (2.1.3), (2.2.3), (6.1.1)* | |

| | | |
|---|---|---|
| | | |
| **02.** | **Experiment 2**<br>*Learning Objective/s:*<br>*To determine the chloride content of water to understand its suitability for domestic use*<br>**Contents:**<br>Estimation of chloride content of water sample<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO- 2.1 Analyse the quality of the drinking water by calculating the chloride content using precipitation titration method.*<br>*(1.3.1) (2.1.3) (2.2.3) (6.1.1)* | **02** |
| **03.** | **Experiment 3**<br>*Learning Objective/s:*<br>*To synthesise aspirin by using acetylation process and calculate its percent yield and atom economy to determine the nature of reaction.*<br>**Contents:**<br>To synthesize aspirin from salicylic acid<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO-3.1 Synthesize aspirin using acetylation process and calculate its percentage yield (1.3.1) (2.2.3)* | **02** |
| **04.** | **Experiment 4**<br>*Learning Objective/s:*<br>*To calculate the enthalpy of dissolution of copper sulphate in water using simple calorimeter.*<br>**Contents:**<br>To determine the enthalpy of dissolution of copper sulphate at room temperature using water as a reaction medium.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO-4.1 Calculate enthalpy of the given system using first law of thermodynamics. (1.2.1), (1.3.1), (2.2.3)* | **02** |
| **05.** | **Experiment 5**<br>***Learning Objective/s:***<br>***To determine the effect of various factors affecting the rate of corrosion of iron***<br>**Contents:**<br>To determine the factors affecting the rate of corrosion.<br>***Learning Outcomes:*** | **02** |

| | | |
|---|---|---|
| | *A learner will be able to*<br>*LO-5.1 Determine the effect of various factors on the rate of corrosion by applying the knowledge of electrochemistry (1.2.1) (1.3.1)* | |
| **06.** | **Designing of experiment and presentation:**<br>***Learning Objective/s:***<br>*To develop the basic knowledge of analytical chemistry using titrimetric experiments*<br>**Contents:**<br>Standardization/estimation of chemical substances using titrimetric analysis.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO-6.1 Identify the existing titrimetric analysis to estimate the given substance and present the result as a team. (1.3.1)(2.2.3), (8.1.1), (8.3.1)* | **03** |
| | **Course Conclusion** | **01** |
| | **Total** | **15** |

**Performance Indicators:**

| P.I. No. | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 1.3.1 | Apply fundamental engineering chemistry concepts to solve engineering problems. |
| 2.1.3 | Identify the engineering chemistry concepts to analyze the given problem |
| 2.2.3 | Identify the existing processes/ solution methods for solving the problems |
| 6.1.1 | Identify and describe the various roles of materials particularly as pertains to protection of thepublic and public interest at global, regional and local level |
| 8.1.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team. |
| 8.3.1 | Present result as a team with smooth integration of contributions from all individual efforts. |

**Course Outcomes:** A learner will be able to -

1. Apply the laws of electrochemistry and thermodynamics for performing the practicals. *(LO-4.1, LO-5.1)*
2. Formulate a drug by applying the concepts of chemistry. *(LO-3.1)*
3. Analyse the quality of water for assessing the public health. *(LO-1.1, LO-2.1)*
4. Demonstrate an ability to work effectively in a team for project-based activity. *(LO-6.1)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSL102.1 | 3 | 2 | | | | - | | - | | | |
| BSL102.2 | 2 | 2 | | | | - | | - | | | |
| BSL102.3 | 2 | 3 | | | | 2 | | - | | | |
| BSL102.4 | 2 | 2 | | | | - | | 3 | | | |
| **Average** | 2 | 2 | | | | 2 | | 3 | | | |

**Textbooks:**

1. Practical book in Engineering Chemistry by Dr. Pijus Khatua and Debashree Singh, First edition, 2016, Platinum Publishers
2. Textbook of green chemistry by AK Ahluwalia, 2008, Ane Book India

**Reference Books:**

1. Engineering Chemistry by Jain and Jain, 17th edition, 2018, Dhanpatrai publications
2. Experiments in Engineering Chemistry by Payal Joshi, first edition, 2016, I.K. International Publishing House Pvt. Ltd.

**Other Resources:**

1. Online chemistry library for open access textbooks: https://chem.libretexts.org
2. Lab Simulation: https://vlab.amrita.edu/?sub=2&brch=190&sim=1546&cnt=1

**IN-SEMESTER ASSESSMENT (25 MARKS)**

1. Lab Performance: 10 Marks
2. Design experiment and presentation: 10 marks
3. Regularity and active participation: 5 marks

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **ESL** | ESL101 | ENGINEERING MECHANICS LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **End Semester Exam** | **Total Marks** |
| 25 | -- | 25 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO8: Individual and Collaborative team work

**Course Objectives:**

1. To demonstrate the equilibrium of coplanar forces
2. To demonstrate law of moments.
3. To determine coefficient of friction between two different surfaces in contact.
4. To analyse the motion of particle.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>The Engineering Mechanics Lab Course marks the transition from physics to engineering applications. This course develops the ability to apply and analyze, which are paramount in engineering profession. | **01** |
| **01.** | **Coplanar Force System**<br>***Learning Objective:***<br>*Learner will be able to apply fundamental engineering concepts to demonstrate the concept of equilibrium of coplanar forces.* | **07** |
| | **Contents:**<br>Equilibrium of concurrent co-planer force system, general co-planer system, Reactions on the beam, Jib crane study.<br>Experiment 1: To verify polygon law of forces (Concurrent force system)<br>Experiment 2: To verify Lami's theorem using simple jib crane.<br>Experiment 3: To determine the reactions of simply supported beam**.** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Identify the type of force system in a team. (P.I.-1.3.1)*<br>*LO 1.2: Determine the whether the system is in equilibrium or not and present the results in a team. (2.2.3,8.3.1)*<br>*LO 1.3: Convert different mechanical systems into sub-stems by using free body diagram. (2.2.1)*<br>*LO 1.4: Determine the reactions of the beam for various loading conditions as a team.(P.I.-1.4.1,8.2.1).* | |

| | | |
|---|---|---|
| **02.** | **Principle of Moment**<br>***Learning Objective:***<br>*Learner will be able to apply mechanical engineering concepts to demonstrate the principle of Moments using the Bell Crank Lever apparatus.*<br>**Contents:**<br>To demonstrate law of moments.<br>Experiment 4: To verify moment equilibrium condition using bell crank lever.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: differentiate between moment and couple (P.I.-1.4.1).*<br>*LO 2.2: verify moment equilibrium condition using bell crank lever and present the results as a team (P.I-1.3.1,8.3.1).*<br>*LO 2.3: convert the bell crank lever diagram into subsystems by using free body diagram. (2.2.1)*<br>*LO 2.4: Demonstrate effective communication while working as team for conducting the experiments (P.I-8.2.1).*<br>*LO 2.5: Verify moment equilibrium condition using bell crank lever and present results as a team(P.I.-2.2.3,8.3.1).* | **07** |
| **03.** | **Friction**<br>***Learning Objective:***<br>*Learner will be able to determine coefficient of friction between two different surfaces in contact.*<br>**Contents:**<br>Concept of Friction, coefficient of friction, angle of repose.<br>Experiment 5: To determine coefficient of friction using friction plane.<br>Experiment 6: To determine coefficient of friction using angle of repose method.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Identify the effects of friction on different surfaces. (P.I.-1.4.1,8.2.1).*<br>*LO 3.2: Identify the parameters affecting the friction values. (P.I.-2.1.2).*<br>*LO 3.3: determine the coefficient of friction and present the results as a team. (P.I.-1.3.1,8.3.1)*<br>*LO 3.4: compare and select the accurate method to determine coefficient of friction. (P.I.-2.2.3)* | **07** |
| **04.** | **Kinematics of particles**<br>***Learning Objectives:***<br>*Learner will be able to analyze the motion of particle.*<br>**Contents:**<br>Study of translational motion and projectile motion<br>**Experiment 7:** To study the motion of the projectile.<br>**Experiment 8:** To measure and verify average speed of the vehicle. | **07** |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Identify the variables associated with the projectile motion (P.I-1.2.1).*<br>*LO 4.2: Determine the range and height of the particle during projectile motion and present the result as a team. (P.I.2.1.2,8.3.1)*<br>*LO 4.3: Estimate velocities and distance travelled by the particle with a collaborative effort of a team. (P.I.-2.2.3,8.2.1).*<br>*LO 4.4: Measure the speed of the particle. (P.I.-1.4.1).* | |
| | **Course Conclusion** | **01** |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| **1.2.1** | Apply laws of natural science to an engineering problem. |
| **1.3.1** | Apply fundamental engineering concepts to solve engineering problems. |
| **1.4.1** | Apply Mechanical engineering concepts to solve engineering problem. |
| **2.1.2** | Identify engineering systems, variables, and parameters to solve the problems. |
| **2.2.1** | Reframe complex problems into interconnected sub-problems. |
| **2.2.3** | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions. |
| **8.2.1** | Demonstrate effective communication, problem solving, conflict resolution and leadership skills. |
| **8.3.1** | Present results as a team, with smooth integration of contributions from all individual efforts. |

**Course Outcomes:** A learner will be able to

1. Learner will be able to Demonstrate the Equilibrium of Coplanar Force System. (LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 2.2)
2. Learner will be able to demonstrate law of moments. (LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5)
3. Learner will be able to determine coefficient of friction between two different surfaces in contact. (LO 3.1, LO 3.2, LO 3.3, LO 3.4)
4. Learner will be able to analyse motion of a particle. (LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 3.3)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESL101.1 | 3 | 3 | | | | | | 3 | | | |
| ESL101.2 | 3 | 3 | | | | | | 3 | | | |
| ESL101.3 | 3 | 3 | | | | | | 3 | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESL101.4 | 3 | 3 | | | | | | 3 | | | |
| **Average** | 3 | 3 | | | | | | 3 | | | |

**Text Books :**

1. Engineering Mechanics by A K Tayal, Fourteenth Edition, 2011 Umesh Publication.
2. Engineering Mechanics by Kumar, Fourth Edition, 2017 Tata McGraw Hill
3. Engineering Mechanics by F. L. Singer, Third Edition, 1975, Harper & Raw
4. Engineering Mechanics by R. C.Hibbeler , Fourth Edition, 2017, Pearson Education

**Reference Books :**

1. Engineering Mechanics by Beer &Johnston, Fourth Edition, 1987 ,Tata McGrawHill
2. Engineering Mechanics (Statics) by Meriam and Kraige, Fourth Edition, 1999 WileyBooks
3. Engineering Mechanics by TImoshenkos Fifth Edition,2015, generic

**IN-SEMESTER ASSESSMENT (25 MARKS)**

1. Practical performance based on all the experiments mentioned in the syllabus with proper understanding : 10 Marks
2. Oral evaluation on experiments conducted on Statics :5 Marks
3. Oral evaluation on experiments conducted on Dynamics:5 Marks
4. Regularity and active participation: 5 Marks

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| ESL | ESL102 | BASIC ELECTRICAL ENGINEERING LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **End Semester Exam(ESE)** | **Total Marks** |
| 25 | 25 | 50 |

**Pre-requisite:**

1. ESC102: Basic Electrical Engineering

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO6: The Engineer and The World
4. PO8: Individual and Collaborative teamwork

**Course Objectives:**

1. To impart the knowledge on the analysis and applications of D.C. circuits and single-phase AC circuits.
2. To impart the knowledge on the elements of residential electrical system, appliances and electrical safety.
3. To impart the knowledge on the construction, working principle of transformer and motors and selection of motor for a specific application.

| Module | Detailed Contents | Hrs |
|---|---|---|
| **00** | **Course Introduction**<br>The Basic Electrical Lab course is designed to introduce fundamental concepts in electrical engineering through hands-on laboratory experiments. Through a series of practical exercises, students will develop essential skills for working with basic electrical components and circuits. | **01** |
| **01.** | ***Learning Objective:***<br>*To impart knowledge on circuit mounting on breadboard, meters used and concept of theorems and laws required for analysis of DC circuits.* | **08** |
| | **Experiment:**<br>Verify network theorems and laws to interpret the current and voltage distribution in DC circuits. | |
| | ***Self-Learning Topics:***<br>*Concepts of Series and parallel circuits and Superposition Theorem.* | |

| | | |
|---|---|---|
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO1.1 Assemble circuit on breadboard and use DC power supply, multimeter, ammeter and voltmeter for measuring current and voltage in DC circuits in a group. (P.I.-4.1,3, 8.3.1)*<br>*LO1.2 Measure current and voltage in electrical circuits and verify Ohm's law, Kirchhoff's laws, mesh analysis and nodal analysis practically and theoretically and submit a report. (P.I.- 4.1.4, 8.3.1)*<br>*LO1.3 Verify Thevenin's theorem, Norton's theorem and Maximum power transfer theorem in a DC circuit and summarize results in a report. (P.I.-4.1.4, 8.2.1)* | |
| **02.** | ***Learning Objective/s:***<br>*To impart knowledge on circuit assembly on breadboard and analysis of Alternating Current (AC) circuits.* | **08** |
| | **Experiment:**<br><br>Analyze series and parallel connected AC circuits by determining circuit elements and resonant conditions. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Determine the inductance of a choke coil by measuring the voltage across and current through a series and parallel connected resistance and choke coil and summarize the results in a report. (4.1.3, 8.2.1)*<br>*LO2.2 Measure the resonance frequency in RLC series and parallel circuit and plot resonance curve. (4.1.4,8.3.1)* | |
| **03.** | ***Learning Objective/s:***<br>*To impart knowledge on household electrical wiring and safety devices, maintenance and up keeping of home appliances used in our day-to-day life.* | **08** |
| | **Experiment:**<br><br>Implementation of given residential electrical system incorporating safety devices and up-keeping of home appliances. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 Assemble small electrical circuits similar to residential wiring system along with safety devices and submit a report. (4.1.3, 8.3.1)*<br>*LO3.2 Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, MCB, ELCB, MCCB etc. (6.1.1, 9.3.1)*<br>*LO3.3 Wire up PVC conduit wiring to control one lamp from two different places in a group. (Staircase wiring) (4.2.1, 8.3.1)*<br>*LO3.4 Maintenance and up-keeping of household electrical appliances and submit a report. (4.1.3, 8.2.1)* | |
| 04 | ***Learning Objective/s:***<br><br>*To introduce concept of motor selection for given application, transformer connections and its testing.* | **05** |
| | **Experiment:**<br>• Identify electrical motors for given application.<br>• Analyse transformer by identifying name plate details, transformation ratio, polarity and regulation. | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*LO4.1 Identify electrical motors for various electrical appliances like Fan, mixer, Vacuum cleaner, Washing machine, Water pump etc. and submit a report. (2.2.4, 8.2.1)*<br>*LO4.1 Verify terminals, study the name plate details and calculate transformation ratio of single-phase transformers. (4.1.3, 8.3.1)*<br>*LO4.1 Perform polarity test on transformers. (2.1.2,8.3.1)*<br>*LO4.1 Determine voltage regulation of single-phase transformer by conducting direct load test and summarize results in a report. (4.2.1, 8.3.1)* | |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 4.1.3 | Apply appropriate instrumentation and/or software tools to make measurements of physical quantities. |
| 4.1.4 | Establish a relationship between measured data and underlying physical principles. |
| 4.2.1 | Design and develop experimental approach, specify appropriate equipment and procedures |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level |
| 8.2.1 | Demonstrate effective communication, problem solving, conflict resolution and leadership skills. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts |

**Course Outcomes:**

Learner will be able to

1. Assemble the DC and AC circuits on breadboard and test the continuity.*(LO1.1, LO2.1, LO3.1)*
2. Select the meters to measure the required variables and analyse the performance of DC and AC circuits. ( *LO1.2, LO1.3, LO2.2)*
3. Assemble simple residential electrical wiring incorporating safety devices. (*LO3.2, LO3.3, LO3.4)*
4. Select motor for household applications and test the transformer. (*LO4.1, LO4.2, LO4.3, LO4.4)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESL102.1 | | | | 3 | | | | 3 | | | |
| ESL102.2 | | | | 3 | | | | 3 | | | |
| ESL102.3 | | | | 3 | | 2 | | 3 | | | |
| ESL102.4 | | 3 | | 3 | | | | 3 | | | |
| **Average** | | 3 | | 3 | | 2 | | 3 | | | |

**Text Books:**

1. Electrical Power Systems, S.L. Uppal and Prof. Sunil S. Rao 15$^{th}$ Edition, Khanna Publishers
2. Basic Electrical Engineering, B.R Patil, 2$^{nd}$ Edition Oxford Higher Education, 2019
3. Art & Science of Utilization of electrical Energy, H Partab, Dhanpat Rai & Co., 2004.
4. Electrical and Electronic Measurements and Measuring Instruments, A K Sawhney Dhanpat Rai and Sons
5. Special Electrical Machines, E G Janardanan PHI 2014
6. Electrical Power Systems, S.L. Uppal and Prof. Sunil S. Rao, 15th Edition, Khanna Publishers

**Reference Books:**

1. Power System Engineering, D P Kothari and I J Nagrath 3$^{rd}$ Edition, Mac Graw Hills,
2. Electrical Engineering Fundamentals, Vincent Del Toro, PHI Second edition, 2011
3. Utilization of Electric Power & Electric Traction, J B Gupta, 10th Edition, Dhanpat Rai and Sons 2012
4. Electrical Engineering, B.L.Theraja Vol-I and II
5. Basic Electrical Engineering, S.N.Singh PHI, 2011

**Other Resources:**

1. NPTEL course on Basic Electrical Technology, IISc Bangalore Prof. L. Umanand https://nptelvideos.com/course.php?id=460
2. Virtual Lab - https://asnm-iitkgp.vlabs.ac.in

**IN-SEMESTER ASSESSMENT (25 Marks)**

1. **Practical Exercises – 10 Marks**
    1. Readiness to perform experiment (2 Marks),
    2. Performance (2 Marks),
    3. Report writing (2 Marks),
    4. Interpretation of result (2 Marks)
    5. Regularity in submission (2 Marks).
2. **Practical Test 1** (Based on first 50% of practical list) – 5 Marks
3. **Practical Test 2** (Based on remaining 50% of practical list) – 5 Marks
4. Regularity and active participation – 5 Marks

**END SEMESTER ASSESSMENT (25 Marks)**

**Two examiners, one internal and one external will do the evaluation**

1. Students will be randomly allocated and experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formulae. It will be checked by the examiners and evaluated out of 05 Marks.

2. Then the student will be allowed to start with the performance of the experiment.
3. Students will be given 1 hour to complete the circuit connection and take readings. The connections and output are verified by the examiners. The weightages 05 Marks.
4. Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
5. Students will be appearing for Oral test front of both Internal and External examiners. The weightage of Oral test will be of 10 marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| ESL | ESL103 | PROGRAMMING LABORATORY-I (C) | 02 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **End Semester Exam(ESE)** | **Total Marks** |
| 50 | 50 | 100 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Engineering tool usage
4. PO11: Life-long learning

**Course Objectives:**

1. To provide exposure to problem-solving by developing an algorithm, flowchart and implement the logic using C programming language.
2. To familiarize basics of Conditional and Looping Control Structures in C.
3. To provide exposure about function definition, declaration and its usage and recursive functions.
4. To familiarize one and multi-dimensional arrays, structures and strings in C.
5. To provide exposure about pointers, operations on pointers and dynamic memory allocation in C programming language.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>Knowledge of problem solving and programming concepts is essential for those who develop applications for users. This course imparts basic knowledge in C programming along with the concepts of design and development of programs using C. | **01** |
| **01.** | **Introduction to Algorithm, Flowchart and C.**<br>***Learning Objective:***<br>*Learner is expected to recall basics of algorithm, flowchart and C. Also expected to understand problem-solving approach and apply the logic to implement program using C. Investigate the functioning of various components of the given control system as a team* | **07** |
| | **Contents:**<br>Basic Concept of Problem solving, Introduction to Algorithm and Flowchart. Character Set, Identifiers and keywords, Data types, Constants, Variables. Operators-Arithmetic, Relational and logical, Assignment, Unary, Conditional, Bitwise, Comma, other operators. Expression, statements, Library Functions, Preprocessor.<br>Data Input and Output – getchar( ), putchar( ), scanf( ), printf( ), gets( ), puts( ), Structure of C program .<br>**Task 1:** Algorithm and flowchart to find greatest of three numbers, sum of N natural numbers. | |

| | | |
|---|---|---|
| | **Task 2:** C program to calculate 40% da from basics, 20% hra from basics. Also calculate the gross salary of an employee. (GS=BS+DA+HRA) | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Apply algorithms on problem statements. (P.I.- 1.1.1)*<br>*LO 1.2: Use symbols to draw flowcharts for problems. (P.I.- 1.3.1)*<br>*LO 1.3: Identify data types, variables and operators to be used in C according to a problem. (P.I.- 2.1.2)*<br>*LO 1.4: Solve the problem using operators in C. (P.I.- 2.2.3)*<br>*LO 1.5: Adapt modern tool VS code to solve problem using data input/output, operators. (P.I.- 5.1.2)*<br>*LO 1.6: Use VS code to check if the result of the C program using operators is accurate(P.I.- 5.3.2)* | |
| **02.** | **Control Structures in C**<br>***Learning Objective:***<br>*Learner is expected to recall basics of Control Structures and understand Conditional structures. Also expected to apply it to solve problems in C.* | **16** |
| | **Contents:**<br>Branching - If statement, If-else Statement, Multiway decision. Looping – while, do-while, for Nested control structure- Switch statement, Continue statement, Break statement, Goto statement.<br>**Task 3:** C Program to compare two numbers and determine whether they are odd or even.<br>**Task 4:** C Program to find percentage marks of four subjects. Then determine whether the student has secured distinction, first class, second class or fail. Percentage >=75 Distinction, Percentage >= 60 First class, Percentage >= 40 second class etc.<br>**Task 5:** C Program to print numbers between 1 and 100 which are multiples of 5 by using do while loop. | |
| | ***Self-Learning Topics:***<br>*Differentiate between break and continue statements based on their usage in loops.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Apply if control statements in C. (P.I.- 1.1.1)*<br>*LO 2.2: Use if else control statements in C. (P.I.- 1.3.1)*<br>*LO 2.3: Identify data types, variables and loops to be used in C for a problem. (P.I.- 2.1.2)*<br>*LO 2.4: Reframe the problem and use nested control structure to solve problems in C. (P.I.- 2.2.1)*<br>*LO 2.5: Adapt modern tool VS code to solve problem using control structures (P.I.- 5.1.2)*<br>*LO 2.6: Use VS code to check if the result of the C program using loops is accurate (P.I.- 5.3.2)* | |
| **03.** | **Functions in C** | **12** |
| | ***Learning Objective:***<br>*Learner is expected to recall function definition, declaration. and understand its usage. Also expected to apply it to solve problems in C.* | |

| | | |
|---|---|---|
| | **Contents:**<br>Function -Introduction of Function, Function Main, Defining a Function, Accessing a Function, Function Prototype, Passing Arguments to a Function, Recursion.<br>Storage Classes –Auto, Extern , Static, Register<br>**Task 6:** C Program to create four types of user defined function for addition ( ) of two numbers.<br>**Task 7:** C Program to find Fibonacci series for given no of elements using recursive function. | |
| | ***Self-Learning Topics:***<br>*Write two programs using functions which have been written using loops.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Apply functions to write program in C. (P.I.- 1.1.1)*<br>*LO 3.2: Use appropriate storage class in C. (P.I.- 1.3.1)*<br>*LO 3.3: Identify data types, variables and type of user defined function to be used in C according to a problem. (P.I.- 2.1.2)*<br>*LO 3.4: Reframe the problem and use recursive function to solve problems in C. (P.I.- 2.2.1)*<br>*LO 3.5: Adapt modern tool VS code to solve problem using functions. ( P.I.- 5.1.2)*<br>*LO 3.6: Use VS code to check if the result of the C program using functions is accurate(P.I.- 5.3.2)* | |
| **04.** | ***Arrays, Strings in C***<br>***Learning Objectives:***<br>*Learner is expected to recall one dimensional arrays and understand its usage and apply it to solve problems in C.* | **12** |
| | **Contents:**<br>Array-Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array.<br>String- Basic of String, Array of String, Functions in String.h<br>**Task 8:** C Program to sort elements in ascending order in an array.<br>**Task 9:** C Program to check if string is palindrome or not. | |
| | ***Self-Learning Topics:***<br>*Write two-dimensional array programs for matrix addition and multiplication.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Use 1D arrays to write program in C. (P.I.- 1.1.1)*<br>*LO 4.2: Apply strings to write programs in C. (P.I.- 1.3.1)*<br>*LO 4.3: Identify data types, variables and type of arrays to be used in C according to a problem. (P.I.- 2.1.2)*<br>*LO 4.4: Reframe the problem and use arrays to solve problems in C. (P.I.- 2.2.1)*<br>*LO 4.5: Adapt modern tool VS code to solve problem using arrays. (P.I.- 5.1.2)*<br>*LO 4.6: Use VS code to check if the result of the C program using arrays is accurate(P.I.- 5.3.2)* | |
| **05.** | **Structures and Pointers in C**<br>***Learning Objective/s:***<br>*Learner is expected to recall pointers, operations on pointers and its usage and apply it to solve problems in C.* | **11** |

| | | |
|---|---|---|
| | **Contents:**<br>Structure- Declaration, Initialization, structure within structure, Operation on structures, Array of Structure.<br>Pointer: Introduction, Definition and uses of Pointers, Address Operator, Pointer Variables, Pointer Arithmetic, Pointers to Pointers, Pointers and Array, Passing Arrays to Function, Pointers and Function, Pointers and two-dimensional Array, Array of Pointers, Dynamic Memory Allocation<br>**Task 10:** C Program to create a structure to enter details for 5 students. The details are name, branch, roll no and marks of five different subjects. Also calculate the total marks and arrange them in ascending order.<br>**Task 11:** C Program to create, initialize, assign and access a pointer variable.<br>**Task 12:** C Program to Swap two numbers using call by value and call by reference functions. | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Apply structures to write program in C. (P.I.- 1.1.1)*<br>*LO 5.2: Use pointers in C to write programs. (P.I.- 1.3.1)*<br>*LO 5.3: Identify data types, variables and type of function for dynamic memory allocation to be used in C according to a given problem. (P.I.- 2.1.2)*<br>*LO 5.4: Reframe the problem and use pointer arithmetic to solve problems in C. (P.I.- 2.2.1)*<br>*LO 5.5: Adapt modern tool VS code to solve problem using pointers, structures. (P.I.- 5.1.2)*<br>*LO 5.6: Use VS code to check if the result of the C program using pointers is accurate (P.I.- 5.3.2)*<br>*LO 5.7: Learn new ways to use pointers and structures in professional work. (P.I.- 11.1.1)*<br>*LO 5.8: Identify new updates like dynamic memory management in C programming so that they can use it for writing efficient programs in future. (P.I.- 11.2.1)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **60** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| **1.1.1** | Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems. |
| **1.3.1** | Apply engineering fundamentals. |
| **2.1.2** | Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem |
| **2.2.1** | Reframe the computer-based system into interconnected subsystems |
| **2.2.3** | Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions |
| **5.1.2** | Create/adapt/modify/extend tools and techniques to solve engineering problems |
| **5.3.2** | Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use |
| **11.1.1** | Describe the rationale for the requirement for continuing professional development |
| **11.2.1** | Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current. |

**Course Outcomes:** A learner will be able to -

1. Illustrate the basic terminology used in computer programming concept of data types, variables and operators using C. (*LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.5, LO 1.6* )
2. Use control structure concepts in C programming (*LO 2.1, LO 2.2, LO2.3 LO 2.4, LO 2.5, LO 2.6* )
3. Develop functions and use it to solve problems in C using modern tools. (*LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6* )
4. Apply arrays and strings to solve problems in C. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5, LO 4.6* )
5. Demonstrate the use of structures, dynamic memory allocation and pointers in C. (*LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6, LO 5.7, LO 5.8* )

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESL103.1 | 3 | 3 | | | 3 | | | | | | |
| ESL103.2 | 3 | 3 | | | 3 | | | | | | |
| ESL103.3 | 3 | 3 | | | 3 | | | | | | |
| ESL103.4 | 3 | 3 | | | 3 | | | | | | |
| ESL103.5 | 3 | 3 | | | 3 | | | | | | 3 |
| **Average** | 3 | 3 | | | 3 | | | | | | 3 |

**Text Books :**

1. The C Programming Language, Brian W. Kernighan, Dennis M. Ritchie, Second Edition, 2015, Pearson Education India.
2. Programming with C, Byron S. Gottfried, Fourth Edition, 2018, Tata McGraw-Hill Publications.
3. Programming in ANSI C, E. Balaguruswamy, Eighth edition, 2019, Tata McGraw-Hill Publications.

**Reference Books :**

1. Programming in C, Pradeep Day and Manas Gosh, Second Edition, 2013, Oxford University Press.
2. Let Us C: Authentic Guide to C Programming Language, Yashwant Kanetkar, Nineteenth Edition, 2023, BPB Publication.

**Other Resources :**

1. NPTEL Course: Introduction to Programming in C By Prof. Satyadev Nandakumar, Department of Computer Science and Engineering, IIT Kanpur
   Web link- https://archive.nptel.ac.in/courses/106/104/106104128/
2. Problem Solving through Programming in C By Prof. Anupam Basu, Department of Computer Science and Engineering Engineering, IIT Kharagpur
   Web link- https://archive.nptel.ac.in/courses/106/105/106105171/

**IN-SEMESTER ASSESSMENT (50 MARKS)**

1. **Task Execution (30 Marks)**

Students will be given minimum 12 tasks.
Students are expected to

1. Identify variables, data types methods/approach required to write the code for the given task and apply the same.
2. Gain knowledge of Operators, data input and output concept
3. Recall basics control structures, understand conditional structures and apply it to solve problems in C.
4. Execute given task for different inputs and verify the result
5. Execute the function and integrate the functions for task completion.
6. Create a 1D, 2D array to solve problem.
7. Apply structure concept to solve the problem.
8. Apply concept of pointers to solve the problem.

Refer the sample task given below.
Example: Write a menu driven (use Switch, do --- while) C program to perform different calculations using function,
Students are expected to,

1. Identify variables, data types methods/approach required to create teacher class and add methods to display details of a given teacher
2. Execute given task for different inputs and verify the result
3. Follow the coding standards
4. Identify errors and rectify the errors.

Students are evaluated based on following:

1. Logic building for the given task (10 marks)
2. Rectifying logical errors and syntax errors (06 marks)
3. Well-structured and organized program (06 marks)
4. Verification of experiment output for different inputs (08 marks)

2. **Regularity and active participation: (05 Marks)**
3. **Practical Test (15 Marks)**

a) Task Execution: 10 Marks

1. Logic building for the given task (04marks)
2. Rectifying logical errors and syntax errors (02 marks)
3. Well-structured and organized program (02 marks)
4. Verification of experiment output for different inputs (02 marks)

b) Oral: 05 Marks

**END SEMESTER EXAMINATION (Practical & Oral Exam) (50 Marks)**

1. Task Execution: 30 Marks
   *Students will be given task (different task for every student) to execute and will be evaluated as per the parameters mentioned in continuous evaluation*
2. Presentation of Results and conclusion, Inferences drawn: 05 Marks
3. Oral based on entire syllabus: 15 Marks

Two examiners, one Internal and one External will do the evaluation.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| SEC | SEC101 | BASIC WORKSHOP PRACTICE I | 01 |

| Examination Scheme | | |
|---|---|---|
| **Term Work** | **Practical /Oral** | **Total** |
| 50 | -- | 50 |

**Pre-requisite :**

There are no specific prerequisites for this course. However, students should have a willingness to learn and a commitment to safety.

**Program Outcomes addressed :**

1. PO1:Engineering knowledge
2. PO5: Engineering tool usage
3. PO6: The Engineer and The World
4. PO8: Individual and collaborative team work
5. PO11: Life-long learning

**Course Objectives :**

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labour.
3. To get exposure to interdisciplinary engineering domain.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>The Basic Workshop Practice I course is intended to give participants with the core information and abilities required for working safely and effectively in a workshop environment. This hands-on course introduces the fundamental principles, equipment, and techniques utilised in a variety of workshop scenarios, such as fitting, hardware and networking, and welding. | **01** |
| **01.** | ***Learning Objectives:***<br>*1. To familiarize participants with reading and interpreting technical drawings, and schematics related to fitting tasks.*<br>*2. To enhance participants' proficiency in fitting various components or materials together accurately and securely using various fitting tools.*<br>*3. To make participants learn to use precision measuring tools to verify part dimensions and ensure quality control.* | **09** |
| | **Content: Fitting**<br>• Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, tapping.<br>• Term work to include one job involving following operations: filing to size, one simple male- female joint, drilling and tapping. | |
| | *Learning Outcomes:*<br>*A learner will be able to* | |

| | | |
|---|---|---|
| | *LO1.1: Read and interpret technical drawings, or schematics related to fitting tasks, identifying dimensions, tolerances, and other specifications accurately. (P.I.- 1.3.1, 11.3.1)*<br>*LO1.2: Demonstrate proficiency in fitting techniques. (P.I.- 5.3.1)*<br>*LO1.3: Competent in the effective use of precision measuring tools to examine work pieces, confirm dimensions, and ensure adherence to quality requirements and standards. (P.I.- 1.4.1, 5.2.2, 11.3.1, 11.3.2)* | |
| **02.** | ***Learning Objectives:***<br>*1. To gain a comprehensive understanding of computer hardware components and peripheral devices.*<br>*2. To learn how to assemble a computer system, set up and configure network infrastructure components, including routers, switches, access points, and cables, to create a functional network environment.*<br>*3. To develop the skills to diagnose and troubleshoot common hardware and network problems.* | **10** |
| | **Content: Hardware and Networking**<br>• Dismantling of a Personal Computer (PC), Identification of components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives, etc.<br>• Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one).<br>• Basic troubleshooting and maintenance.<br>• Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping. | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO2.1: Identify and understand the various hardware components of a computer system. (P.I.- 5.1.2, 11.1.1)*<br>*LO2.2: Assemble a computer system, set up and configure network infrastructure components to create a functional network environment. (P.I.- 1.2.1, 5.2.2, 11.2.1)*<br>*LO2.3: Develop the skills to diagnose and troubleshoot common hardware and network problems. (P.I.- 1.3.1, 6.1.1, 6.3.1)* | |
| **03.** | ***Learning Objectives:***<br>*1. To understand welding symbols and their meanings as per standard welding blueprints. Interpret welding drawings and specifications accurately.*<br>*2. To become familiar with welding equipment, including welding machines, electrodes, torches, gas cylinders, filler metals, and other tools. Learn how to set up and operate welding equipment safely and efficiently.*<br>*3. To develop proficiency in various welding techniques such as lap welding, butt welding, fillet welding, and groove welding. Practice achieving proper weld bead geometry, penetration and fusion.* | **08** |
| | **Content: Welding**<br>Introduction to welding equipment. Edge preparation for welding jobs. | |

| | | |
|---|---|---|
| | Arc welding for different job like, lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles. One job on gas welding. | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO3.1: Interpret welding symbols and blueprints accurately, understanding weld joint designs, dimensions, and specifications as per industry standards. (P.I.- 8.3.1, 11.3.1)*<br>*LO3.2: Produce welds that meet industry standards and specifications, demonstrating the ability to achieve proper weld penetration, fusion, and surface finish while minimizing defects such as porosity, lack of fusion, and undercutting. (P.I.- 1.3.1, 1.4.1, 5.2.2, 5.3.1, 6.1.1, 6.3.1, 8.1.1, 11.3.2)* | |
| **04.** | ***Learning Objectives:***<br>*1. To gain knowledge of the different parts of a lathe machine, including the bed, headstock, tailstock, carriage, tool post, chuck, and various controls.*<br>*2. To gain an understanding of lathe operations such as turning between centers, chucking, facing, taper turning, and threading. Understand the sequence of operations and the appropriate use of cutting tools and feeds for each operation.* | **02** |
| | **Content: Machine Shop**<br>• Machine Shop (Demo of one simple lathe job) (Only for Mechanical Engineering students, other department students can utilized this time to complete the pending work, if any). | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO4.1: Identify different parts of a lathe machine and understand operations that can be carried out on it. (P.I.- 11.1.1, 11.3.1)* | |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply Mechanical engineering concepts to solve engineering problems. |
| 5.1.2 | Create/adapt/modify/extend tools and techniques to solve engineering problems. |
| 5.2.2 | Demonstrate proficiency in using discipline-specific tools. |
| 5.3.1 | Discuss limitations and validate tools, techniques and resources. |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level. |
| 6.3.1 | Identify risks/impacts in the life-cycle of an engineering product or activity |
| 8.1.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |
| 11.1.1 | Describe the rationale for the requirement for continuing professional development. |

11.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.

11.3.1 Source and comprehend technical literature and other credible sources of information.

11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

**Course Outcomes:** A learner will be able to

1. Develop the necessary skill required to handle/use different fitting tools. (*LO 1.1, LO 1.2, LO 1.3* )
2. Develop skill required for hardware maintenance and installation of operating system. (*LO 2.1, LO 2.2, LO 2.3* )
3. Identify the network components and perform basic networking and crimping. (*LO 2.1, LO 2.2, LO 2.3* )
4. Prepare the edges of jobs and do simple arc welding. (*LO 3.1, LO 3.2* )

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SEC101.1 | 3 | | | | 3 | | | | | | 3 |
| SEC101.2 | 3 | | | | 3 | 3 | | | | | 3 |
| SEC101.3 | 3 | | | | 3 | 3 | | | | | 3 |
| SEC101.4 | 3 | | | | 3 | 3 | | 3 | | | 3 |
| **Average** | 3 | | | | 3 | 3 | | 3 | | | 3 |

**Continuous Internal Assessment (CIA) - (50 Marks)**

Job Work with complete workshop book: 40 Marks

Attendance and Active participation: 10 marks

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| VEC | VEC101 | UNIVERSAL HUMAN VALUES | 02 |

**Program Outcomes addressed**:

1. PO6 : The Engineer & The World
2. PO7 : Ethics
3. PO11: Life-long learning

**Course Objectives :**

1. To help the student see the need for developing a holistic perspective of life.
2. To sensitize the student about the scope of life – individual, family (inter-personal relationship), society and nature/existence
3. To strengthen self-reflection.
4. To develop more confidence and commitment to understand, learn and act accordingly

| **Topic Title** | **Aspirations and Issues** | **Basic Realities (underlying harmony)** |
|---|---|---|
| Welcome and Introductions | Getting to know each other | Self-exploration |
| Aspirations and Concerns | Individual academic, career… Expectations of family, peers, society, nation… Fixing one's goals | Basic human aspirations<br>Need for a holistic perspective<br>Role of UHV |
| Self-Management | Self-confidence, peer pressure, time management, anger, stress… Personality development, self-improvement… | Harmony in the human being |
| Health | Health issues, healthy diet, healthy lifestyle Hostel life | Harmony of the Self and Body<br>Mental and physical health |
| Relationships | Home sickness, gratitude towards parents, teachers and others Ragging and interaction Competition and cooperation Peer pressure | Harmony in relationship<br>Feelings of trust, respect… gratitude, glory, love |
| Society | Participation in society | Harmony in the society |
| Natural Environment | Participation in nature | Harmony in nature/existence |
| **Total no. of hours**: **30** | | |

Course Outcomes : ,
, Analyze the significance of value inputs provided in formal education along with skills and develop a broader perspective about life and education
, Formulate their aspirations and concerns at different levels of living, and the way to fulfill them in a sustainable manner.
, Evaluate their current state of understanding and living, and model a healthy lifestyle
, Examine the issues of home sickness, interactions with seniors on the campus, peer pressure with better understanding and feel grateful towards parents, teachers and others
, Develop more confidence and commitment for value-based living in family, society and nature

**Text Books :**

1. Human values & Professional Ethics by R. R.Gaur, R Sangal, G. P.Bagaria, 2010, Excel Books , New Delhi

**Reference Books :**


1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, Published by 2004 by New Age Intl. Publishers, New Delhi.
3. The Story of Stuff by Annie Leonard, published in 2010 by Free Press.
4. Small is Beautiful by E. F. Schumacher, published in 1973 by Harper & Row.
5. Slow is Beautiful by Cecile Andrews, published in 2006 by New Society Publishers


**Other Resources :**

1. NPTEL Course: Exploring Human Values: Visions of Happiness and Perfect Society, By Prof. A.K. Sharma, Department of Humanities and Social Sciences, IIT Kanpur:-Web link- https://nptel.ac.in/courses/109104068
2. NPTEL Course: Moral Thinking: An Introduction To Values And Ethics By Prof. Vineet Sahu, IIT Kanpur:-Web link- https://onlinecourses.nptel.ac.in/noc23_hs89/preview

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **BSC** | BSC204 | ENGINEERING MATHEMATICS-II | 03+01* |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 + 25* | 30 | 50 | 1.5 | 2 | 125 |

**Pre-requisite:**

1. Differentiation of several variable I & II
2. Vector Differentiation

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis

**Course Objectives:**

1. To provide the Basic knowledge of the concepts of Mathematics applicable to the field of engineering.
2. To build a mathematical foundation of the methodology required for solving application based problems in the field of Engineering.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>Mathematics is the fundamental step which creates a solid foundation for all Applied fields of Engineering. Professional Engineering applications have Mathematics as an integral part of their evolution. Forexample: Formulation in Mathematics to various engineering field using case study.<br>Introduction to differential equations from Electrical circuit. Introduction to Multiple Integration from real life application.Use the concept of vector integration into Fluid Mechanics**.**<br>Hence, Formulation Based Mathematics is a fundamental requisite to all fields of Engineering for analyzing their performances. | **01** |
| **01.** | **Differential Equations of First Order and First Degree**<br>***Learning Objective/s:***<br>*Learner will be able to*<br>***1.*** *Analyse and interpret the basic fundamentals of differential equations (D.E)of first order & first degree.* | **6-8** |

| | | |
|---|---|---|
| | **2.** *Determine the solution of a first order D.E by applying the basic concepts ofexact and linear DE.* | |
| | **Contents:**<br>Definition, Formation of Differential equation, Exact differential Equations, Non Exact Differential Equation, Integrating Factors, Rules for finding the integrating factor, Linear Differential Equations, Equation reducible to Linear form , Bernoulli's equation. | |
| | ***Self-Learning Topics:***<br>***Self-Learning Topics:***<br>*Application of differential equations of First Order and First Degree in electricalcircuits and thermodynamics.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1 : Identify the exact differential equation and linear differential equations and solve them using appropriate method by applying the fundamentals of differentiation and integration. (PI-2.1.3 , 2.2.3 & 1.1.1)*<br>*LO 1.2 : Apply the fundamental engineering concepts to model a first order DE and solve it.( PI-1.3.1)* | |
| **02.** | **Linear Differential Equations with Constant Coefficients of Higher Order type f(D)y = X**<br>***Learning Objective:***<br>*Learner will be able to*<br>1. *Analyse and interpret the basic fundamentals of higher order differentialequations (HODE).*<br>2. *Determine the solution of a HODE by applying the basic concepts of complementary function and particular integral.* | **7-9** |
| | **Contents:**<br>Complementary Function, Particular Integral, Type 1. X = $e^{ax}$ , Type 2 X = $x^n$ ,Type 3 X = $cos(ax+b) or\ sin(ax+b)$ ,Type 4 X = $e^{ax}V$ Type 5 X= $xV$, General Type - Method of variation of parameters | |
| | ***Self-Learning Topics:***<br>1. *Differential equations with Variable Coefficients*<br>2. *(Cauchy's and Legendre's Linear Differential Equations)*<br>3. *Applications of Higher Order Linear Differential Equations to develop amathematical model of linear differential equations.* | |
| | ***Learning Outcomes:***<br>*LO 2.1: Identify the nature of HODE and solve them by applying the concept of complementary function and particular integral using the fundamentals of differentiation and integrations. (PI-2.1.3, 2.2.3 & 1.1.1)*<br>*LO 2.2 : Apply the fundamental engineering concepts to model a higher order DE and solve it.(PI-2.3.1 & 1.3.1)* | |
| **03.** | **Beta and Gamma Functions** | **5-7** |
| | ***Learning Objective:***<br>**1.** *Analyse and interpret the basic definition of Beta and Gamma Functions andtheir properties.*<br>**2.** *Apply the definition and properties of Beta and Gamma Functions to* | |

| | | |
|---|---|---|
| | *solve definite integrals.*<br>**Contents:**<br>Definitions, Gamma Function, Beta Function, Properties of Beta and Gamma Function, Relationship between Beta and Gamma Function, Duplication Formula.<br>***Self-Learning Topics:***<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Analyze a definite integral, apply the basic definition & properties of beta and gamma function to solve it by identifying the appropriate substitution. (PI-2.1.1, 1.1.1, 1.2.1 & 2.2.3).* | |
| **04.** | **Double Integration**<br>***Learning Objectives:***<br>*1. Analyze the fundamentals of Double integration in different coordinate systems (Cartesian and polar) and apply it to solve problem.*<br>*2.* ***Apply the concepts of double integrations to evaluate area and mass of the Lamina.***<br>**Contents:**<br>Definition, Evaluation of Double Integration in Cartesian Coordinates and Polar Coordinates, Evaluation of double integrals by changing the order of Integration, Evaluation of integrals over the given region, Evaluation of double integrals by changing to polar Co-ordinates, Application of double integrals to compute Area.<br>***Self-Learning Topics:***<br>*Mass of a Lamina*<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Identify the region of integration. (P.I.-2.1.3)*<br>*LO 4.2: Apply the fundamentals of integration to solve problem in double integration by changing the coordinate systems if applicable. (P.I.-1.1.1, 2.2.1)*<br>*LO 4.3: Apply the concept of double integration to find area of bounded regions. (P.I.-1.2.1).* | **7-9** |
| **05.** | **Triple Integration**<br>***Learning Objective/s:***<br>*1. Analyze the fundamentals of Triple integration in different coordinate systemsand apply it to solve problem.*<br>***2.*** *Apply the concepts of triple integrations to evaluate volume of a solid.*<br>**Contents:**<br>Definition, Evaluation of Triple Integral using Cartesian coordinates, Evaluation of Triple Integral using cylindrical coordinates, Evaluation of Triple Integral using Spherical coordinates.<br>***Self-Learning Topics:***<br>***Volume of a solid***<br>***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Identify the region of integration. (P.I.-2.1.3)* | **5-7** |

| | | |
|---|---|---|
| | *LO 5.2: Apply the fundamentals of integration to solve problem in triple integration by changing the coordinate systems if applicable. (PI-1.1.1 & 2.2.1)*<br>*LO 5.3 : Apply the concept of triple integration to find the volume of a solid. (PI- 1.2.1)* | |
| **06.** | **Integration of vector function**<br>***Learning Objective/s:***<br>Analyze the fundamentals of Line integral, surface integral and volume integral andapply it to solve problems using Green's Theorem, Stoke's Theorem & Gauss Divergence Theorem. | **7-9** |
| | **Contents:**<br>Integration of vector function, Line Integral, Green's Theorem (without proof), Surface Integral, Volume Integral, Stoke's Theorem & Gauss Divergence Theorem(without proof) | |
| | ***Self-Learning Topics:***<br>***Work done by a force*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: Identify and apply the concept of vector differentiation & definite integral to evaluate Line integral, surface integral and volume integral.(PI-1.1.1, 1.2.1 & 2.1.3).*<br>*LO 6.2: Differentiate between the problems and solve using appropriate theorem (Green's Theorem, Stoke's Theorem & Gauss Divergence Theorem). (P.I.- 2.2.4)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.1 | Apply mathematical techniques as calculus/algebra to solve problems. |
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problem. |
| 2.1.1 | Articulate problem statements and identify objectives. |
| 2.1.3 | Identify the mathematical knowledge that applies to a given problem. |
| 2.2.1 | Reframe complex problems into interconnected sub-problems |
| 2.2.3 | Identify existing processes/solution methods for solving the Problems. |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 2.3.1 | Combine mathematical principles and engineering concepts to formulate mathematical models of an engineering problem. |

**Course Outcomes:** A learner will be able to -

1. Analyse whether the first order Differential equation is exact or Linear and solve it by applying the appropriate method ( *LO 1.1, LO 1.2*)
2. Analyse the procedure to find complementary function and particular integral of higher order differential equation solve it by applying the suitable method. *(LO 2.1, LO 2.2)*
3. Implement the fundamentals of Beta and Gamma Function to evaluate the definite integral. *(LO 3.1)*

4. Apply the fundamentals of multiple integration to analyse and evaluate the area of a lamina and volume of a solid. *(LO 4.1 , LO 4.2, LO 4.3,  LO 5.1, LO 5.2, LO 5.3)*

5. Apply the concepts of line integral, surface integral and volume integral in order to analyse and evaluate problems using Green's theorem, Stoke's theorem, Gauss-divergence theorem. *(LO 6.1, LO 6.2)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSC204.1 | 3 | 3 | | | | | | | | | |
| BSC204.2 | 3 | 3 | | | | | | | | | |
| BSC204.3 | 3 | 3 | | | | | | | | | |
| BSC204.4 | 3 | 3 | | | | | | | | | |
| BSC204.5 | 3 | 3 | | | | | | | | | |
| **Average** | 3 | 3 | | | | | | | | | |

**Text Books :**

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication, forty fourth Edition, 2021
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, Tenth Edition, 2011

**Reference Books :**

1. Engineering Mathematics by Srimanta Pal and Subodh, C. Bhunia, Oxford University Press, First Edition, 2015
2. Engineering Mathematics by P. Sivaramakrishna Das and C. Vijayakumari, Pearson, First Edition, 2017

**IN-SEMESTER ASSESSMENT (75 MARKS)**

**1. Continuous Assessment - Theory-(20 Marks)**

1. Numerical Assignments (Minimum 20 problems): 5 marks
2. Class test based on above Numerical assignment: 5 marks
3. Team - Pair - Solo: 5 marks
4. Regularity and active participation: 5 marks

**2. Continuous internal evaluation of Tutorial (25 Marks)**

1. Tutorials: 20 Marks

Students must be encouraged to write at least 6 class tutorials. Each tutorial carries 20 Marks. Average will be taken of all six tutorials out of 20 marks.

2. Regularity and active participation: 5 marks

**3. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **BSC** | BSC205 | ENGINEERING PHYSICS-II | 02 |

| **Examination Scheme** | | | | | |
|---|---|---|---|---|---|
| **Distribution of Marks** | | | **Exam Duration (Hrs.)** | | **Total Marks** |
| **In-semester Assessment** | | **End Semester Examination (ESE)** | | | |
| **Continuous Assessment** | **Mid-Semester Exam (MSE)** | | **MSE** | **ESE** | |
| 15 | 20 | 40 | 1 | 1.5 | 75 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer and The World

**Course Objectives:**

1. To provide the Basic knowledge on the concepts of physics pertaining to the field of engineering.
2. To build a foundation to the methodology necessary for solving problems by applying the knowledge of physics in the field of engineering.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction** | **01** |
| **01.** | **Crystal Structure**<br>***Learning Objective:***<br>*1. To introduce the fundamental knowledge of cubic crystal structures.*<br>*2. To apply the knowledge of crystal parameters to identity the simple cubic structure.* | **3-5** |
| | **Contents:**<br>Crystals: Unit cell: Space lattice, Basis and Crystal structure: Cubic Structures (SC, BCC and FCC): Unit cell characteristics for simple cubic: Unit cell volume, Number of atoms per unit cell, Coordination number, Atomic radius, Nearest neighbour distance, Packing fraction, Percentage of void space and Density. | |
| | ***Self-Learning Topics:*** *Crystals: Lattice parameters.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: state various parameters of unit cell of a crystal and its importance to identify crystal structures. (P.I.- 1.2.1)*<br>*LO 1.2: diagrammatically describe the structure of different cubic unit cell. (P.I.- 1.2.1)*<br>*LO 1.3: solve the problems related to crystal structure. (P.I.- 1.2.2.)*<br>*LO 1.4: identify cubic crystal structure knowing their various parameters. (P.I.- 2.1.2)* | |

| | | |
|---|---|---|
| | *LO 1.5. derive the unit cell parameters of cubic crystal structure. (P.I.- 2.1.3)* | |
| **02.** | **Analysis of Crystal Structure**<br>***Learning Objective:***<br>1. *To interpret the use of X-ray law.*<br>2. *2. To apply the concept of Miller Indices and law to identify the crystal planes* | **4-6** |
| | **Contents:**<br>Crystal planes and Miller indices; Interplanar spacing: Relation between interplanar spacing and Miller indices for cubic unit cell. Diffraction of X-ray and Bragg's law; Bragg's spectrometer: Principle, Construction and working; Determination of crystal structure using Bragg's spectrometer. | |
| | ***Self-Learning Topics: -*** *Crystals: Lattice parameters.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*A learner will be able to*<br>*LO2.1: apply the hall effect phenomena for execution of experiment. (P.I.- 1.2.1)*<br>*LO2.2: write the required theory and procedure for the experiment. (P.I.- 4.3.1)*<br>*LO2.3: draw the principal planes of simple cubic structure. (P.I.- 4.3.3)*<br>*LO2.4: identify the principal planes of simple cubic structure from the given models. (P.I.- 1.2.1)*<br>*LO2.5: determine the miller indices for the same and interplanar distance and write the result. (P.I.- 1.2.2, P.I.- 4.3.3)* | |
| **03.** | **Non-Crystalline Materials** | **3-5** |
| | ***Learning Objective:***<br>1. *To gain the basic knowledge of non-crystalline solids.*<br>2. *2. To recognize the solids with amorphous structure and their importance in various applications* | |
| | **Contents:**<br>Structure: order and disorder, importance of short range order, properties of non-crystalline solid; Classes: metals/metalloid glasses, alloys of transitions metals with rare earth atoms. Silica glasses and related alloys. | |
| | ***Self-Learning Topics: Application of non-crystalline materials.*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to A learner will be able to*<br>*LO 3.1: differentiate crystalline and non-crystalline material. (P.I.- 1.2.1)*<br>*LO 3.2: define non-crystalline material and list the properties of non-crystalline solid for various applications. (P.I.- 1.2.1)*<br>*LO 3.3: identify the importance of short range order in non-crystalline materials. (P.I.- 2.1.2)*<br>*LO 3.4: identify various non crystalline materials by knowing their properties. (P.I.- 2.2.3)* | |
| **04.** | **Magnetic and Dielectric Materials** | **6-8** |
| | ***Learning Objectives:***<br>1. *To identify the properties of magnetic and dielectric materials.* | |

| | | |
|---|---|---|
| | 2. *To apply magnetic and dielectric materials as solutions to enhance existing and future technology* | |
| | **Contents:**<br>Magnetic materials: Ferromagnetism: Magnetization of ferromagnetic materials, hysteresis loop: soft and hard magnetic materials, Magnetoresistive materials, Applications of magnetic materials. Dielectric materials: Dielectric materials: Dielectric constant; Dielecctric polarization; Dielectric susceptibility; Dipoles; Nonpolar and polar dielectric, Applications of dielectric materials. | |
| | ***Self-Learning Topics:*** *Magnetization of materials.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: state various parameters related to magnetic and dielectric materials and their importance in various applications (P.I.- 1.2.1)*<br>*LO 4.2: solve the problems involving magnetic and dielectric materials using the concepts and basic formulae. (P.I.- 1.2.2)*<br>*LO 4.3: identify the types of ferromagnetic materials and dielectric materials in terms of their poperties. (P.I.- 2.1.2).*<br>*LO 4.4: Draw the hysteresis loop for ferromagnetic materials by knowing the concept of magnetization. (2.1.3)*<br>*LO 4.5: use magnetic materials and dielectric materials in various applications. (P.I.- 6.1.1)*<br>*LO 4.6: state the advantages, disadvantages of using magnetic and dielectric materials in various devices. (P.I.- 6.2.2)* | |
| **05.** | **Nanomaterials**<br>***Learning Objective/s:***<br>*1. To explore the basics of nanomaterials.*<br>*2. To identify the applications of nanomaterials in current technology.* | **3-5** |
| | **Contents:**<br>Introduction; Properties (Optical, electrical, magnetic, mechanical); Surface to volume ratio; Two main approaches in nanotechnology to synthesize Nanomaterials (Bottom up technique and Top down technique); Synthesis methods: Ball milling; Chemical vapour deposition; Applications. | |
| | ***Self-Learning Topics :*** *Advantages and disadvantages of Ball milling and Chemical vapour deposition methods* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: define nanomaterial and differentiate between two approaches of synthesizing nanomaterials. (P.I.- 1.2.1)*<br>*LO 5.2: solve the problems related to surface area to volume ratio. (P.I.- 1.2.2)*<br>*LO 5.3: classify various synthesis methods of nanomaterials in terms of approaches. (2.1.2).* | |

| | | |
|---|---|---|
| | *LO 5.4: write about various synthesis methods and identify the suitable method for the preparation of a different nanomaterials. (P.I.- 2.2.3)*<br>*LO 5.5: analyse the properties of nanomaterials. (P.I.- 6.1.1)* | |
| **06.** | **Characterization Techniques of Nanomaterials**<br>***Learning Objective/s:***<br>*The learner will be able to predict the tools for specific characterization of nanomaterials.* | **3-5** |
| | **Contents:**<br>Tools for characterization of Nanomaterials: Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM). | |
| | ***Self-Learning Topics:***<br>*Difference between optical and electron microscope* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: state working principle of different tools (SEM, TEM and AFM).and its application in analysing various properties of nanomaterials (P.I.- 1.2.1)*<br>*LO 6.2: interpret the importance of electron microscope over optical microscope. to characterize nanomaterials (P.I.- 2.2.3)*<br>*LO 6.3: analyse different characterization tools in terms of their principle, construction, working. (P.I.- 2.2.3)*<br>*LO 6.4: identify merits, demerits and challenges in using the characterization tools. (P.I.- 6.2.2)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of physics to an engineering problem. |
| 1.2.2 | Apply the formulae derived from the concept to solve engineering problem. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions. |
| 6.1.1 | Identify and describe various role of science particularly as pertains to protection of the public and public interest at global, regional and local level. |
| 6.2.2 | Interpret and explain the limitations in the usage of devices for protection of the public |

**Course Outcomes:**

A learner will be able to -

1. Learner will be able to apply the knowledge of crystal parameters to analyse the relevant basic engineering problems.
( *LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO1.5, LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO2.5*)
2. Learner will be able to apply the fundamental knowledge of non-crystalline solids for various applications of it.
( *LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
3. Learner will be able to apply the fundamental knowledge of magnetic and dielectric materials in various technical fields by analyzing their intrinsic behaviours.
( *LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5, LO 4.6)*
4. Learner will be able to use the basic knowledge of nanomaterials and their characterization techniques to identify their applications in societal issues.
( *LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 6.1, LO 6.2, LO 6.3, LO 6.4*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSC205.1 | 3 | 3 | | | | | | | | | |
| BSC205.2 | 3 | 3 | | | | | | | | | |
| BSC205.3 | 3 | 3 | | | | 3 | | | | | |
| BSC205.4 | 3 | 3 | | | | 3 | | | | | |
| **Average** | 3 | 3 | | | | 3 | | | | | |

**Text Books :**

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar Revised Edition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat Rai Publications.

**Reference Books :**

| | |
|---|---|
| 1. | Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley |
| 2. | Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley |
| 3. | The Physics of Amorphous Solids, Richard Zallen, Wiley - VCH |
| 4. | Introduction to nanotechnology, Charles P Poole and Frank J Owens, 1st Edition, Wiley-Interscience. |
| 5. | Nano: The essentials: Understanding Nanoscience and Nanotechnology, T Pradeep, 1st Edition, 2017, McGraw Hill. |

**Other Resources :**

1. Online physics library, California State University:-Web link- https://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web linkwww.physics.rutgers.edu

3. Theory of the structure of Non-Crystalline Solids, Conference Review Paper, Int. conf. on Theory of the structure of Non-Crystalline Solids. Jozef Bicerano et al.
4. NPTEL Course: Nano structured materials-synthesis, properties, self-assembly and applications by Prof. A. K. Ganguli, IIT Delhi:- Web linkhttps://nptel.ac.in/courses/118102003.

**IN-SEMESTER ASSESSMENT (35 MARKS)**

**Continuous Assessment - Theory-(15 Marks)**

1. MCQ test: 4 marks
2. Class test: 4 marks
3. Open book test/Open notes test: 4 marks
4. Regularity and active participation: 3 marks

**Mid Semester Exam (20 Marks)**

Mid semester examination will be based on 40 % to 50% of the syllabus.

**END SEMESTER EXAMINATION (40 MARKS)**

End semester will be based on the syllabus coverage upto Mid Semester Examination (MSE) carrying 20% to 30% weightage and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| BSC | BSC206 | ENGINEERING CHEMISTRY- II | 02 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 15 | 20 | 40 | 1 | 1.5 | 75 |

**Pre-requisite: NIL**

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6 -The engineer and the world

**Course Objectives:**

1. To enable the students to apply the laws of chemistry to an engineering problem.
2. To enable the students to appreciate material properties and their engineering applications.
3. To enable the students to analyse and select the most appropriate engineering material.
4. To acknowledge the current developments in the field of nanotechnology, energy storage systemsand green chemistry for sustainable development.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>This course provides the insights into the properties, composition and behavior of materials and enables engineers to understand how different materials react under various conditions, allowing them to select appropriate materials for specific applications. | **01** |
| **01.** | **Alloys**<br>***Learning Objective:***<br>*To classify the different types of alloys and interpret their properties andapplications in industry.*<br>**Contents:**<br>Introduction, Significance of alloying, Ferrous Alloys-Plain carbonsteels and special steels: - Nichrome and Stainless steel, Non-ferrous: - Duralumin, Alclad, Shape memory alloys: definition, properties and uses.<br>Self-Learning Topics:<br>*Applications of aluminum alloys in aeronautical engineering.* | **4-6** |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1 State the significance of making alloys (P.I.-1.3.1)*<br>*LO- 1.2 State the role of carbon in steels (P.I.-1.3.1)*<br>*LO-1.3 Classify the plain carbon steels on the basis of their carbon content. (P.I.-2.1.3)*<br>*LO-1.4 Distinguish between plain carbon steels and alloy steels (P.I.-2.1.3)*<br>*LO-1.5 Identify the role of various alloying elements in alloy steel (P.I.-2.1.3)*<br>*LO-1.6 State the composition, properties and uses of SS and Heat resistant steel. (P.I.-1.3.1)*<br>*LO-1.7 State the composition, properties and applications of duralumin in alclad. (P.I.-1.3.1)*<br>*LO 1.8 State the concept of shape memory alloys and their applications in various industries. (P.I.-1.3.1)* | |
| **02.** | **Polymers** | **4-6** |
| | *Learning Objective: To use the knowledge of synthesis, properties and uses of various polymers in industry. This will aid in identifying the impact of disposal of plastics on general health and the environment.* | |
| | **Contents:**<br>Preparation, properties and uses of Phenol formaldehyde, PMMA,Kevlar. Effect of heat on the polymers (Glass transition temperature). Molecular weight of polymer and numericals. Conducting polymers and their applications. Electroluminescent polymer, Biodegradable polymers. | |
| | ***Self-Learning Topics:***<br>*Classification of polymers, Thermoplastic and Thermosetting plastics.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1 Apply the basic concepts of polymer chemistry (P.I.-1.3.1)*<br>*LO -2.2 Synthesize thermoplastic and thermosetting polymers for industrial use.(P.I.-2.2.3)*<br>*LO-2.3 Calculate the molecular weight of polymer by number average andweight average methods. (P.I.-1.2.2)*<br>*LO-2.4 Apply the knowledge of high-performance polymeric materials for the protection of public health. (P.I.-6.1.1)*<br>*LO-2.5 State the concept of glass transition temperature, factors affecting the same. (P.I.-1.3.1)*<br>*LO-2.6 Identify the correct polymer for various applications on the basis of glass transition temperature. (P.I.-2.1.3)*<br>*LO-2.7 State the concept of conducting polymers, electroluminescent polymer and biodegradablepolymers for various applications in industry. (P.I.-1.3.1)*<br>*LO-2.8 Apply the knowledge of disposal of biodegradable polymers forprotection of environment and sustainable development. (P.I.-7.2.1)* | |
| **03.** | **Advanced Functional materials** | **4-6** |

| | | |
|---|---|---|
| | ***Learning Objective:***<br>*To familiarize with the composite materials, their properties and applications invarious industries and for the protection and safety of society.* | |
| | **Contents:**<br>Introduction, Constitution- i) Matrix phase ii) Dispersed phase. Classification- (A) Particle - reinforced composites- i) Large – particle reinforced composites ii) Dispersion – strengthened composites. (B) Fiber – reinforced composites- i) Continuous – aligned ii) Discontinuous – aligned (short)- (a) aligned (b) randomly oriented (C) Structural Composites- i) Laminates (ii) Sandwich Panels. Their applications in aeronautical engineering and other industries. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO-3.1 State the properties of composite materials (P.I.-1.3.1)*<br>*LO-3.2 State the functions of matrix and dispersed phase (P.I.-1.3.1)*<br>*LO- 3.3 Classify the composite materials on the basis of types of reinforced materials used. (P.I.-2.3.1)*<br>*LO- 3.4 Analyze the structural and mechanical properties of composites for industrial use. (P.I.-2.3.1)*<br>*LO- 3.5 Analyze the properties of composite materials for the applications in aeronautical engineering. (P.I.-2.3.1).* | |
| **04.** | **Carbon Nanomaterials**<br>***Learning Objectives:***<br>*To use carbon nanomaterials on the basis of their mechanical and electrical propertiesin various industrial applications and modern devices.* | **3-5** |
| | **Contents:**<br>Introduction to carbon nanomaterials, structure, electrical and mechanical properties of graphene, CNTs and Fullerenes. Application of Nanomaterials in various industries. | |
| | ***Self-Learning Topics:***<br>*Inorganic nanomaterials like metals, metal oxides etc.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO-4.1 Define Carbon nanomaterials (P.I.-1.3.1)*<br>*LO-4.2 Analyze the structures of graphene, CNTs and fullerene for theirelectrical and mechanical properties. (P.I.-2.3.1)*<br>*LO-4.3 Apply the knowledge of properties of carbon nanomaterials in industry. (P.I.-1.3.1)* | |
| **05.** | **Batteries** | **4-6** |
| | **Contents:**<br>Introduction and Characteristics of batteries. Construction, working and applications of Lithium-ion batteries, Hydrogen oxygen alkaline fuel cells. E-waste Management, Battery e-waste management. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics:***<br>*Classification of batteries.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO-5.1 State the characteristic properties of batteries (1.3.1)*<br>*LO-5.2 Write the construction and working of Li-ion and fuel cell batteries. (1.3.1)*<br>*LO-5.3 Analyze the uses of batteries in various devices for solving real-world problems. (2.1.3)*<br>*LO-5.4 Identify the impact of disposal of batteries on the environment and society. (6.1.1)*<br>*LO-5.5 Apply e-waste management of batteries for sustainable development and environment protection. (6.1.2)* | |
| **06.** | **Spectroscopic Techniques** | **3-5** |
| | ***Learning Objective/s:***<br>*To differentiate between the various ranges of electromagnetic spectrum used in thedifferent types of spectroscopic techniques like absorption and emission spectroscopy* | |
| | **Contents:**<br>Spectroscopy - Principle, atomic and molecular spectroscopy. Beer lambert's law and UV-Visible Spectroscopy, Selection rules. Introduction to fluorescence and phosphorescence, Jablonski diagram. Material Characterization using different Spectroscopic Techniques. | |
| | ***Self-Learning Topics:***<br>*Electromagnetic radiation, characteristics of electromagneticradiation, electromagnetic spectrum.* | |
| | ***Learning Outcomes:*** | |
| | *A learner will be able to*<br>*LO-6.1 Classify spectroscopic techniques on the basis of atomic or molecular level of study. (P.I.-2.1.3)*<br>*LO-6.2 State the fundamental selection rules in spectroscopic technique (P.I.- 1.3.1)*<br>*LO-6.3 State the Beer Lambert's law (P.I.-1.2.1)*<br>*LO-6.4 To calculate absorbance, concentration and molar extinction coefficientof given compounds using Beer Lambert's law. (P.I.-1.2.2)*<br>*LO-6.5 State the phenomena of fluorescence and phosphorescence. (P.I.-1.3.1)*<br>*LO-6.6 Analyze the various radiative and non-radiative transitions occurring ina photo excited electron with the help of Jablonsky diagram. (P.I.-2.1.3)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **30** |

**Performance Indicators:**

| P.I. No. | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 1.2.2 | Apply the formulae based on the concepts of engineering chemistry for solving the numerical problems. |
| 1.3.1 | Apply fundamental engineering chemistry concepts to solve engineering problems. |

2.1.3 Identify the engineering chemistry concepts to analyze the given problem
2.2.3 Identify the existing processes/ solution methods for solving the problems
6.1.1 Identify and describe the various roles of materials particularly as pertains to protection of the public and public interest at global, regional and local level
6.1.2 Analyse the environmental aspects of engineering problems for its impact on sustainability.

**Course Outcomes:** A learner will be able to -

1. Apply the concepts of engineering chemistry for solving the engineering problems (*LO-1.1, LO-1.2, LO-1.3, LO-1.4, LO-1.5, LO-1.6, LO-1.7, LO-1.8, LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-2.7, LO-2.8, LO-3.1, LO-3.2, LO-3.3, LO-3.4, LO-3.5, LO-4.1, LO-4.2, 4.3, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5, LO-6.1, LO-6.2, LO-6.3, LO-6.4, LO-6.5, LO-6.6)*
2. Analyse the quality and properties of engineering materials for solving real world problems. (*LO-1.1, LO-1.2, LO-1.3, LO-1.4, LO-1.5, LO-1.6, LO-1.7, LO-1.8, LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-2.7, LO-2.8, LO-3.1, LO-3.2, LO-3.3, LO-3.4, LO-3.5, LO-4.1, LO-4.2, 4.3, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5, LO-6.1, LO-6.2, LO-6.3, LO-6.4, LO-6.5, LO-6.6)*
3. Identify the suitable engineering material for the protection of the environment and public health. ( *LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-2.7, LO-2.8, LO-3.1, LO-3.2, LO-3.3, LO-3.4, LO-3.5, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5,)*
4. Apply the knowledge of e-waste management and biodegradable polymers for the sustainable development. (*LO-2.1, LO-2.2, LO-2.3, LO-2.4, LO-2.5, LO-2.6, LO-2.7, LO-2.8, LO-5.1, LO-5.2, LO-5.3, LO-5.4, LO-5.5,)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSC206.1 | 3 | 3 | | | | 3 | | | | | |
| BSC206.2 | 3 | 3 | | | | 3 | | | | | |
| BSC206.3 | 3 | 3 | | | | 3 | | | | | |
| BSC206.4 | 3 | 3 | | | | 3 | | | | | |
| **Average** | 3 | 3 | | | | 3 | | | | | |

Text Books :

1. A textbook of engineering chemistry by S. Dara, 2014 edition, Chand Publication.
2. Engineering Chemistry by Jain and Jain, $17^{th}$ edition, 2018, Dhanpatrai publications.

**Reference Books :**

1. Engineering Chemistry by Jain and Jain, $17^{th}$ edition, 2018, Dhanpatrai publications
2. Elements of 2017 by Y. R. Sharma, Spectroscopy $29^{th}$ edition, Pragati Prakashan
3. Nano forms of carbon and its Applications by Prof Maheshwar Sharon and Dr. Madhuri Sharon, First edition, 2007, Monad nanotech Pvt Ltd

**Other Resources :**

1. Online chemistry library for open access text books: https://chem.libretexts.org

**IN-SEMESTER ASSESSMENT (35 MARKS)**

**1. Continuous Assessment - Theory-(15 Marks)**

1. Assignment on live problems: 8 marks
2. Poster making: 4 marks
3. Regularity and active participation: 3 marks

**2. Mid Semester Exam (20 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (40 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **AEC** | AEC 201 | PROFESSIONAL COMMUNICATION & ETHICS-I | 02+01 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| **Distribution of Marks** | | | **Exam Duration (Hrs.)** | | **Total Marks** |
| **In-semester Assessment** | | **End Semester Examination (ESE)** | | | |
| **Continuous Assessment** | **Mid-Semester Exam (MSE)** | | **MSE** | **ESE** | |
| 50 | -- | -- | -- | -- | 50 |

**Pre-requisite:**

1. Keen desire to build confidence, develop language skills and reduce fear of public speaking
2. Intermediate knowledge of Spoken English
3. Intermediate level grasp of English Grammar and Vocabulary

**Program Outcomes addressed:**

1. PO 7: Ethics
2. PO 8: Individual and Collaborative Teamwork
3. PO 9: Communication
4. PO 11: Life-long learning

**Course Objectives:**

1. To demonstrate the fundamental concepts of interpersonal and professional communication.
2. To encourage active listening with focus on content, purpose, ideas and tone.
3. To facilitate fluent speaking skills in social, academic and professional situations.
4. To train in reading strategies for comprehending academic and business correspondence.
5. To promote effective writing skills in business, technology and academic arenas.
6. To inculcate confident personality traits along with grooming and social etiquettes.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>Every learning should lead toward the building of a holistic individual and a good citizen. Communication Skills and Ethics as a subject is the very fundamental requirement of a human being in any social and/or professional ecosystem. The syllabus has been compiled with the strategic idea of helping individual students to enhance, incorporate and implement the four pillars of Communication, Listening, Speaking, Reading and Writing (LSRW Skills), in all walks of life. There is an added emphasis on Ethical behavior and communication which is an integral value that every good human being, who also aims at being an impressive professional, should imbibe. The learner will also gain basic skills in professional writing and | **01** |

| | | |
|---|---|---|
| | public speaking, exude confidence in presenting themselves and their work, with hands on training in real time. | |
| **01.** | ***Fundamentals of Communication***<br><br>***Learning Objective:***<br>*To aid the learner in understanding the importance of communication in the spoken and written form so that they can express themselves effectively and ethically in any professional or social setting.*<br><br>*To encourage active listening with focus on content, purpose and ideas which can then be shared using ICT tools, ethical use of social media and appropriate professional etiquette, as individuals and team members.* | **7-9** |
| | **Contents:**<br>1.1 Introduction to Theory of Communication<br>a) Definition<br>b) Objectives<br>c) The Process of Communication<br>1.2 Methods of Communication<br>i. Verbal (Written & Oral)<br>ii. Non-verbal<br>a. Non-verbal cues perceived through the five senses: (Visual, Auditory, Tactile, Olfactory and Gustatory cues)<br>b. Non-verbal cues transmitted using: (Body, Voice, Space, Time and Silence)<br>1.3 Barriers to Communication<br>a) Mechanical/External<br>b) Physical/Internal<br>c) Semantic & Linguistic<br>d) Psychological<br>e) Socio-Cultural<br>1.4 Communication at the Workplace<br>a) Corporate Communication - Case Studies<br>b) Short Group Presentations on Business Plans<br>c) Selecting Effective Communication Channels<br>1.5 Professional Etiquette<br>a) Formal Dress Code<br>b) Cubicle Étiquette<br>c) Formal Dining Étiquette<br>d) Responsibility in Using Social Media<br>e) Showing Empathy and Respect<br>f) Learning Accountability and Accepting Criticism<br>g) Demonstrating Flexibility and Cooperation | |
| | ***Self-Learning Topics:***<br>*Visit nearby Government office e.g. Passport/Post/Electricity/Telephone, as such, communicate with employees and get related information. Evaluate your communication with them & find out the flaws and/or barriers in the communication process that you faced. Document it for further discussion.*<br><br>*Reading up on various case studies depicting barriers in communication which led to conflicts; finding alternative methods of resolving them* | |

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| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1: Identify the various channels of communication in a business organization (9.2.1)*<br>*LO1.2: Differentiate between verbal and non-verbal communication. (8.2.3)*<br>*LO1.3: Apply verbal and non-verbal cues to communicate more effectively in a group (8.2.1)*<br>*LO1.4:Identify barriers in communication and overcome them efficiently (7.1.1)*<br>*LO1.5: Implement the correct method of listening, speaking, reading and writing keeping 'You-attitude' in perspective. (7.2.2)*<br>*LO1.6: Deliver a short speech for special occasions or an extempore with appropriate professional tools and social etiquette. (9.2.2, 9.3.2))*<br>*LO1.7: Introduce self with confidence and composure to the class. (8.2.4)*<br>*LO1.8: Implement appropriate grooming and ethical way of presenting oneself (11.1.1)*<br>*LO1.9:Utilise the knowledge of responsible and ethical use of social media (7.1.1)*<br>*LO1.10: Exhibit flexibility and empathy in the professional space (8.2.2)*<br>*LO1.11: Identify conflict situations and attempt to come up with a resolution. (8.2.1)* | |
| **02.** | ***Verbal Aptitude For Employment*** | **2-4** |
| | ***Learning Objective:***<br>*To facilitate clear comprehension, interpretation, and evaluation of verbal technical and non-technical data.*<br>*To facilitate fluent and precise presentation skills, in social, academic, and professional situations, with correct syntax, lexicon and semantics.* | |
| | **Contents:**<br>2.1 Vocabulary Building<br>a) Meaning of Words in Context<br>b) Synonyms & Antonyms<br>c) Avoiding redundancy<br>d) Word Form Charts<br>e) Prefixes & Suffixes<br>2.2 Grammar<br>a) Identifying Common Errors<br>b) Subject - Verb Agreement<br>c) Articles<br>d) Preposition<br>e) Pronunciation | |
| | ***Self-Learning Topics:***<br>*Maintain a journal of new vocabulary; add, learn and apply in conversation 3 new words daily.* | |
| | ***Learning Outcomes:*** | |
| | *A learner will be able to*<br>*LO2.1: Identify the commonly found grammatical errors in the written and spoken format of communication. (9.1.1)*<br>*LO2.2: Apply appropriate words and parts of speech such as prefixes, suffixes, synonyms and antonyms in the written and oral form of communication. (9.2.2)*<br>*LO2.3: Eliminate the use of pleonasms, tautologies and redundancies during communication (9.1.3)*<br>*LO2.4: Employ proper idioms, proverbs and clichés in their written and spoken communication (9.1.3)* | |

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| | *LO2.5: Listen to grammatically correct input, understand and analyse the same (11.3.1)* | |
| **03.** | ***Developing Basic Language Skills-LSRW Skills***<br><br>***Learning Objective:***<br>*To listen, read, write, summarise and present concrete technical and non-technical data precisely with minimum errors keeping the audience in mind.*<br><br>*To comprehend the need for ethical concepts such as Plagiarism checks and Copyright in professional writing.*<br><br>*To generate and deliver a speech and/or presentation using both rational and out of the box thinking.* | **4-6** |
| | **Contents:**<br>3.1 Listening Skill-<br>Listening to recordings of Formal and Informal communication situations and Activity sheets (Listening Tasks with Recordings and Activity Sheets)<br>3.2 Speaking Skill-<br>Developing and Delivering Short Speeches, Informative Speeches (that center on people, events, processes, places, or things), Persuasive Speeches (to persuade, motivate or take action) and Special Occasion Speeches- (anchoring, hosting, compering events in institute)<br>a) Pair-work Conversational Activities / Role play<br>b) Introducing Self and/or a Classmate<br><br>3.3 Reading Skill<br>Reading Short and long passages for comprehension<br>3.4 Writing Skill-<br>Summarization of non-technical passages, reports.<br>Writing review of Short Stories- *Lamb to the Slaughter- by Roald Dahl, The Green Leaves* by Grace Ogot, *Uncle Podger Hangs a Picture* by Jerome K Jerome, R.K. Narayan (*Malgudi Days*), Ruskin Bond (*Celestial Omnibus*)<br>a) Graphic Organizers for Summaries<br>i. Radial Diagrams like Mind Maps ○ Flow Charts ○ Tree Diagrams Cyclic Diagrams<br>ii. Linear Diagrams like Timelines ○ Pyramids ○ Venn Diagrams<br>b) Point-form Summaries<br>c) One-sentence Summaries of Central Idea<br>3.5 Intellectual Property Rights -<br>a) Understanding the importance of Copyrights<br>b) Paraphrasing, referencing and In-text citations<br>c) Running a Plagiarism Check on Paraphrased Passages | |
| | ***Self-Learning Topics:***<br><br>*Read either autobiography or biography of A.P.J. Kalam, Nelson Mandela, or any such revolutionary thinker and write its summary* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO 3.1: Listen to team members, peers respectfully, without prejudice to understand ideas and opinions. (8.2.2, 8.2.3, 9.2.1)* | |

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| | *LO3.2: Read and comprehend long/short, technical/non-technical passages. (9.1.1)*<br>*LO3.3: Comprehend and derive appropriate answers to the questions related to each passage. (9.2.1)*<br>*LO3.4: Analyse and derive significant information from a given passage (9.1.1)*<br>*LO3.5: Summarise passages in paragraph format and as graphical organisers (9.1.3)*<br>*LO3.6: Identify the utility and importance of Copyrights (7.2.2, 9.3.1, 11.1.1)*<br>*LO3.7: Generate plagiarism reports by running a plagiarism check (7.2.2, 9.3.2, 11.3.1)* | |
| **04.** | ***Business Correspondence***<br><br>***Learning Objectives:***<br>*To train in writing strategies for comprehensive academic and business correspondence.*<br>*To promote competent writing skills in business, technology and academic areas using effective media.*<br>*To find and fill gaps in knowledge required for basic written business correspondence and continued professional growth.* | **6-8** |
| | **Contents:**<br><br>4.1. Seven Cs of Business Correspondence<br>1) Completeness<br>2) Conciseness<br>3) Consideration<br>4) Concreteness<br>5) Clarity<br>6) Courtesy<br>7) Correctness<br>4.2. Parts of a Formal Letter and Formats<br>1)Parts/Elements of a Formal Letter<br>i. Letterheads and/or Sender's Address<br>ii. Dateline<br>iii. Reference Number<br>iv. Inside Address<br>v. Attention Line (Optional)<br>vi. Salutation<br>vii. Subject Line / Caption Line / Reference Line<br>viii. Body of the Letter<br>ix. Complimentary Close<br>x. Signature Block<br>xi. Identification Marks<br>xii. Enclosures/Attachments<br>xiii. Carbon Copy Notation (courtesy copy)<br>xiv. Postscript<br>2)Complete/ Full Block Format<br><br>4.3 Emails<br>1) Format of Emails<br>2) Features of Effective Emails<br>3) Language and style of emails<br><br>4.4 Types of Letters in Both Formal Letter Format and Emails -<br>1) Enquiry letter (internship, placement, workshop)<br>2)Request/Permission Letters<br>(Leave letter, apology letter, seeking permission for facilities) | |

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| | ***Self-Learning Topics:*** *Collect Official letters and evaluate them for language, tone, format and content* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Apply the 7 C's of Business correspondence? Why is 'You attitude' important in business communication? (7.1.1, 7.2.2)*<br>*LO 4.2: Write a Sales/Complaint/Adjustment/Request letter using the correct format. (9.3.2)*<br>*LO 4.3: Generate a job application letter? State: How does it promote your growth? (11.1.1* | |
| **05.** | ***Basic Technical Writing***<br>*Learning Objective/s*:<br>*To promote effective technical writing skills in business, technology and academic arenas.*<br>*To create easy to understand technical documents with logical flow of ideas keeping the end user in mind.*<br>*To identify gaps in research papers and attempt to source information for the same*. | **4-6** |
| | **Contents:**<br>5.1. Introduction<br>1) What is Technical Writing?<br>2) Importance and Principles of Technical Writing<br>3) Difference between Technical Writing & Literary Writing<br>4) Framing Definitions<br><br>5.2. Writing User Instructions<br>1) User Instructions<br>2) Hazard Notations /Special Instructions-<br>(Note, Precaution Warning, Caution and Danger)<br><br>5.3 Basics of Research Methodology<br>Importance of Research, Types of research, How to select topic?<br>1) Structure of a Technical Research Paper<br>2) Referencing styles (APA, IEEE) | |
| | ***Self-Learning Topics:*** *Collect User Manuals and study them for language and tone of instructions, hazard notations, and order of instructions.* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Delineate the difference between technical writing, academic writing and literary writing. (9.1.1)*<br>*LO5.2: Frame clear definitions (9.1.3)*<br>*LO5.3: Write and present a clear set of instructions for the end user for a particular task (9.1.3, 9.2.2)*<br>*LO5.4Critically choose a research topic and write a research paper (11.3.1)* | |

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| | **Activities for Practical:**<br>*1. Listening skill - Listening to audio and video content of various types like Monologues, dialogues, formal talk and discussion about the same.*<br>*2. Self-Introduction and introducing others - Learning formal self-introduction and introducing colleagues through practice activity.*<br>*3. Group Discussion on various relevant topics - Minimum three rounds to be conducted for facilitating enough practice.*<br>*4. Debates on several relevant issues- Two rounds to be conducted.*<br>*5. Selection of Ethical Case Study, Analysis, discussion and report documentation.*<br>*6. Reading of short stories, writing summaries and learning to critically evaluate the stories – Students will be given selected list of short stories and guided for writing summaries after critical evaluation of the same.*<br>*7. Selecting a socio-psychological or socio-technical or socio economic problem, creating a short paper in the relevant format. Detailed discussion about format for technical paper will be held. Students will create a short research paper using the given template.*<br>*8. Team activity: Poster Presentation on a specific theme based awareness creation-students will work as a team of 4 members to create the poster as per the given guidelines, followed by presentation.*<br>*9. Assignment on Business Correspondence- practice for drafting various business letters*<br>*10. Assignment on writing accurate technical instructions for the end user.* | **4**<br>**2**<br>**6**<br>**4**<br>**2**<br>**2**<br>**2**<br>**4**<br>**2**<br>**2** |
| | **Course Conclusion** | **01** |
| | **Total** | **60** |

**Performance Indicators:**

**P.I. No.P.I. Statement**

7.1.1 Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2 Examine and apply moral & ethical principles to known case studies
8.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.2.2 Treat other team members respectfully
8.2.3 Listen to other members
8.2.4 Maintain composure in difficult situations
9.1.1 Read, understand and interpret technical and non-technical information
9.1.3 Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.1 Listen to and comprehend information, instructions, and viewpoints of others
9.2.2 Deliver effective oral presentations to technical and non-technical audience
9.3.1 Create technical figures, reports with data to complement reports and presentation
9.3.2 Use a variety of media effectively to convey a message in a document or a presentation
11.1.1 Describe the rationale for the requirement for continuing professional development
11.3.1 Source and comprehend technical literature and other credible sources of information

**Course Outcomes:** A learner will be able to -

1. Evaluate information they listen to and express their ideas ethically and with greater clarity.
2. Present convincingly before an audience using accurate and appropriate lexis and .

enhanced digital content.
3. Read and analyse objectively, summarize graphically and paraphrase effectively.
4. Communicate effectively and ethically along the various channels of communication within a business organization and follow the general code of conduct and professional etiquette of the organization.
5. Write a set of effective and easy to understand academic articles and technical instructions and convey the same using global information technology and Netiquette.
6. Conduct ably and ethically within the social circles with empathy and confidence, thus exhibiting a well-groomed and balanced personality

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AEC201.1 | | | | | | | | 3 | 3 | | 2 |
| AEC201.2 | | | | | | | | | 3 | | |
| AEC201.3 | | | | | | | | | 3 | | 2 |
| AEC201.4 | | | | | | | 3 | | 2 | | 2 |
| AEC201.5 | | | | | | | | | 3 | | 2 |
| AEC201.6 | | | | | | | 2 | 3 | 2 | | 2 |
| **Average** | | | | | | | 3 | 3 | 3 | | 2 |

**Text Books :**

1. SanjayKumar&PushpLata(2018).CommunicationSkills,NewDelhi:OxfordUniversityPress
2. Rizvi, A. M. (2010). Effective Technical Communication: A guide for Scientists and Engineers.
3. Dahl, R. (1953), "Lamb to the Slaughter". Harper's Magazine. Harpers.

"The Green Leaves", Land without Thunder, Short Story by Grace Ogot, East African

4. Publishing House, Kenya, 1068

**IN- SEMESTER ASSESSMENT (50 Marks)**

1. Speaking Listening
   GD/Debating Skills + group dynamics (10)
2. Ethical Case Study a project (10)
   (Continuous work as individual with set due date)
3. Critical Analysis of a SS or novella + report (Individual) (10)

   **OR**

   Short Technical Paper on any socio Technical problem,Presentation 7 minutes. (Individual) (10)
4. Poster Presentation on a given theme teams of 4 Students can choose any 2 out of 3 (10 marks each)
5. Assignments until End Semester syllabus (05)
6. Regularity and active participation (05)

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| ESC | ESC203 | BASIC ELECTRONICS ENGINEERING | 02 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 15 | 20 | 40 | 1 | 1.5 | 75 |

**Pre-requisite:**

1. ESC102- Basics of Electrical Engineering
2. BSC102- Engineering Physics-I

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solutions
4. PO11: Life-long learning

**Course Objectives:**

1. To impart the knowledge to demonstrate competence in comprehending the concepts of semiconductor diodes and solve the problems to analyse its applications.
2. To demonstrate the ability to execute a solution process and analyse results to design real life applications such as an amplifier, switch, etc.
3. To introduce number system and use logic gates to analyse and design circuits for a given expression.
4. To recognize the utilisation of measuring devices and its working.
5. To introduce various transducers and sensors to adapt to the current technologies regarding new developments in the relevant fields.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>Electronics is a branch of engineering that has grown exponentially in recent years, and now electronics has become a very important part of our lives. This is foundation course deals with fundamental concepts of semiconductors devices, transistors, number system, logic gates, measuring instruments, transducers and sensors. With the growing popularity and production of electric vehicles (EVs) in India, it is projected that semiconductor use in fields including safety, electrification, communication, and networking would rise. | **01** |
| **01.** | **Introduction to Basic Electronic system** | **5-7** |

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| | ***Learning Objective:***<br>1. *To demonstrate competence in engineering fundamentals and specialized engineering knowledge to comprehend the concepts of semiconductor diodes.*<br>2. *To identify the engineering systems, variables, and parameters to solve the problems for analyzing the applications of semiconductor diodes.* | |
| | **Contents:**<br>Semiconductor Diode - Ideal versus Practical, Characteristics and Parameters, Diode Approximations, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Diode as clipper and clampers; Zener diode- Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications. | |
| | ***Self-Learning Topics:*** *LASER diode* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Apply fundamental engineering concepts to comprehend the characteristics and parameters of semiconductor diodes. (P.I.-1.3.1)*<br>*LO 1.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend diode equivalent circuit and its load line analysis. (P.I.-1.4.1)*<br>*LO 1.3: Identify engineering systems to analyze the applications of diode such as switch, rectifier, clipper, clampers etc. (P.I.-2.1.2)*<br>*LO 1.4: Identify existing methods for analyzing voltage, currents of zener diode and opto –electronic devices. (P.I.-2.2.3)* | |
| **02.** | **Introduction to Transistor**<br>***Learning Objective:***<br>***1.*** *To demonstrate competence in engineering fundamentals and specialized engineering knowledge to comprehend the concepts of bipolar junction transistor.*<br>***2.*** *To identify the engineering systems, variables, and parameters for analyzing the applications of bipolar junction transistor as an amplifier and also as a switch.* | **6-8** |
| | **Contents:**<br>Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Potential Divider Bias circuit; DC load line analysis, Q point, comparison of characteristics of transistors in different configurations, Applications: Transistor as an amplifier, transistor as a switch. | |
| | ***Self-Learning Topics:*** *Self-biasing.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Apply fundamental engineering concepts to comprehend the concept of biasing with potential divider bias circuit. (P.I.-1.3.1)* | |

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| | *LO 2.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend the types and characteristics of bipolar junction transistor. (P.I.-1.4.1)*<br>*LO 2.3: Identify engineering systems to find gain, operating point of bipolar junction transistor etc. (P.I.-2.1.2)*<br>*LO 2.4: Identify solution methods to use bipolar junction transistor as an amplifier and switch. (P.I.-2.2.3)* | |
| **03.** | **Introduction to Number system and Logic gates**<br>***Learning Objective:***<br>*1. To analyze the number systems, different types of numbers and Boolean algebra.*<br>*2. To Demonstrate the ability to generate alternative design solutions using logic gates.* | **5-7** |
| | **Contents:**<br>Number System: Binary Numbers systems, Decimal to Binary and Binary to Decimal Conversion, BCD, Octal and Hexadecimal numbers, Negative numbers representation, 1's, 2's, Complements, BCD codes, Excess-3 code, Gray code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Logic gates: Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs). | |
| | ***Self-Learning Topics:*** *Flip- flops* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Integrate mathematical tools to perform conversion in number System. (P.I.- 2.2.2)*<br>*LO 3.2: Compare alternative solutions to select the best methodology to implement logic gates. (P.I.-2.2.4)*<br>*LO3.3: Determine design objectives to implement electronic circuits using logicgates (P.I.-3.1.6)*<br>*LO3.4: Apply formal design principles to build simplified circuits using universal gates. (P.I.-3.3.3)* | |
| **04.** | **Electronic Instruments**<br>***Learning Objectives:***<br>*To comprehend the working of CRO, DSO, function generators, power supply and access sources to read technical datasheets of instruments.* | **1-3** |
| | **Contents:**<br>Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration. | |
| | ***Self-Learning Topics: ----*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Apply concepts of electronics and communication engineering and allied* | |

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| | *disciplines to comprehend the working principle of CRO and DSO. (P.I.-1.4.1)*<br>*LO 4.2: Comprehend technical datasheets of instruments. (P.I.-11.3.1)* | |
| **05.** | **Introduction to Transducers**<br>***Learning Objective/s:***<br>*To demonstrate competence in engineering fundamentals to introduce the concept transducer for the desired application.* | **2-4** |
| | **Contents:**<br>Transducers, classification of transducers, selection of transducers, Resistance- temperature detector (RTD), inductive transducers, Linear variable differential transformer (LVDT). | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Apply fundamental engineering concepts to comprehend the concept of transducers and its working. (P.I.-1.3.1)*<br>*LO 5.2: Apply concepts of electronics and communication engineering to comprehend various types of transducers used in electronics. (P.I.-1.4.1)* | |
| **06.** | **Introduction to Sensors**<br>***Learning Objective/s:***<br>*To demonstrate competence in engineering fundamentals to comprehend the concepts of sensor as per the application.* | **3-5** |
| | **Contents:**<br>Definition, Classification & selection of sensors, Proximity sensors: Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors: Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive. | |
| | ***Self-Learning Topics:*** *Sensors used in IOT.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: Apply laws of natural science to an engineering problem to understand the concept of sensors. (P.I.-1.2.1)*<br>*LO 6.2: Apply concepts of electronics and communication engineering and allied disciplines to comprehend the types of sensors. (P.I.-1.4.1)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply concepts of electronics and communication engineering and allied disciplines to solve engineering problems. |

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| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.2 | Identify/ assemble/integrate mathematical tools to information and resources. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions. |
| 2.2.4 | Compare and contrast alternative solutions to select the best methodology. |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications. |
| 3.3.3 | Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications. |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information. |

**Course Outcomes:** A learner will be able to -

1. Apply the fundamentals of engineering to demonstrate the concepts of semiconductor diodes and analyse its applications. *(LO 1.1, LO 1.2, LO1.3, LO1.4*)
2. Apply the fundamentals of engineering to design transistor-based applications such as an amplifier, switch, etc. *(LO 2.1, LO 2.2, LO2.3, LO2.4*)
3. Formulate mathematical models to introduce number system and use logic gates to design circuits for a given expression. *(LO 3.1, LO 3.2, LO3.3, LO3.4*)
4. Recognize the utilisation of measuring devices and its working. *(LO 4.1, LO 4.2*)
5. Apply the fundamentals of engineering to introduce various transducers and sensors to adapt to the current technologies regarding new developments in the relevant fields. *(LO 5.1, LO 5.2, LO6.1, LO6.2*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESC203.1 | 3 | 3 | | | | | | | | | |
| ESC203.2 | 3 | 3 | | | | | | | | | |
| ESC203.3 | | 3 | 3 | | | | | | | | |
| ESC203.4 | 2 | | | | | | | | | | 2 |
| ESC203.5 | 3 | | | | | | | | | | |
| **Average** | 3 | 3 | 3 | | | | | | | | 2 |

**Text Books :**

1. Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India, 3rd edition, 2019.
2. Electronics A Systems Approach, Neil Storey, 2011, 4th edition, Pearson Education Publishing Company Pvt. Ltd.

3. Electronic Devices and Circuits, Salivahanan, N Suresh Kumar, 2013, 3rd edition, McGraw Hill Publications.

4. Basic Electronics & Linear Circuits, Bhargava N. N., D C Kulshreshtha and S C Gupta, 2013, 2nd edition, Tata McGraw Hill.

5. Electronic Devices and Circuit Theory Robert L. Boylestad Louis Nashelsky,11th edition, Pearson New International Edition.

**Reference Books :**

1. Electronic Devices and Circuits, David A Bell, 2016, 5th Edition, Oxford.
2. The Art of Electronics 3rd Edition by Horowitz and Hill, 3rd edition, 2015.
3. Digital Logic and Computer Design, M. Morris Mano, 2008 ISBN-978-81-203-0417-8, PHI Learning.
4. Electronic Instrumentation and Measurements (3rd Edition) – David A. Bell, 2013, Oxford University Press.
5. Electronic Communication Systems, George Kennedy, 4th Edition, TMH, 2009.

**Other Resources :**

1. NPTEL Course: Introduction to Basic Electronics By Prof. T.S. Natarajan, Basic Electronics andLab, IIT Madras :-Web link- https://nptel.ac.in/courses/122106025
2. NPTEL Course: Digital Electronic Circuits By Prof. Goutam Saha, NOC:Digital ElectronicCircuits, IIT Kharagpur :-Web link- https://nptel.ac.in/courses/108105132
3. NPTEL Course: Introduction to Microcontrollers & Microprocessors By Prof. Dr. S.P. DasMicrocontrollers and Applications, IIT Kanpur :- Web link- https://nptel.ac.in/courses/107/106/10710608

**IN-SEMESTER ASSESSMENT (50 MARKS)**

**1. Continuous Assessment - Theory-(20 Marks)**

1. *Numerical Assignment/s (min 20 problems) – 04 Marks*
2. *Class test based on above numerical assignment – 04 Marks*
3. *Open book test/ Open notes test: 04 Marks*
4. *Regularity and active participation:05 Marks*

**2. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 30% weightage, and the syllabus covered from MSE to ESE carrying 70% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| BSC-LC | BSL203 | ENGINEERING PHYSICS-II LABORATORY | 0.5 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 25 | - | - | - | - | 25 |

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO4: Conduct investigations of complex problems
3. PO8: Individual and Collaborative Team Work
4. PO9: Communication

**Course Objectives:**

1. To demonstrate the fundamental concepts of physics and evaluate the process of an experiment/project quantitatively and qualitatively.
2. To improve the knowledge gained in the theory course.
3. To develop the abilities of modelling, measurements, observations and analysing data.
4. To develop the experimental skill in assembling and handling laboratory instruments.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction** | **01** |
| **01.** | **Experiment 1**<br>***Learning Objective:***<br>*To apply the concept of miller indices to identify principal crystal planes. To determine the interplanar distance in simple cubic structure.*<br>**Contents:**<br>Miller Indices: Study of miller indices for planes in simple cubic structure.<br>***Learning Outcome:***<br>*LO1.1: A learner will be able to apply the concept of miller indices and analyze principal crystal planes to determine the interplanar distance in simple cubic structure. (P.I.- 1.2.1, 1.2.2, 4.3.1, 4.3.3)* | **02** |
| **02.** | **Experiment 2**<br>***Learning Objective:***<br>*To simulate XRD pattern for a given crystal system* | **02** |

| | | |
|---|---|---|
| | **Contents:**<br>X-ray Diffraction: Simulation of X-ray Diffraction (XRD) pattern of a material.<br>***Learning Outcome:***<br>*LO2.1. A learner will be able to apply the knowledge of x-ray diffraction and analyze the crystal structure by simulating XRD pattern for various materials using software and write the result. (P.I.- 1.2.1, 1.2., 4.1.3, 4.3.3)* | |
| **03.** | **Experiment 3**<br>***Learning Objective:***<br>*1. To apply the knowledge magnetic materials in order to study the phenomena of magnetic hysteresis.*<br>*2. To gain the knowledge of importance of hysteresis loop.*<br>**Contents:**<br>Magnetization: Drawing hysteresis curve (B-H curve) of a magnetic material.<br>***Learning Outcome:***<br>*LO 3.1: A learner will be able to apply basic concepts of magnetization and analyze the B-H curve of a ferromagnetic material to determine the loss of energy per unit volume to magnetize the material and write the result. (P.I.- 1.2.1, 1.2., 4.3.1, 4.3.3).* | **02** |
| **04.** | **Experiment 4**<br>***Learning Objectives:***<br>*1. To apply the knowledge of dielectric materials.*<br>*2. To determine the dielectric constant of a given material.*<br>**Contents:**<br>Dielectrics: Determination of dielectric constant of a given material.<br>***Learning Outcome:***<br>*LO4.1: A learner will be able to apply the knowledge of dielectrics and analyse experimental data to determine the dielectric constant of the given material and write the result. (P.I.- 1.2.1, 1.2.2, 4.3.1, 4.3.3)* | **02** |
| **05.** | **Experiment 5**<br>***Learning Objective/s:***<br>*To simulate and visualize nanostructures.*<br>**Contents:**<br>Nanomaterials: Simulation experiment for structure of nanomaterials.<br>***Learning Outcome :***<br>LO5.1: *A learner will be able to apply the knowledge of nanomaterials and analyse the structure of the nanomaterials using simulation software and write the result. (P.I.- 1.2.1, 1.2., 4.1.3, 4.3.3)* | **02** |
| **06.** | **Course Project**<br>***Learning Objective/s:***<br>*1. To apply various concepts of physics in a project.*<br>*2. To execute the chosen project through practical demonstration* | **03** |

| | | |
|---|---|---|
| | **Contents:**<br>Report writing and Demonstration of the project. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1: apply the concepts of physics to execute, demonstrate and present the project effectively as a team. (P.I.- 1.2.1, 1.2.2, 4.2.1, 4.3.1, 8.1.2, 8.3.1,9.1.2, 9.2.2)* | |
| | **Course Conclusion** | **01** |
| | **Total** | **15** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.2.1 | Apply laws of physics to an engineering problem. |
| 1.2.2 | Apply the formulae derived from the concept to solve engineering problem. |
| 4.1.3 | Apply appropriate instrumentation and/or software tools to make measurements of physical quantities. |
| 4.2.1 | Design and develop experimental approach, specify appropriate equipment and procedures. |
| 4.3.1 | Use appropriate procedures, tools and techniques to conduct experiments and collect data. |
| 4.3.3 | Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions. |
| 8.1.2 | Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective teamwork, to accomplish a goal. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |
| 9.1.2 | Produce clear, well-constructed, and well- supported written engineering documents. |
| 9.2.2 | Deliver effective oral presentations to technical and non- technical audiences. |

**Course Outcomes:**

1. Learners will be able to apply the fundamental knowledge of different materials to determine various parameters through relevant experiments.
   (*LO 1.1, LO3.1, LO 4.1*)

2. Learners will be able to apply the basic concept of different materials to simulate their structures and diffraction pattern using relevant software. (*LO 2.1, LO5.1*)

3. Learners will be able to use fundamental knowledge of physics for the execution, presentation of the chosen project as a team and write effective report. (*LO 6.1*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSCLC203.1 | 3 | | | 3 | | | | | | | |
| BSCLC203.2 | 3 | | | 3 | | | | | | | |
| BSCLC203.3 | 3 | | | 3 | | | | | | | |
| BSCLC203.4 | 3 | | | 3 | | | | 3 | 3 | | |
| **Average** | 3 | | | 3 | | | | 3 | 3 | | |

**Text Books :**

1. A Textbook of Engineering physics, Dr. M. N. Avadhanulu and Dr. P. G. Kshirsagar Revised Edition, 2014, S. Chand Publishing.
2. Engineering physics, R. K. Gaur and S. L. Gupta, Revised Edition, 2012, Dhanpat Rai Publications.

**Reference Books :**

1. Fundamentals of Physics, Halliday /Resnick/Walker, Twelve Edition, 2021, Wiley
2. Introduction to solid state physics, Charles Kittel, Eighth Edition, 2005, Wiley
3. Introduction to nanotechnology, Charles P Poole and Frank J Owens, 1st Edition, Wiley-Interscience.

**Other Resources :**

1. Online physics library, California State University:-Web link- https://phys.libretexts.org/
2. Physics website, The State University of New Jersey :-Web linkwww.physics.rutgers.edu

**IN-SEMESTER ASSESSMENT (25 MARKS)**

1. Lab Performance: 10 marks
2. Project (Final Report and Demonstration): 10 marks
3. Regularity and active participation: 5 marks

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| BSL | BSL204 | ENGINEERING CHEMISTRY II LABORATORY | 0.5 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Examination (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 25 | - | 25 | 25 | - | 25 |

**Pre-requisite: Nil**

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge:
2. PO2: Problem Analysis:
3. PO6: The engineer and the world
4. PO8: Individual and collaborative teamwork

**Course Objectives:**

1. To enable the students to apply the laws of chemistry to an engineering problem.
2. To acquaint the students with practical knowledge of the basic concepts of chemistry to gainexperimental skill.
3. To enable the students to utilize the fundamental laboratory techniques for analysis.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>1. Code of conduct in chemistry laboratory<br>2. Safety and precautions to be observed in chemistry laboratory<br>3. Orientation on evaluation of laboratory performance | **01** |
| **01.** | **Experiment 1**<br>***Learning Objective/s:***<br>***To calculate percentage of iron in plain carbon steel and relate it with the classification of plain carbon steel.*** | **02** |
| | To determine the percentage of iron present in a plain carbon steel | |
| | ***Learning Outcomes:***<br>*LO -1.1 A learner will be able to calculate the percentage of iron in plain carbon steel by redox titration method. (1.2.1), (1.3.1), (2.2.3).* | |
| **02.** | **Experiment 2**<br>*Learning Objective/s:*<br>*To apply the knowledge of condensation polymerization for the synthesis of urea formaldehyde.* | **02** |

| | | |
|---|---|---|
| | **Synthesis of Urea formaldehyde.** | |
| | ***Self-Learning Topics: Nil*** | |
| | ***Learning Outcomes:***<br>*LO-2.1 A learner will be able to synthesize thermosetting resin using condensation polymerization reaction and calculate its yield and state its societal benefits. (1.2.1), (1.3.1), (2.2.3), (6.1.1).* | |
| **03.** | **Experiment 3**<br>*Learning Objective/s:*<br>*To compare the viscosity of pure solvent and the solution of polymer for calculating the molecular weight of polymer.* | **02** |
| | To Determine molecular weight of a polymer using Ostwald's viscometer. | |
| | ***Learning Outcomes:***<br>*LO-3.1 A learner will be able to c*alculate the specific viscosity of polymer with respect to pure solvent and its molecular weight using Ostwald's Viscometer (1.2.1), (1.3.1), (2.2.3). | |
| **04.** | **Experiment 4**<br>*Learning Objective/s:*<br>*To construct the Daniel cell and calculate its $E^0$ using Nernst equation.* | **02** |
| | To determine the emf of galvanic cell-Daniel cell. | |
| | ***Learning Outcomes:***<br>*LO-4.1 A learner will be able to construct and calculate $E^0$ of Daniel cell using electrode reactions and compare with theoretical values to conclude whether Daniel cell is working or not. (1.2.1), (1.3.1), (2.2.3).* | |
| **05.** | **Experiment 5**<br>*Learning Objective/s:*<br>*To determine the concentration of iron and verify Beer Lambert's law.* | **02** |
| | To determine iron from the given sample using UV-Visible spectrophotometer. | |
| | ***Learning Outcomes :***<br>*LO-5.1 A learner will be able to measure the absorbance of standard and unknown concentrations of given analyte using UV-Visible spectrophotometer and verify Beer Lambert's law (1.2.1), (1.3.1), (2.2.3).* | |
| **06.** | ***Demonstration***<br>*Learning Objective:*<br>*To develop the basic knowledge of analytical chemistry using titrimetric experiment.* | **04** |
| | Demonstration of titrimetric experiment and conclusion. | |
| | ***Learning Outcomes:***<br>*LO-6.1 A learner will be able to analyze and calculate the proposed substances in an experiment using fundamental laws and basic concepts of engineering chemistry and demonstrate the results as a team (1.2.1), (1.2.2), (1.3.1),(2.1.3) (8.1.1), (8.3.1).* | |
| | **Total** | **15** |

**Performance Indicators:**

| P.I. No. | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering Problem. |
| 1.2.2 | Apply the formulae based on the concepts of engineering chemistry for solving the numericalproblems. |
| 1.3.1 | Apply fundamental engineering chemistry concepts to solve engineering problems. |
| 2.1.3 | Identify the engineering chemistry concepts to analyze the given problem |
| 2.2.3 | Identify the existing processes/ solution methods for solving the problems |
| 6.1.1 | Identify and describe the various roles of materials particularly as pertains to protection of thepublic and public interest at global, regional and local level |
| 8.1.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team. |
| 8.3.1 | Present result as a team with smooth integration of contributions from all individual efforts. |

**Course Outcomes:** A learner will be able to -

1. Apply the laws of electrochemistry and spectroscopy for performing the practicals. (*LO- 4.1, LO-5.1)*
2. Analyze the materials for engineering applications. (*LO-1.1, LO-3.1, LO-5.1)*
3. Synthesize the polymer and use it for societal benefits. (*LO-2.1)*
4. Demonstrate an ability to work effectively in a team for the project. (*LO-6.1)*

**CO-PO Mapping Table with Correlation Level**

| **CO ID** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BSL204.1 | 3 | 2 | | | | - | | - | | | |
| BSL204.2 | 3 | 2 | | | | - | | - | | | |
| BSL204.3 | 2 | 2 | | | | 2 | | - | | | |
| BSL204.4 | 3 | 2 | | | | - | | 3 | | | |
| **Average** | 3 | 2 | | | | 2 | | 3 | | | |

**Text Books :**

1. Practical book in Engineering Chemistry by Dr. Pijus Khatua and Debashree Singh, First edition, 2016, Platinum Publishers
2. Textbook of green chemistry by AK Ahluwalia, 2008, Ane Book India

**Reference Books :**

1. Experiments in Engineering Chemistry by Payal Joshi, first edition, 2016, I.K. International Publishing House Pvt. Ltd.

**Other Resources :**

1. Online chemistry library for open access text books: https://chem.libretexts.org
2. https://vlab.amrita.edu/?sub=2&brch=190&sim=1546&cnt=1

**IN-SEMESTER ASSESSMENT (25 MARKS)**

1. Lab Performance: 10 Marks
2. Demonstration of the experiment: 10 marks
3. Regularity and active participation: 5 marks

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| ESL | ESL204 | ENGINEERING GRAPHICS LABORATORY | 02 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **End Semester Exam (ESE)** | **Total Marks** |
| 50 | 50 | 100 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO5: Modern tool usage
4. PO9: Communication

**Course Objectives:**

1. To inculcate proper understanding of the theory of projection.
2. To enable students to understand and represent three-dimensional objects on a two-dimensional surface in a way that accurately conveys their shape, size, and orientation.
3. To acquaint students with representing internal features of a three-dimensional object by way of section that accurately conveys their internal orientation.
4. To communicate proper ideas by representing the two-dimensional views into a three dimensional object.
5. To enable students to read and interpret a given orthographic projection to draw the missing view.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>This is foundation course which deals with fundamental concepts of technical drawing and modern tools associated with it. This course will empower the imagination and visualization which will help in communicating the technicality of the product. | **01** |
| **01.** | **Introduction to Engineering Graphics**<br>***Learning Objective:***<br>*To identify different types of lines and dimensioning standards as per IS system.*<br>**Contents:**<br>Principles of Engineering Graphics and their significance, Types of Lines,Dimensioning Systems as per IS conventions<br>Introduction to CAD tool (AutoCAD): An overview of AutoCAD software to make simple drawings.<br>**Experiment:**<br>To demonstrate the basic commands in AutoCAD software. | **08** |
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO 1.1: represent the fundamental drawing essentials such as line types, line weights, dimensioning systems, tolerance, etc. (P.I.-2.2.3)* | |

| | | |
|---|---|---|
| | *LO1.2: Identify standard procedures according to IS conventions. (P.I.-2.2.2)*<br>*LO1.3: Demonstrate the use of basic AutoCAD commands. (P.I.-5.1.1)*<br>*LO1.4: Draw simple drawings with the use of basic AutoCAD commands. (P.I.-5.2.2)* | |
| **02.** | **Name of the Module**<br>***Learning Objective:***<br>*To develop the imagination in creating the orthogonal and sectional orthographic viewsfor communicating the features in the product.*<br><br>**Contents:**<br>2.1 Projection of Points and Lines: Projection of points in different quadrants. Projection of lines keeping the ends in different quadrants.<br>2.2 Orthographic Projections: Concept of First Angle and Third Angle Projection. Fundamentals of Orthographic Projections. Different views of a simple machine part as per the first angle projection method recommended by I.S. Multi view drawing from pictorial views using CADSoftware (AutoCAD)<br>2.3 Sectional Orthographic Projections: Full or Half Sectional views of the Simple Machine parts. Sectional view using CAD Software (AutoCAD).<br>**Experiment:** To demonstrate the ability to convert the isometric drawings intoorthogonal and sectional orthographic drawings.<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Differentiate between the apparent length and true length of the lines by projecting the lines in a two-dimensional space from different quadrants and represent the procedure in the form of drawing or report. (P.I.-1.3.1,9.3.1)*<br>*LO 2.2: Develop the ability to create orthographic projections of objects in different views, including front, top, and side views. (P.I.-1.4.1,9.1.1)*<br>*LO 2.3: Create sectional orthographic projections of objects including half and full sections. (P.I.-2.1.3, 9.1.1)*<br>*LO 2.4: Demonstrate the application of orthographic and sectional orthographic projections in different fields, including engineering, architecture, and manufacturing by representing them in a report. (P.I.-2.2.3,9.3.1)*<br>*LO 2.5: Demonstrate the use of basic AutoCAD commands. (P.I.- 5.1.1)*<br>*LO2.6: Apply the basics of AutoCAD to create the simple orthographic drawings. (P.I.- 5.2.2,9.3.1)* | **20** |
| **03.** | **Name of the Module**<br>***Learning Objective:***<br>*To develop the ability in visualization of the two-dimensional views of the object to produce the isometric drawing.*<br><br>**Contents:**<br>Isometric Drawing: Principles of Isometric Projection, Isometric Views, Conversion of Orthographic Views to Isometric Views. | **12** |

| | | |
|---|---|---|
| | (Excluding Sphere). Construction of Isometric View from Orthographic views with CAD Software (Auto CAD)<br><br>**Experiment:** To demonstrate the ability to convert the orthographic views into isometricdrawings.<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Identify the nature of simple geometries when plotted on isometric plane. (P.I.- 1.3.1)*<br>*LO3.2: apply the fundamental geometrical procedures from mathematics to draw the given isometric views. (P.I.-1.2.1)*<br>*LO3.3: Develop their ability to visualize three-dimensional objects and represent them on a two-dimensional surface. (P.I.-2.1.3,9.3.1)*<br>*LO3.4: Draw the isometric drawings from the two-dimensional views. (P.I.-2.2.3)*<br>*LO3.5: create isometric drawings of objects in AutoCAD. (P.I.-5.1.1,9.1.1)*<br>*LO 3.6: develop proficiency in the orientation and scale of the object while drawing the AutoCAD (P.I.-5.2.2,9.1.1)* | |
| **04.** | **Name of the Module**<br><br>***Learning Objectives:***<br>***To develop the ability of the students to read the orthographic and sectional orthographicprojections to draw the missing views.***<br><br>**Contents:**<br>Orthographic Reading: The identification of missing views from the givenviews. Creation of the third view from the two available views so that all the details of the object are obtained using CAD Software (AutoCAD).<br><br>**Experiment:** To demonstrate the ability to visualize and interpret the missing views ofOrthographic projections.<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Read and interpret technical drawings that use orthographic and sectionalorthographic projections. (P.I.-,2.2.3,9.1.1)*<br>*LO 4.2: identify the missing view by visualizing the two views in combined manner. (P.I.-1.3.1)*<br>*LO 4.3: redraw the simple orthographic view into sectional orthographic view (P.I.-1.2.1)*<br>*LO 4.4: identify the position and orientation of the missing view. (P.I.-2.2.1)*<br>*LO 4.5: Demonstrate the use of basic AutoCAD commands to produce the missing viewby reading the orthographic projections on a two-dimensional space. (P.I.- 5.1.1, 9.3.1)*<br>*LO 4.6: use the theory of projection efficiently to create the missing view in AutoCAD (P.I.-5.2.2)* | **05** |
| **05.** | **Name of the Module**<br><br>***Learning Objective/s:***<br>*To develop the ability to imagine the solid geometries and represent the views in a twodimensional space.* | |

| | | |
|---|---|---|
| | **Contents:**<br><br>1.1 Projection of Planes: Projection of Triangular, Square, Rectangular, Pentagonal, Hexagonal or Circular planes inclined to either HP or VP only.<br><br>1.2 Projection of Solids: Solid projection (of Prism, Pyramid, Cylinder, Cone only) with the axis inclined to HP or VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method.<br><br>1.3 Section of Solids: Section of Prism, Pyramid, Cylinder and Cone cut by plane perpendicular to at least one reference plane and incline to other in simple positions of the solid. (Section in initial position only) | **14** |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br><br>*LO 5.1: create orthographic projections of planes and different types of solids. (P.I.- 1.3.1)*<br><br>*LO 5.2: create different views of solid geometries. (P.I.-1.2.1)*<br><br>*LO 5.3: develop the ability to create auxiliary views, which are used to show the true shape and size of features that are not parallel to the principal planes of projection (P.I.-2.2.4,9.1.1)*<br><br>*LO 5.4: create section views of solids using different cutting planes in different orientations and represent them in the form of two-dimensional drawings. (P.I.- 2.2.3,9.3.1)* | |
| | **Total** | **60** |
| **MINIMUM 2 experiments should be conducted from each module.** | | |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply mechanical engineering concepts to solve engineering problems. |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem. |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions. |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities |
| 5.2.2 | Demonstrate proficiency in using discipline specific tools. |
| 9.1.1 | Read, understand and interpret technical and non-technical information. |
| 9.3.1 | Create engineering-standard figures, reports and drawings to complement writing and presentations. |

**Course Outcomes:** A learner will be able to -

1. Apply the basic concepts and standards in accordance with IS conventions and demonstrate basic commands using AUTOCAD. (LO 1.1, LO 1.2, LO1.3, LO1.4, LO 2.1)

2. Apply the basic principles of projections in converting pictorial views into orthographic Views and draw using AUTOCAD. (LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5, LO 2.6, LO 5.1, LO 5.2)
3. Apply the basic principles of projections in converting orthographic Views into isometric drawing using conventional method and AUTOCAD. (LO 2.2, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6)
4. Represent the internal features of the objects by providing the sectional views of the object. (LO 2.3, LO 2.4, LO 5.1, LO 5.2, LO 5.3, LO 5.4)
5. Apply the basic principles of projections to draw the missing views using AUTOCAD. (LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5, LO 4.6)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESL204.1 | 2 | 3 | | | 3 | | | | 2 | | |
| ESL204.2 | 3 | 3 | | | 3 | | | | 2 | | |
| ESL204.3 | 3 | 3 | | | 3 | | | | 3 | | |
| ESL204.4 | 3 | 3 | | | | | | | 3 | | |
| ESL204.5 | 3 | 3 | | | 3 | | | | 3 | | |
| **Average** | 3 | 3 | | | 3 | | | | 3 | | |

**Text Books :**


1. Engineering Drawing (Plane and solid geometry), N.D. Bhatt, 54th Edition, 2023, CharotarPublishing House Pvt. Ltd.
2. Engineering Drawing, N.H.Dubey, 16th Edition, 2015, Nandu Publications
3. Machine Drawing, N.D. Bhatt & V.M. Panchal, 49th Edition, 2014, Charotar Publishing HousePvt. Ltd.


**Reference Books :**


1. Engineering Drawing, Narayana, K.L. & P Kannaiah ,3rd Edition, 2012, Scitech Publisher
2. AutoCAD 2024: A Problem-Solving Approach, Basic and Intermediate, , Prof. Sham Tickoo,30th Edition, 2023, CADCIM Technologies


**Other Resources :**

1. NPTEL Course: Engineering Drawing by Prof. P.S. Robi, Department of Mechanical Engineering, IIT Guwahati:-Web link- https://nptel.ac.in/courses/112103019.
2. NPTEL Course: Engineering Graphics and Design by Prof. S.R.Kale, Department of

Mechanical Engineering, IIT Delhi :-

Web link- https://onlinecourses.nptel.ac.in/noc21_me128

**IN-SEMESTER ASSESSMENT (50 MARKS)**

1. **AutoCAD Assignments (10 Marks):** AutoCAD assignments will be evaluated as a part of continuous laboratory experiments which will be done in AutoCAD software. The Assignments will be based on the following topics:
    i. Redraw the given views using basic AutoCAD Commands. (2 Problems)
    ii. Orthographic Projections (2 Problems)
    iii. Sectional Orthographic Projections (2 Problems)
    iv. Isometric Projections (3 Problems)
    v. Reading of Orthographic Drawings (1 Problems)

2. **Sketchbook Assignments (10 Marks)*:*** Regular Assignments will be given based on the topic covered in the class and will be evaluated at regular intervals as a part of continuous assessment. The Assignments will be based on the following topics:
    1) Projection of Lines (2 Problems)
    2) Orthographic Projections (2 Problems)
    3) Sectional Orthographic Projections (2 Problems)
    4) Reading of Orthographic Projections (1 Problems)
    5) Isometric Projections (2 Problems)
    6) Projection of Planes (2 Problems)
    7) Projections of Solids (2 Problems)
    8) Section of Solids (2 Problems)

3. **Regularity and active participation: 5 marks**

4. **Class Tests (25 Marks) :**

    1. **AutoCAD (15 Marks):** The test will be based on Orthographic Projections on AutoCAD software.

        **Evaluation Criterion:**

        1. Completion and accuracy of the drawing.
        2. Presentation of labels, dimensions, title block on the sheet.

    2. **Manual Drawing Exam (10 Marks):** The test will be based on projections of lines and projections of Solids.

        **Evaluation Criterion:**

        1. Completion and accuracy of the drawing.
        2. Neatness of the drawing.
        3. Proper space management of the sheet.

**END SEMESTER EXAMINATION (50 MARKS)**

**Topic for the End Semester Practical Examination (Auto CAD) (2.5 hours)**

1. **Isometric drawing. (1 problem) (20 Marks) (Excluding the curves on an inclined plane):**

   The two-dimensional views will be provided such as Front view, Top View and Side view of the object. The task will be to convert the given views in to an isometric drawing (three-dimensional model)

2. **Sectional Orthographic Projection (1 problem). (15 Marks):**

   An isometric figure will be given and the task will be to convert the isometric figure in a sectional 2D view which will include the sectional Front view, Top View and Side view of the three-dimensional figure.

3. **Reading of Orthographic Projections (1 problem) (15 Marks):**

   The two views of the model will be given as an AutoCAD file and the task will be to generate the missing view of the drawing.

**Note:**

**1. Printout of the answers have to be taken preferably in A4 size sheets and should be assessed by External Examiner only.**

**2. Knowledge of Auto CAD software, concepts of Engineering Graphics related to specified problem and accuracy of drawing should be considered during evaluation.**

Two examiners, one Internal and one External will do the evaluation

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **ESL** | ESL205 | PROGRAMMING LABORATORY-II (JAVA) | 02 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **End Semester Exam(ESE)** | **Total Marks** |
| 50 | 50 | 100 |

**Pre-requisite:**

1. ESL103: Programming Laboratory-I ( C )

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO5: Engineering tool usage
5. PO11: Life-long learning

**Course Objectives:**

1. To impart the knowledge in object-oriented paradigm in the Java programming language.
2. To inculcate the importance of Classes & objects along with constructors,
3. To impart skills of inheritance, interface and packages and demonstrate the concept of reusabilityfor faster development.
4. To introduce usage of Exception Handling, Multithreading, Input Output streams in variousapplications.
5. To impart the knowledge of designing, implementing, testing, and debugging graphical userinterfaces in Java using Swings and AWT components that can react to different user events.

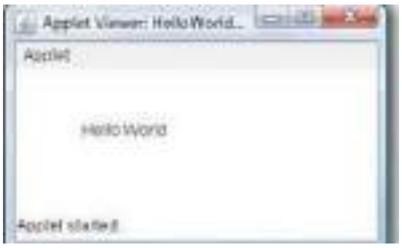
| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction** Java is platform independent, open-source object oriented programming language enriched with free and open source libraries. In current industrial scenario Java has the broad industry support and is prerequisite with many allied technologies like Advanced Java, Java Server Pages, and Android Application Development. Thus, current industrial trends necessitate acquiring Java knowledge for graduates. | **01** |
| **01.** | **Introduction to Java**<br>***Learning Objective:***<br>***Learner is expected to gain proficiency in concept like programming tokens like variables, data types, operators, control structures, function. Also expected to apply the concepts for writing program*** | **11** |
| | **Contents:**<br>OOP concepts: Objects, class, Encapsulation, Abstraction, Inheritance, Polymorphism, message passing.<br>Java development kit, Java Virtual Machine, Garbage collection in java | |

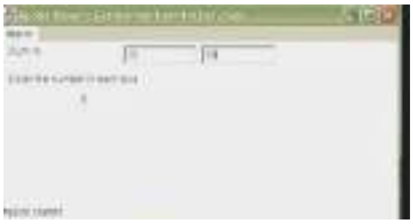
<table>
<tr><td></td><td>Basic programming constructs: variables, data types operators, expressions, branching and looping.<br><br>Setup a Java Programming development environment by using:<br><br>a) Command prompt. (Classpath and path setup)<br>b) Any IDE (Eclipse, Netbeans etc.)<br><br>Demonstration<br><br>1. How to Install Java?<br>2. Setting environment Variables to Run Java Programs.<br>3. Editing a Java Program and its Compilation and Execution.<br>4. About main () Method<br>5. Few Simple Java Programs<br>6. Writing and running simple Java programs<br>7. Explain control structures in java<br><br>Task 1:<br><br>Write simple java program<br><br>1. To show basic syntax, variables, and data types<br>2. Implement basic arithmetic operations using Java.<br>3. Write a program using if statement (eg. to check if a number is even or odd.)<br>4. Implement a simple calculator using methods for arithmetic operations. Use switch control to write menu driven program.<br><br>Task 2:<br><br>Practice method overloading by creating multiple methods with different parameters.</td><td></td></tr>
<tr><td></td><td>Learning Outcomes:<br>A learner will be able to<br><br>LO 1.1: Illustrate the concept of keywords, data types, variables, operators, and expressions (PI-1.1.1)<br>LO 1.2: Apply the fundamental control structures to solve problem (PI-1.3.1)<br>LO 1.3: Identify mathematical expression or formula to write and execute a program (PI-2.1.3)<br>LO 1.4: Write java code using keywords, data types, variables, operators, and expressions in notepad, then compile and execute the program. Implement a java program using control structure (PI-2.2.3)<br>LO 1.5: Use modern JAVA IDE like eclipse, NetBeans (PI-5.1.1).<br>LO 1.6: Install JDK and adapt JAVA IDE like eclipse and Set path in command prompt for executing java program (PI-5.1.2)</td><td></td></tr>
<tr><td>02.</td><td>Class and object<br><br>Learning Objective:<br>1. To investigate the functioning of various components of the given control systemas a team.<br>2. To grasp the fundamental concept of input output. Also expected to writeprogram using different input output constructs.</td><td>08</td></tr>
<tr><td></td><td>Contents:<br><br>Classes, objects, data members, member functions, Constructors, methodoverloading. Input and output functions in Java, scanner class</td><td></td></tr>
</table>

| | | |
|---|---|---|
| | **Demonstration**<br>1. Encapsulation: creating a class.<br>2. Creating objects in a program.<br>3. Defining more method in a class.<br>4. Constructor in a class and its use<br>5. Demonstration of constructor overloading.<br>6. Use of this keyword: to avoid name space collision.<br>**Task 3:**<br>Create a simple Java class representing an entity(e.g., Person, Car) with attributes and methods.<br>• Instantiate objects of the class and demonstrate basicoperations.<br>**Task 4:**<br>Practice encapsulation by defining private variables with public accessors /mutators.<br>**Demonstration**<br>1. Use of print (), println () and printf ().<br>2. Command Line Input in Java<br>3. Take Input using Scanner Class<br>4. Read Input with DataInputStream<br>**Task 5:**<br>Write a Java program that prints out informationabout any entity (eg. Student, Animal etc.)<br>**Task 6:**<br>Write a Java program that takes input from userwith following ways<br>1. Command line arguments.<br>2. Use the Scanner class to prompt the user for the required input<br>Read information with DataInputStream | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Use print statement (PI-1.1.1)*<br>*LO 2.2: Implement a program by taking input from user (PI-1.3.1)*<br>*LO 2.3: Identify classes and objects for problem statement (PI-2.1.1)*<br>*LO 2.4: Apply concept of constructors overloading to write java program (PI-2.3.1)*<br>*LO 2.5: Explore the concept and write recursive function (PI-3.2.1)*<br>*LO 2.6: Write static, non-static and recursive method in java program (PI-3.4.2)* | |
| **03.** | **Inheritance, Interfaces, Packages**<br>***Learning Objective:***<br>*1. Learner is expected to gain knowledge of code reusability. Also expected to write program using inheritance.*<br>***2.*** *Learner is expected to grasp the concept of total abstraction and multiple inheritance Also expected to apply interface concept to achieve multiple inheritance.*<br>***3.*** *Learner is expected to gain the knowledge in concept of grouping related classes, interfaces, and sub-packages. Also expected to apply the concept of packages to write well-structured application.* | **16** |

| | | |
|---|---|---|
| | **Contents:**<br>Types of inheritance, Method overriding, super, Abstract class and abstract method, final, Interface. Define package, types of package, naming and creating packages.accessing package.<br>**Demonstration**<br>1. Simple Inheritance<br>2. Multilevel Inheritance<br>3. Use of super Keyword<br>4. Method Overriding in Inheritance<br>5. Abstract Class<br>6. Create a base class (e.g., Shape) with common properties and methods, and derived classes (e.g., Circle, Rectangle) inheritingfrom it.<br>7. Method overriding and dynamic method dispatch<br>8. Override methods in the derived classes to demonstrate dynamic method dispatch.<br>**Task 7:** Write a program using inheritance for given problem statement<br>**Demonstration**<br>1. Some properties of Interface<br>2. Define Interface<br>3. Interface and single Inheritance<br>4. Interface and multiple Inheritance<br>**Task 8:** Develop a program with the interface for given problem statement.<br>**Demonstration**<br>1. Importing a Java Built-in API package.<br>2. Creating a User's Own Package<br>3. Package with Default Access Specifier for its Classes<br>4. Utilization of a Package in a Java Program<br>5. Inheritance with a Class in a Package<br>6. Access Protection of Classes in Package<br>**Task 9:** Write a program to import built-in packages<br>**Task 10:** Create user defined package for the given problem.<br>1. Write a class and interface to the package. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Summarize the concept of polymorphism using inheritance, concept ofabstraction using interfaces, and packages in java (PI-2.4.1)*<br>*LO 3.2: Show polymorphism by inheriting the features of one class to other class (PI-2.4.4)*<br>*LO 3.3: Explore the single inheritance and multilevel inheritance (PI-3.2.1)*<br>*LO 3.4: Implement the program using inheritance and interfaces to achieve reusability.Also implement the packages to group classes and interfaces in the package (PI-3.4.2)* | |
| **04.** | **Exception Handling and Multi-threading**<br>***Learning Objectives:***<br>*1. To impart skills that can enable students to check and handle the proper functioning of applications. Also expected to apply the exception handling for proper functioning of applications.* | **08** |

| | | |
|---|---|---|
| | *2. Learner is expected to know the concept of multithreading. Also expected toapply it for multitasking.* | |
| | **Contents:**<br>Exception handling using try, catch, finally, throw and throws, Multipletry and catch blocks, user defined exception.<br>Thread lifecycle, thread class methods, creating threads using extends andimplements keyword.<br>**Demonstration**<br>1. Exception handling using try, catch, finally, throw and throws,<br>2. Exception handling Multiple try and catch blocks,<br>3. Exception handling user defined exception<br>**Task 11:** Write a program for handling the given exceptionusing try, catch, finally, throw and throws.<br>**Demonstration**<br>1. Creating Threads using the Thread Class.<br>2. Creating Threads Implementing the Runnable Interface.<br>3. Life cycle of thread: Thread Methods: wait(). sleep(), notify(),resume(), suspend(). stop().<br>**Task 12:** Create threads to run the given multiple processesin the given program. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Illustrate the concept the exception handling and threads in java (PI-1.1.1)*<br>*LO 4.2: Apply the fundamentals of exception handling to handle error (PI-1.3.1)*<br>*LO 4.3: Write a program to show exception handling in java (PI-2.1.3)*<br>*LO 4.4: Create user-defined exception handling (PI-2.2.3)*<br>*LO 4.5: Explore the multiple task handling with threads (PI-3.2.1).*<br>*LO 4.6: Implement threads to achieve multi-tasking(PI-3.4.2)* | |
| **05.** | **Graphical User Interface**<br>***Learning Objective/s:***<br>*1. Learner will gain the knowledge of handling events through GUI. Also expectedto apply it for creating small applications.*<br>*2. Learner is expected to develop proficiency in the concept of swing. Also expected to apply it for developing GUI with good look and feel*<br>*3. Learner will learn the concept of connecting database with business logic. Alsoexpected to apply it for retrieving and saving data.* | **16** |
| | **Contents:**<br>Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class. Event handling using event class.<br>GUI design with Swing class in JAVA Introduction to JDBC, JDBC-ODBC connectivity<br>**Demonstration**<br>1. Java Programming for Applet<br>2. Structure of an Applet<br>3. A Simple Java Applet Program<br>4. An Applet using Methods | |

<table>
<tr><td></td><td>
5. An HTML File Hosting Applet Programs<br>
6. GUIs with AWT Component Frame, Panel, Button, TextField,TextArea, List, Choice, ChoiceBox, Label, Scrollbar, etc.<br><br>
Task 13: Develop a program using applet (Applet tag. Adding Applet to HTM file, passing parameter to applet, embedding <applet> tags in java code, adding controls to applets.)<br><br>
Task 14: Develop a program for GUI using appletExample<br>


<br><br>
Demonstration:<br>
1. Create a JFrame container<br>
2. Create a JPanel container<br>
3. Create a Swing button<br>
4. Creating JFrame, JButton and method call inside the java constructor<br>
5. Inherit the JFrame class<br>
6. Button with ActionListner<br>
7. Button with image<br>
Task 15: Develop a GUI using layouts and components of swing
</td><td></td></tr>
<tr><td></td><td>
Learning Outcomes :<br>
A learner will be able to<br>
LO 5.1: List all data and techniques to solve problem (PI-1.1.1)<br>
LO 5.2: Determine different layout manager to develop software (PI-1.4.1)<br>
LO 5.3: Examine layout managers for flexible window layouts while creating GUI (PI-3.1.6)<br>
LO 5.4: Write modules to handle events through components of GUI using applets and Abstract Window Toolkit (AWT) (PI-3.4.2)<br>
LO 5.5: Extend study on eclipse to solve problem (PI-5.1.1)<br>
LO 5.6: Adapt eclipse and HTML to create GUI using applet and AWT (PI-5.1.2)<br>
LO 5.7: Illustrate the path from CLI to GUI (PI-11.2.1)<br>
LO 5.8: Summarize the advantages of GUI of problem (PI-11.2.2)
</td><td></td></tr>
<tr><td></td><td>Course Conclusion</td><td></td></tr>
<tr><td colspan="2" align="right">Total</td><td>60</td></tr>
</table>

**Self-Learning Topics**

- **MySQL**
  1. Installation of MySQL
  2. DBMS related Tasks with MySQL
  3. Steps to connect to the Database,
  4. Connectivity with MySQL using JDBC

- **Micro-projects**
  A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

1. Mini Banking System for handling deposits and withdrawal.
2. Medical Store Stock Management System.
3. Bus Reservation System.
4. Student Information System
5. Library Management System
6. Attendance Management System.
7. Develop a small animation using applet, graphics and multithreading

**Guidelines for developing micro projects:**

1. Declare four to five classes and may include Interfaces if required.
2. Must use Most of the Object Oriented Concepts.
3. Must implement concepts of Inheritance and Exception Handling.
4. Must Create Own Package.
5. May use the constructor overloading and overriding.
6. May Use Multithreading if required.

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.1.1 | Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply theory and principles of computer science engineering to solve an engineeringproblem |
| 2.1.1 | Identifies processes/modules of a computer based system and parameters to solve a problem |
| 2.1.3 | Identifies mathematical algorithmic knowledge that applies to a given problem |
| 2.2.3 | Identify existing solution/methods to solve the problem, including forming justifiedapproximations and assumptions. |
| 2.3.1 | Able to apply computer engineering principles to formulate modules of a system withrequired applicability and performance |
| 2.4.1 | Applies engineering mathematics to implement the solution. |
| 2.4.4 | Arrive at conclusions with respect to the objectives. |
| 3.1.6 | Ability to develop software requirement specifications |
| 3.2.1 | Ability to explore design alternatives. |
| 3.4.2 | Ability to implement and integrate the modules. |
| 5.1.1 | Identify modern engineering tools, techniques and resources for engineering activities |
| 5.1.2 | Create/adapt/modify/extend tools and techniques to solve engineering problems. |
| 11.2.1 | Identify historic points of technological advance in engineering that required practitioners toseek education in order to stay current |
| 11.2.1 | Recognize the need and be able to clearly explain why it is vitally important to keep currentregarding new developments in your field |

**Course Outcomes:** A learner will be able to -

1. Install java environment and write a java program using fundamental concepts. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.5, LO 1.6*)
2. Apply concepts of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem*(LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5, LO 2.6*)
3. Achieve reusability in programming by using concept of Inheritance, Interface and Packages. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4*)
4. Implement concept of Multithreading, and exceptions to obtain robust and faster programmed solutions to problems. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5, LO 4.6*)
5. Design and develop application using Abstract Window Toolkit, Swings with database connectivity *(LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6, LO 5.7, LO 5.8*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESL205.1 | 3 | 3 | | | 3 | | | | | | |
| ESL205.2 | 3 | 3 | 3 | | | | | | | | |
| ESL205.3 | | 3 | 3 | | | | | | | | |
| ESL205.4 | 3 | 3 | 3 | | | | | | | | |
| ESL205.5 | 3 | | 3 | | 3 | | | | | | 3 |
| **Average** | 3 | 3 | 3 | | 3 | | | | | | 3 |

**Text Books :**

1. Java: The Complete Reference, Herbert Schildt, Ninth Edition, 2017, McGraw Hill Education.
2. Programming with Java, E. Balagurusamy, Seventh Edition, 2019, McGraw Hill Education

**Reference Books :**

1. Beginning JAVA, Ivor Horton, Seventh Edition, 2011, Wrox.
2. JAVA Programming Black Book, by D.T. Editorial Services, 2015, Dreamtech Press.
3. Java One Step Ahead, Anita Seth, B.L.Juneja, First Edition, 2017, oxford university press.

**Other Resources :**

1. NPTEL Course: Programming in Java, By Debasis Samanta, Computer Science and Engineering, Indian Institute of Technology Kharagpur.:-Web link-https://onlinecourses.nptel.ac.in/noc23_cs74/co
2. Web link-www.w3schools.com

3. Web link-www.tutorialspoint.com
4. Web link-https://starcertification.org/Certifications/Certificate/securejava

**IN-SEMESTER ASSESSMENT (TERM WORK) (50 MARKS)**

**1. Task Execution (30 Marks)**

Students will be given minimum 15 experiments.
Students are expected to

1. Identify variables, data types methods/approach required to write the code for the given task and apply the same.
2. Execute given task for different inputs and verify the result
3. Create a simple Java class representing an entity (e.g., Person, Car) with attributes and methods. Instantiate objects of the class and demonstrate basic operations.
4. Apply simple inheritance and multilevel inheritance.
5. Import a Java Built-in API package and also create user's own package
6. Handle the proper functioning of applications by applying the exception handling.
7. Develop proficiency in the concept of swing and apply it for creating small applications (GUI)

Students are evaluated based on following:

1. Logic building for the given task (10 marks)
2. Rectifying logical errors and syntax errors (06 marks)
3. Well-structured and organized program (06 marks)
4. Verification of experiment output for different inputs (08 marks)

Refer the sample task given below.
Example:
Create a Persona class to add details of the person, inherit features of person class into Employee class and display details using method.
Students are expected to.

1. Identify Variables, data types methods/approach required to create teacher class and add methods to display details of a given teacher
2. Execute given task for different inputs and verify the result
3. Follow the coding standards
4. Identify errors and rectify the errors.

Students are evaluated based on following:

1. Logic building for the given task (10 marks)
2. Rectifying logical errors and syntax errors (06 marks)
3. Well-structured and organized program (06 marks)
4. Verification of experiment output for different inputs (08 marks)

**2. Regularity and active Participation (05 Marks)**

**3. Mid Semester Examination (15 Marks)**

a) Task Execution: 10 Marks

Students are evaluated based on following:

1. Logic building for the given task (04 marks)

2. Rectifying logical errors and syntax errors (02 marks)
3. Well-structured and organized program (02 marks)
4. Verification of experiment output for different inputs (02 marks)

b) Oral: 05 Marks

**END SEMESTER EXAMINATION (Practical & Oral Exam) (50 Marks)**

1. Task Execution: 30 Marks
   *Students will be given task (different task for every student) to execute and will be evaluated as per the parameters mentioned in continuous evaluation*
2. Presentation of Results and conclusion, Inferences drawn: 05 Marks
3. Oral: 15 Marks

Two examiners, one Internal and one External will do the evaluation.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| ESL | ESL 206 | BASIC ELECTRONICS ENGINEERING LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **ContinuousAssessment** | **End Semester Exam(ESE)** | **Total Marks** |
| 25 | 25 | 50 |

**Pre-requisite:**

1. ESC102- Basic Electrical Engineering
2. BSC102- Engineering Physics I

**Program Outcomes addressed:**

1 PO2: Problem Analysis
2 PO3: Design / Development of Solutions
3 PO4: Conduct investigations of complex problems
4 PO5: Modern tool usage
5 PO6: The engineer and the world
6 PO8: Individual and Collaborative Team work
7 PO9: Communication
8 P11: Life-long learning

**Course Objectives:**

1. To familiarize with electronics components, measuring devices, source devices for building and analysing analog as well as digital circuits.
2. To provide practical exposure to sensors and transducers and build a basic data acquisition system
3. To provide hands-on experience in designing real time application circuits.

| Module | Details | Hrs. |
|---|---|---|
| **00.** | **Course Introduction**<br>Electronics is pervasive in the modern era which provides a platform to comprehend the basics of components, ICs devices with some practical application. This provides a roadmap to venture in the field of electronics. The electronic circuits form the integral part for almost all used in industrial machinery, computers, microprocessors, household appliances,medical equipment, internet and e-commerce. | **01** |
| **01.** | Name of the Module*:* Electronic Devices<br>***Learning Objective:***<br>*Analyze experimental results to validate theoretical concepts and understand practical implications. Evaluatecircuit parameters to achieve desired performancecharacteristics.*<br>**Contents:**<br>1. Study of CRO & Measurement of Voltage Amplitude & Frequency. | **10** |

| | | |
|---|---|---|
| | 2. Testing of Components using Instruments and fault detection.<br>3. V. I. Characteristics of Si & Ge diode.<br>4. Zener Diode Characteristics<br>5. Applications of Diode:<br>a. Clipper – positive, negative, combinational, biased and combinational<br>b. Clamper – positive and negative<br>c. Rectifier – Half Wave / Full wave with/without filter.<br>6. Characteristics of BJT in Common Emitter Configuration. | |
| | ***Self-Learning Topics:***<br>*Advanced Component Testing using LCR Meters* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Analyze an electronic device model by observing and plotting the response withvarious inputs and make a document in the form of report. (P.I.- 2.4.1, P.I.- 9.3.1).*<br>*LO 1.2: Use a systematic approach to measure data and analyze the system's performance across various parametric variation in a team. (P.I.- 4.3.1, P.I.- 8.3.1).* | |
| **02.** | **Name of the Module: Digital Circuits**<br>***Learning Objective:***<br>*Explore digital circuit fundamentals by understanding logic gates, Boolean expressions,universal gates, and their practical applications.* | **8** |
| | **Contents:**<br>**Suggested List of Experiments: (Any Two)**<br>1. Introduction to Logic Gates – NOT, AND, OR, NAND NOR andXOR<br>2. For a given Boolean expression, design and verify the circuit usingUniversal Gates.<br>3. Basics of AND gate and its application in car wiper control<br>4. Basics of NOT gate and its application in fuel level Indicator. | |
| | ***Self-Learning Topics:***<br>*Simulation based exploration for all the hardware based digital circuits* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Identify and analyze various IC's required for a digital system, use systematic techniques to test and verify with the help of truth table as a team. (P.I.-2.4.1, P.I.-8.3.1)*<br>*LO 2.2: Devise an optimal design, verify a given Boolean expression and make a document in form of report. (P.I.- 3.3.3, P.I.- 9.3.1)* | |
| **03.** | Name of the Module*:* **Sensor/ Transducer Applications**<br>Learning Objective: *To teach the fundamentals of sensor/transducer and model the basic data acquisitionsystem.* | **4** |
| | **Suggested List of Experiments: (Any One)**<br>**Contents:** | |

<table>
<tr><td></td><td>
1. Intruder detection using IR sensor<br>
2. Collision avoidance using ultrasonic sensor<br>
3. Fire alarm system using temperature sensor<br>
4. Movement detection using flex sensor<br>
5. Light detection using LDR<br>
6. Interactive doorbell system using Proximity sensor<br>
7. Gas detection using gas sensors<br><br>
Self-Learning Topics:<br>
Explore and compare software simulations to carry out basic real-life projects in thefield of data acquisition system.<br><br>
Learning Outcomes:<br>
A learner will be able to<br>
LO 3.1: Identify and analyze various sensors/transducers required for a data acquisition system, use systematic techniques to test and verify same as a team.(P.I.-2.4.1, P.I.-.8.3.1)<br>
LO 3.2: Design, a prototype of a simple Data Acquisition system, test and convey a document in report form. (P.I.- 3.3.3, P.I.- 9.3.1)
</td><td></td></tr>
<tr><td>04.</td><td>
Name of the Module: Real Time Applications<br>
Learning Objectives:<br>
Develop practical electronic skills through designing and implementing real-life applications.<br><br>
Contents:<br>
1. Regulated Power Supply using transistor and zener diode<br>
2. Electronic lock using basic logic gates<br>
3. Cockpit warning light control using basic logic gates.<br>
4. Universal NOR gate and its application in automobile alarm system<br>
5. Universal NAND gate and its application in level monitoring inchemical plant<br>
6. Mosquito Trap bat.<br>
7. Electronic safety lock using vibration sensor<br>
8. Water Level Indicator<br>
9. Smoke Detector<br>
10. Smart Trash Bin<br>
11. Virtual Piano<br>
12. Voltage Doubler Circuit<br><br>
Self-Learning Topics:<br>
Smart sensors in the field of IoT.<br><br>
Learning Outcomes:<br>
A learner will be able to<br>
LO 4.1: To demonstrate the analysis with clear, well-constructed presentations to a group of technical and non-technical group with concrete well written documents (P.I.- 2.4.1, P.I.- 9.3.1)
</td><td>6</td></tr>
</table>

| | | |
|---|---|---|
| | *LO 4.2: To design for real life scenarios and check for the sustainability and feasibility of the application (P.I.- 3.3.3, P.I.- 11.3.1).*<br>*LO 4.3: To demonstrate proficiency by recognizing the sources of error in measurements, modelling or simulations and verify credibility of results as a team. (P.I.- 5.3.3, P.I.- 8.3.1).*<br>*LO 4.4: Measure the impact of technological development on society considering factors like environment, user needs, safety and protection (P.I.-6.2.2).* | |
| | **Course Conclusion** | **01** |
| | **Total** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 2.4.1 | Extract desired understanding and conclusions consistent with objectives and limitations ofthe analysis |
| 3.3.3 | Identify relevant data from the given resources and arrive at an optimal design solution for particular specifications. |
| 4.3.1 | Use appropriate procedures, tools, and techniques to conduct experiments and collect data |
| 5.3.3 | Recognize sources of error in measurements, modelling or simulations and verify credibility of results. |
| 6.2.2 | Comprehend legal requirements relevant to engineering design with reference to standards/regulations. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts |
| 9.3.1 | Create engineering-standard figures, reports and drawings to complement writing and presentations |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |

**Course Outcomes:** A learner will be able to –

1. Apply knowledge about the electronic equipment such as oscilloscopes, function generators, multimeter, timers etc. for analog testing, measuring the parameters electronics devices such as diode, Zener diode, Transistor etc (*LO 1.1, LO 1.2*)
2. Demonstrate and analyze the use of basic gates and apply it in various applications in digital domain. (*LO 2.1, LO 2.2*)
3. Analyse sensors/transducers and assemble a prototype for a basic data acquisition system. (*LO 3.1, LO 3.2*)
4. Design analyse, test, and ensure functionality of real-life electronic applications using acquired skills and electronic test instruments. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESL 206.1 | | 2 | | 2 | | | | 2 | 2 | | |
| ESL 206.2 | | 2 | 2 | | | | | 2 | 2 | | |
| ESL 206.3 | | 2 | 2 | | | | | 2 | 2 | | |
| ESL 206.4 | | 2 | 2 | | 2 | 2 | | 2 | 2 | | 2 |
| **Average** | | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | | 2 |

**Text Books:**

1. Basic Electronics By B.L.Theraja,S Chand Publications.
2. Basic Electronics Engineering. Satya Sai Srikant, Prakash Kumar Chaturvedi, Springer, Year:2020
3. A Textbook of Basic Electronics, Dr. Barun RayChaudhuri Chhaya Prakashan Pvt. Ltd.

**Reference Books :**

1 Learning Art of Electronics: A Hands-on Lab Course By. Paul Horowitz and Thomas, C. Hayes, 2020

2 Basic Electronics--theory and practice J. A. Sam Wilson, Publisher, Gregg Division,McGraw-Hill, 1977.

3 Practical Electronics for Inventors, 4th Edition by Paul Scherz, Simon Monk, 2016

4 Getting started in Electronics – Forest M. Mims Publisher. Fort Worth: Radio Shack,12$^{th}$ edition, 1994.

5 Self-teaching guide: All new electronics – Harry Kybett and Earl Boysen, 3$^{rd}$ edition 2008.

**Other Resources :**

1. Basic Electronics Course – NPTEL By Dr. M.B. Patil, IIT Bombay.
2. Virtual Lab of Basic Electronics. Basic Electronics (iitkgp.ac.in).

**IN-SEMESTER ASSESSMENT (50 MARKS)**

**1. Continuous Assessment - Theory-(25 Marks)**

1. Lab Experiments: 10 Marks
2. Internal Assessment:
   i. Practical Test 1 (Based on 50% of the Practical list): 5
   ii. Practical Test 2 (Based on remaining 50% of the Practical list): 5
3. Regularity and active participation: 5 marks

**END SEMESTER EXAMINATION (Pract. /Oral Exam) (25 Marks)**

Performance of experiments based on the course content.

Students will have to:

1. Draw the circuit diagram.: 03 Marks
2. Identify the components.: 01Marks
3. Make proper connections on breadboard.:03Marks
4. Take accurate readings from instruments.:03 Marks
5. Tabulate the readings and plot graphs if required.:05 Marks
6. Orals:10 Marks

Two examiners, one Internal and one External will do the evaluation

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| SEC | SEC202 | BASIC WORKSHOP PRACTICE II | 01 |

| Examination Scheme | | |
|---|---|---|
| **Term Work** | **Practical /Oral** | **Total** |
| 50 | -- | 50 |

**Pre-requisite:**

1. SEC101- Basic Workshop Practice I

**Program Outcomes addressed :**

1. PO1: Engineering knowledge
2. PO5: Engineering tool usage
3. PO6: The engineer and the world
4. PO8: Individual and collaborative team work
5. PO11: Life-long learning

**Course Objectives :**

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labour.
3. To get exposure to interdisciplinary engineering domain.

| Module | Detailed Contents | Hrs |
|---|---|---|
| | **Course Introduction**<br>The Workshop Practice II course is intended to give students with the core information and abilities required for developing engineering skill sets and getting an exposure to work in an interdisciplinary engineering domain including basic electronic work shop. This hands-on course introduces the fundamental principles, equipment, and techniques utilised in workshop scenarios, such as carpentry, sheet metal working, brazing and forging. | **01** |
| **01.** | ***Learning Objectives:***<br>*1. To gain proficiency in accurate measuring, marking, and layout techniques, including the use of squares, levels, and other layout tools.*<br>*2. To develop proficiency in the use of basic carpentry hand tools such as hammers, saws, chisels, planes, and measuring devices.* | **09** |
| | **Content: Carpentry**<br>• Use and setting of hand tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood turning and modern wood turning methods.<br>• Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning. | |
| | *Learning Outcomes :*<br>*A learner will be able to* | |

| | | |
|---|---|---|
| | *LO1.1: Accurately measure and layout components of carpentry projects using appropriate tools and techniques, ensuring precision and alignment. (P.I. - 1.3.1, 5.2.1, 11.3.1)*<br>*LO1.2: Exhibit proficiency in the use of common carpentry hand tools and power tools, including accurate handling, operation, and maintenance. (P.I. - 1.4.1, 5.2.2, 11.3.2)* | |
| **02.** | ***Learning Objectives:***<br>*1. To provide hands-on experience in measuring instruments, electronic components, PCB circuit design and to familiarize students with PCB fabrication process.*<br>*2. To provide hands-on experience in assembly and testing of electronics circuit.* | **10** |
| | **Content: Basic Electronic work shop**<br>• Introduction to measuring instruments and electronic components like resistors, capacitors, inductors, diodes, transistors, etc.<br>• Demonstration of PCB simulation software for making the layout, layout transfer to PCB, etching, drilling and soldering technique.<br>• Assembling and testing the circuit for correct functionality. | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO2.1: Select appropriate electronic components based on design requirements and place them effectively on the PCB layout. (P.I. - 5.2.1, 5.2.2, 11.3.1)*<br>*LO2.2: Demonstrate a clear understanding of what PCBs are, how they function, and their importance in electronic devices and systems. (P.I. - 8.2.1, 8.3.1)*<br>*LO2.3: Comprehend the basic principles of PCB design, including component placement, routing, signal integrity, and manufacturability. (P.I. - 6.1.1, 6.4.2, 8.2.1, 8.3.1, 11.3.2)* | |
| **03.** | ***Learning Objectives:***<br>*1. To become proficient in the use of various sheet metal working tools and equipment, such as shears, brakes, punches, rollers, and spot welders.*<br>*2. To grasp the fundamental principles and techniques involved in forging, which includes heating, shaping, and cooling metal through the application of force.* | **10** |
| | **Content: Sheet metal working, Brazing and Forging (Smithy)**<br>• Use of sheet metal, working hand tools, cutting, bending, spot welding. One job covering maximum operation with soldering or brazing.<br>• At least one forging job to be demonstrated and a simple job to be made for Term Work in a group of 4 students. | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO3.1: Use various sheet metal working tools and equipment proficiently. (P.I. - 5.2.2, 5.3.2, 11.1.1, 11.3.2)*<br>*LO3.2: Demonstrate competence in operating forging equipment and tools, including heating furnaces, power hammers, presses, and hand tools, to manipulate metal effectively. (P.I. - 5.2.2, 8.1.1, 8.3.1, 11.1.1, 11.3.2)* | |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems |
| 1.4.1 | Apply Mechanical engineering concepts to solve engineering problems. |
| 5.2.1 | Identify the strengths and limitations of tools for creating engineering designs. |
| 5.2.2 | Demonstrate proficiency in using discipline-specific tools. |
| 5.3.2 | Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use. |

6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level.

6.4.2 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline.

8.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.

8.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.

11.1.1 Describe the rationale for the requirement for continuing professional development.

11.3.1 Source and comprehend technical literature and other credible sources of information.

11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

**Course Outcomes :**

A learner will be able to

1. Develop the necessary skill required to handle/use different carpentry tools. (*LO 1.1*, *LO 1.2*)
2. Identify different electronic components to design, fabricate and assemble PCB. (*LO 2.1, LO 2.2, LO 2.3*)
3. Develop the necessary skill required to use different sheet metal and brazing tools. (*LO 3.1, LO 3.2*)
4. Demonstrate the forging operation with the help of a simple job. (*LO 3.1, LO 3.2*)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SEC202.1 | 3 | | | | 3 | | | | | | 3 |
| SEC202.2 | | | | | 3 | 3 | | 3 | | | 3 |
| SEC202.3 | | | | | 3 | | | 3 | | | 3 |
| SEC202.4 | | | | | 3 | | | 3 | | | 3 |
| **Average** | 3 | | | | 3 | 3 | | 3 | | | 3 |

**Continuous Internal Assessment (CIA) - (50 Marks)**

Job Work with complete workshop book: 40 Marks

Attendance and Active participation: 10 marks

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| IKS | IKS201 | INDIAN KNOWLEDGE SYSTEM | 02 |

**Program Outcomes addressed**:
1. PO1 : Engineering knowledge
2. PO6 : The engineer & The World
3. PO7 : Ethics
4. PO11: Life-long learning

**Course Objectives :**
1. To introduce fundamentals of Ancient Indian Educations to understand the pattern and purpose of studying vedas, vedangas, upangas, upveda, purana & Itihasa
2. To help students to trace, identify and develop the ancient knowledge systems.
3. To help to understand the apparently rational, verifiable and universal solution from ancient Indian knowledge system for the holistic development of physical, mental and spiritual wellbeing
4. To build in the learners a deep rooted pride in Indian knowledge, committed to universal human right, well-being and sustainable development..

| Module | Details |
|---|---|
| **01.** | **Indian Knowledge System**<br>Caturdaśa Vidyāsthānam, 64 Kalas, Shilpa Śāstra, Four Vedas, Vedāṅga, Indian Philosophical Systems, Vedic Schools of Philosophy ( Sāṃkhya and Yoga, Nyaya and Vaiśeṣika, Pūrva-Mīmāṃsā and Vedānta), Non-Vedic schools of Philosophical Systems (Cārvāka, Buddhist, Jain), Puranas (Maha-puranas, Upa-Puranas and Sthala-Puranas), Itihasa (Ramayana, Mahabharata), Niti Sastras, Subhasitas |
| **02.** | **Foundation concept for Science & Technology**<br>Linguistics & Phonetics in Sanskrit (panini's), Computational concepts in Astadhyayi Importance of Verbs, Role of Sanskrit in Natural Language Processing, Number System and Units of Measurement, concept of zero and its importance, Large numbers & their representation, Place Value of Numerals, Decimal System, Measurements for time, distance and weight, Unique approaches to represent numbers (Bhūta Saṃkhya System, Kaṭapayādi System), Pingala and the Binary system, Knowledge Pyramid, Prameya – A Vaiśeṣikan approach to physical reality, constituents of the physical reality, Pramāṇa, Saṃśaya |
| **03.** | **Indian Mathematics & Astronomy in IKS**<br>Indian Mathematics, Great Mathematicians and their contributions, Arithmetic Operations, Geometry (Sulba Sutras, Aryabhatiya-bhasya), value of $\pi$, Trigonometry, Algebra, Chandah Sastra of Pingala, Indian Astronomy, celestial coordinate system, Elements of the Indian Calendar Aryabhatiya and the Siddhantic Tradition Pancanga – The Indian Calendar System Astronomical Instruments (Yantras) Jantar Mantar or Raja Jai Singh Sawal. |

| | |
|---|---|
| **04.** | **Indian Science & Technology in IKS**<br>Indian S & T Heritage ,sixty-four art forms and occupational skills (64 Kalas) Metals and Metalworking technology (Copper, Gold, Zinc, Mercury, Lead and Silver), Iron & Steel, Dyes and Painting Technology), Town & Planning Architecture in India, Temple Architecture, Vastu Sastra |
| **05.** | **Humanities & Social Sciences in IKS**<br>Health, Wellness & Psychology, Ayurveda Sleep and Food, Role of water in wellbeing Yoga way of life Indian approach to Psychology, the Triguṇa System Body-Mind-IntellectConsciousness Complex. Governance, Public Administration & Management reference to<br>ramayana, Artha Sastra, Kauṭilyan State |
| **Total no. of hours**: **30** | |

**Course Outcomes :**

1. Explore the diverse realms of the Indian Knowledge System, spanning philosophy, literature, and ethics, to appreciate its holistic approach to education.
2. Understand foundational concepts in Science and Technology from ancient Indian perspectives, including linguistics, mathematics, and astronomy.
3. Discover the rich heritage of Indian Mathematics, Astronomy, and Science, exploring their contributions to global knowledge and technological advancement.
4. Engage with interdisciplinary perspectives in Humanities and Social Sciences rooted in ancient Indian wisdom, fostering critical thinking and holistic development.
5. Apply insights from ancient Indian knowledge systems to contemporary challenges, promoting innovation and sustainable solutions.
6. Cultivate a deeper appreciation for Indian heritage while developing analytical skills and interdisciplinary insights for real-world application.

**Text Books :**

1. Exploring the Indian Knowledge System: Insights from Prof. B Mahadevan, Prof. B Mahadevan, IIM Bengaluru Press
2. Kapur K and Singh A. K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust,Bombay, 1995.
3. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008

**Reference Books :**

1. Reshmi ramdhoni, Ancient Indian Culture and Civilisation, star publication ,2018
2. Supriya Lakshmi Mishra, Culture and History of Ancient India (With Special Reference of Sudras), 2020.
3. DK Chakkrabarty, Makkhan Lal, History of Ancient India (Set of 5 Volumes), Aryan book Internation publication, 2014

**Other Resources :**

1. NPTEL Course: Indian Knowledge System(IKS): Concepts and Applications in Engineering, By By Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghava, Indian Institute of Management Bangalore (IIMB), Chanakya University, Bangalore :-Web link- https://onlinecourses.swayam2.ac.in/imb23_mg53/preview

2. NPTEL Course: Indian Knowledge System(IKS): Humanities and Social Sciences, By Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan, Indian Institute of Management Bangalore (IIMB), Chanakya University, Bangalore :-Web link- https://onlinecourses.swayam2.ac.in/imb23_mg55/preview

# G. Syllabi
# Second Year

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **PCC** | EEPCC301 | ENGINEERING MATHEMATICS-III | 03+01* |

<table>
<tr><th></th><th colspan="5">Examination Scheme</th></tr>
<tr><th colspan="3">Distribution of Marks</th><th colspan="2" rowspan="2">Exam Duration (Hrs.)</th><th rowspan="3">Total Marks</th></tr>
<tr><th colspan="2">In-semester Assessment</th><th rowspan="2">End Semester Exam (ESE)</th></tr>
<tr><th>Continuous Assessment</th><th>Mid-Semester Exam (MSE)</th><th>MSE</th><th>ESE</th></tr>
<tr><td>20+25@</td><td>30</td><td>50</td><td>1.5</td><td>2</td><td>125</td></tr>
</table>

**Pre-requisite:**

1. BSC101- Engineering Mathematics-I
2. BSC204- Engineering Mathematics-II

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis

**Course Objectives:**

1. To provide the basic knowledge on the concepts of Mathematics in the field of Engineering.
2. To build a foundation to the methodology necessary for solving problems by applying the knowledge of Mathematics to the field of Engineering.

<table>
<tr><th>Module</th><th>Details</th><th>Hrs</th></tr>
<tr><td></td><td>Course Introduction<br>Engineering Mathematics III is often a foundational course designed to provide students with the mathematical tools and concepts essential for various engineering disciplines. Engineering Mathematics III has many applications in Electrical engineering such as<br>• To introduce the study of Harmonic Analysis, Circuit Analysis and Control system using the various Mathematical Transforms,<br>• Application of Fourier series in Spectrum analysis, and Concept of complex numbers and variables provides a knowledge to solve electrical engineering problems.</td><td>01</td></tr>
<tr><td rowspan="3">01.</td><td>Laplace Transform</td><td rowspan="3">7-9</td></tr>
<tr><td>Learning Objective/s:<br>To analyze the standard Laplace Transforms using basic definitions and apply it to solve mathematical problems.</td></tr>
<tr><td>Contents:<br>Definition of Laplace Transforms, Condition of existence of Laplace Transform, Laplace Transforms of standard functions:<br>$e^{at}, sinat, cosat, sinhat, coshat, t^n\ n > 0.$</td></tr>
</table>

| | | |
|---|---|---|
| | Properties of Laplace Transform: Linearity, First Shifting Theorem, Change of scale Property, Multiplication by t, Division by t, Laplace Transform of derivatives and integrals, Heaviside's Unit Step function. | |
| | ***Self-Learning Topics:***<br>Second Shifting Theorem, Laplace Transform of Periodic functions. | |
| | *Learning Outcomes :*<br>*A learner will be able to*<br>*LO 1.1: Interpret standard Laplace transforms and its applicability to a given mathematical problem. (P.I.- 1.1.1)*<br>*LO 1.2: Apply the properties of Laplace Transform and use it for solving advanced mathematical problems. (P.I.- 1.1.2)*<br>*LO 1.3: Identify unit steps functions to solve engineering problems. (P.I-2.1.2)*<br>*LO 1.4: Identify the correct properties of Laplace Transform applicable to a given problem (P.I.-2.1.3)* | |
| 02. | **Inverse Laplace Transform** | **6-8** |
| | ***Learning Objective/s:***<br>*To analyze and apply the techniques of Laplace and inverse Laplace transform to solve differential equations. .* | |
| | **Contents:**<br>Definition of Inverse Laplace Transform, Properties of Inverse Laplace Transform: Linearity, Shifting Theorem, Finding Inverse Laplace Transform using partial fraction, Finding Inverse Laplace Transform using differentiation Property, Solution of Differential equations-initial value problem and Boundary Value Problem. | |
| | ***Self-Learning Topics: Convolution Theorem.*** | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 2.1: Interpret standard Inverse Laplace transforms and its applicability to a given mathematical problem. (P.I.-1.1.1)*<br>*LO 2.2: To solve initial and boundary value problems of differential equation by applying advanced mathematical techniques. (P.I.-1.1.2)*<br>*LO 2.3: Identify the correct properties of inverse Laplace Transform applicable to a given problem (P.I.-2.1.3)*<br>*LO 2.4: Identify the types of partial fraction method to find the solution of inverse Laplace transform. (P.I.-2.2.3)* | |
| 03. | **Fourier Series** | **7-9** |
| | ***Learning Objective/s:***<br>*To analyze various wave forms and use the knowledge of periodic wave forms in determining a function in terms of its sine and cosine counterparts.* | |

| | | |
|---|---|---|
| | **Contents:**<br>Dirichlet's conditions, Definition Periodic function and graphical representation of periodic function: sine wave form, cosine wave form, square wave form, saw tooth wave form, Definition of Fourier series,<br>Fourier series of periodic function with period $2\pi$ and Fourier series of periodic function with period 2l, Fourier series of even and odd functions, Half range Sine and Cosine Series. | |
| | ***Self-Learning Topics:***<br>*Parseval's Identity, Complex form of Fourier Series, Orthogonal and orthonormal set of functions.* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 3.1: To apply mathematical techniques of algebra and calculus in determining Fourier coefficients. (P.I.-1.1.1)*<br>*LO 3.2: To apply fundamental concept of mathematics to solve engineering problems. (P.I.-1.3.1)*<br>*LO 3.3: Articulate and interpret the basics of periodic functions and series. (P.I.-2.1.1)*<br>*LO 3.4: Identify the knowledge of periodic functions to solve given engineering problems. (P.I.-2.1.3)*<br>*LO 3.5: To synthesize the information about any given mathematical function and express it in terms of sine and cosine waveforms. (P.I.-2.1.3)* | |
| 04. | **Z-Transform** | **6-8** |
| | ***Learning Objective/s:***<br>*To identify the properties and theorem of z-transform to apply and solve engineering problems.* | |
| | **Contents:**<br>Significance of z-transform, Definition and Region of Convergence, z-Transform of Standard Functions, Properties of z-transform: Linearity, Change of Scale, Shifting Property, Multiplication and Division property, Convolution theorem. | |
| | ***Self-Learning Topics:***<br>*Initial Value Theorem and Final Value Theorem* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 4.1: Interpret standard z-transforms and its applicability to a given mathematical problem. (P.I.-1.1.1)*<br>*LO 4.2: Apply the properties of z-transform and use it for solving advanced mathematical problems. (P.I.- 1.1.2)*<br>*LO 4.3: To apply knowledge of fundamental engineering concepts in finding z-Transforms. (P.I.- 1.3.1)*<br>*LO 4.4: Identify the correct properties of z-Transform applicable to a given problem. (P.I.-2.1.3).*<br>*LO 4.5: Identify the existing solutions to solve given problems.( P.I.-2.2.3)* | |
| 05. | **Inverse z-Transform** | **5-7** |

| | | |
|---|---|---|
| | ***Learning Objective/s:***<br>*To apply the concept of Inverse z-transform and analyze its methods to solve difference equations in discrete time system.* | |
| | **Contents:**<br>Definition of Inverse z-transform, Region of Convergence, Finding Inverse z-transform using Partial fraction, Finding Inverse z-transform using Convolution theorem, Solution of Difference Equations. | |
| | ***Self-Learning Topics:***<br>*Finding Inverse z-transform using Binomial expansion.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 5.1: To apply inverse z-transforms and its applicability to a given mathematical problem. (P.I.-1.1.1)*<br>*LO 5.2: To apply knowledge of fundamental engineering concepts in finding inverse z-transforms. (P.I.-1.3.1)*<br>*LO 5.3: To identify the various methods such as Partial fraction, Convolution theorem to finding solution of inverse z-transform. (PI-2.2.3)*<br>*LO 5.4: To apply the knowledge of Partial fraction, and Convolution theorem to finding solution of given problems. (PI-2.1.3)* | |
| 06. | **Complex Variables-I** | **6-8** |
| | ***Learning Objective/s:***<br>*To analyses if a given complex function is analytic or not by applying basic definitions and theorems of Complex Variables.* | |
| | **Contents:**<br>Statement of D'Moivre's Theorem, Expansion of sinnθ, cosnθ in terms of sines and cosines of multiples of θ ,Expansion of sinnθ, cosnθ in powers of sinθ, cosθ .Complex Variables, Calculus of Complex Variables: Limit, Continuity Differentiability<br>Analytic Functions: Necessary and sufficient conditions for f(z) to be analytic, Cauchy-Riemann equations: Cartesian coordinate and Polar coordinates. | |
| | ***Self-Learning Topics:***<br>*Roots of a complex number, Conformal mapping* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: To apply mathematical techniques such as calculus and algebra to solve mathematical problems of complex variables and functions. (P.I-1.1.1)*<br>*LO 6.2: To apply the fundamental concept of complex functions to solve engineering problems. (P.I.-1.3.1)*<br>*LO 6.3: To interpret complex functions using the knowledge of complex variables. (P.I-2.1.2)*<br>*LO 6.4: Identify if given complex function is analytic or not using Cauchy Riemann Equations. (P.I-2.1.2)* | |

| | | |
|---|---|---|
| | *LO 6.5: To identify the concept of analyticity by using Cauchy-Riemann equations to solve given problem. (P.I-2.1.3)*<br>*LO 6.6: To Identify if the derivatives of a given complex function exist or not by applying the theory of complex variables to a given problem. (P.I-2.1.3)* | |
| | **Course Conclusion**<br>Engineering Mathematics provides the problem solving skills necessary for electrical engineering to design, analyse and optimize system and device across a wide range of applications. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.1 | Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems |
| 1.1.2 | Apply advanced mathematical techniques to model and solve engineering problems |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 2.1.1 | Articulate problem statements and identify objectives |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| 2.2.3 | Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions. |

**Course Outcomes :** A learner will be able to

1. Analyse the techniques of Laplace and inverse Laplace transform and apply it to determine the solutions of differential equations. *(LO1.1, LO1.2, LO1.3, LO1.4, LO2.1, LO2.2, LO2.3, LO2.4)*
2. Analyse the periodic functions and expand it by using Fourier series to solve complex engineering problems.*(LO3.1, LO3.2, LO3.3, LO3.4, LO3.5)*
3. Apply the concept of Z-transform and Inverse Z-Transform to analyse its methods to solve difference equations.*(LO4.1, LO4.2, LO4.3, LO4.4, LO4.5, LO5.1, LO5.2, LO5.3 LO5.4)*
4. Apply the concept of complex variables to analyse the function is holomorphic or not.*(LO6.1, LO6.2, LO6.3, LO6.4, LO6.5, LO6.6)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC301.1 | 3 | 2 | | | | | | | | | |
| EEPCC301.2 | 3 | 2 | | | | | | | | | |
| EEPCC301.3 | 3 | 2 | | | | | | | | | |
| EEPCC301.4 | 3 | 2 | | | | | | | | | |
| **Average** | 3 | 2 | | | | | | | | | |

**Text Books :**

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced engineering mathematics, H.K. Das, S. Chand, Publications

**Reference Books :**

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
2. Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
3. Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
4. Laplace transforms, Murray R. Spiegel, Schaum’s Outline Series

**Other Resources :**

1 NPTEL Course: Laplace Transform,IMSc By Prof. .Indrava Roy, Web link- https://nptel.ac.in/courses/111/106/111106139/

**IN-SEMESTER ASSESSMENT (75 Marks)**

**1. Continuous Assessment (45 Marks)**

**Continuous Internal Evaluation of Theory (20 Marks)**

Numerical Assignments: 5 Marks
Class test based on above numerical Assignment: 5 Marks
Team-pair- Solo: 5 Marks
Regularity and attentiveness: 5 Marks

**Continuous Internal Evaluation of Tutorial (25 Marks)**

Minimum six Tutorials: 20 Marks
Regularity and attentiveness: 5 Marks
Students must be encouraged to write at least 6 class tutorials. At least 6 Class tests will be conducted based on class tutorials on entire syllabus. Each class tests carries 20 Marks. Average will be taken of all class tests.

**2. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% of the syllabus

**END SEMESTER EXAMINATION (50 Marks)**

End semester examination will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying70%- 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **PCC** | EEPCC302 | CIRCUIT AND SIGNAL ANALYSIS | 03+01* |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20+25@ | 30 | 50 | 1.5 | 2 | 125 |

**Pre-requisite :**

1. BSC101- Engineering Mathematics I
2. BSC204 - Engineering Mathematics II
3. ESC102- Basic Electrical Engineering

**Program Outcomes addressed :**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Modern tool usage

**Course Objectives:**

1. To impart the knowledge of various fundamental electrical theorems for analysis of electrical circuits from application point of view.
2. To inculcate the problem solving and analysis skills in students.
3. To impart knowledge on signals and system.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Overview of course, application of course in Industry/real life problem. This is a foundation course which deals with fundamental knowledge of signals and systems, basic elements of electrical network, analysis of electrical network using fundamental laws. The fundamental concepts of this subject are essential for analyzing the electrical power system/machines/electronic system under various conditions. | **01** |
| **01.** | **Network Theorems** | **7-9** |
| | ***Learning Objective/s:***<br>*To* apply the fundamental theorems in electrical engineering to analyze electrical network with dependent voltage/current sources and validate the results of analysis with software tool. | |
| | **Contents:**<br>With DC Dependent Sources: Mesh analysis, Nodal analysis, Superposition theorem, Thevenin's theorems and Norton's theorem and Maximum power transfer theorem; With AC Sources: Magnetic coupling, Thevenin's theorem, Superposition theorem, Norton's theorem and Maximum power transfer theorem. Simulation of electrical network with software tools and verification using theorem | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Apply fundamental Kirchhoff laws and theorems in electrical engineering to simplify any complex electrical network with DC dependent sources and AC sources (PI-1.4.1)*<br>*LO1.2 Apply advanced mathematical techniques to model and solve the electrical network. (PI-1.1.2)*<br>*LO1.3 Apply network theorems to identify and determine various circuit parameters such as current and voltage. (PI- 2.1.2).*<br>*LO1.4 Apply network theorems to identify and determine power dissipated across circuit elements, optimum load to be connected for maximum power flow and role of source resistance that applies to a given electrical network. (PI- 2.1.3).*<br>*LO1.5 Identify and use software tool to model/build an electrical network. (PI-5.1.1)*<br>*LO1.6 Simulate the electrical circuit in software and validate the results analytically using network theorems. (PI-5.3.1)* | |
| **02.** | **Graph Theory and Network Topology** | **5-7** |
| | ***Learning Objective/s:***<br>*To develop the problem-solving skills to analyze complex electrical network using graph theory techniques* | |
| | **Contents:**<br>Introduction, Graph of network, Tree, Co-tree, Loop incidence matrix, Cut set matrix, Tie set matrix and Loop current matrix, Number of possible trees of a graph, Application of graph theory to circuit analysis. Principle of duality. | |
| | ***Self-Learning Topics:***<br>*KCL and KVL equilibrium equation representation of electrical network.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Model the graphical structure of an electrical network with the use of graph theory (PI-1.1.2)*<br>*LO2.2 Identify tree, Co-tree, twig, link of graph using electrical engineering concept of nodes and meshes. (PI-1.4.1)*<br>*LO2.3 Derive the loop incidence matrix, tieset matrix and loop current matrix of the graph. (PI-2.3.1)*<br>*LO2.4 Derive the equilibrium equation from the graph of electrical network. (PI-2.3.1)*<br>*LO2.5 Apply engineering mathematics tools to solve the equilibrium equation for voltage/ current. (PI-2.4.1)* | |
| **03.** | **Switching Transients Analysis** | **8-10** |
| | ***Learning Objective/s:***<br>*To analyze the effect of energy storage elements inductor, capacitor and energy dissipating element resistor in the electrical network under transient and steady state conditions and validate the results of analysis with software tool.* | |

<table>
<tr><td rowspan="3"></td><td>Contents:<br>Transient analysis of DC and AC circuit: Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, forced and natural response, time constant, steady state and transient state response. Introduction to transient analysis in ac circuits.<br>Laplace Transforms: Application of Laplace transform to solve RL, RC and RLC electrical network.<br>Simulation of RL, RC & RLC electrical network with software tools for switching transient and steady state.</td><td rowspan="3"></td></tr>
<tr><td>Self-Learning Topics:<br>Application of Fourier transform in electrical network.</td></tr>
<tr><td>Learning Outcomes:<br>A learner will be able to<br>LO3.1 Reframe the switching conditions in electrical network into initial condition, transient and steady state condition. (PI-2.2.1)<br>LO3.2 Derive the equivalent circuit of electrical network for different stages of switching condition by fundamental laws. (PI-2.3.1)<br>LO3.3 Apply fundamental laws of KVL and KCL to formulate the differential equation and Laplace mathematical model of the equivalent network. (PI-1.4.1)<br>LO3.4 Apply advanced mathematical techniques to solve a first order and second order differential equation of voltage/current of electrical network in time domain. (PI-1.1.2)<br>LO3.5 Apply engineering mathematics and computations to solve Laplace equation model of the equivalent network. (PI-2.4.1)<br>LO3.6 Combine the initial, transient and steady state response to obtain the total response of the network. (PI-2.3.1)<br>LO3.7 Analyze the behaviour of the circuit in terms of voltage, current, time constant for different switching conditions. (PI-2.4.4)<br>LO3.8 Identify and use software tool to model/build an electrical network. (PI-5.1.1)<br>LO3.9 Demonstrate the electrical circuit in discipline specific software and analyse switching transients in network. (PI-5.2.2)</td></tr>
<tr><td rowspan="3">04.</td><td>Two port parameters and network functions</td><td rowspan="3">6-8</td></tr>
<tr><td>Learning Objective/s:<br>Derive circuit parameters and network functions to analyze the two-port representation of an electrical network, which describe the concise representation of the network’s behaviour.</td></tr>
<tr><td>Contents:<br>Circuit parameters: Open circuit and short circuit parameters, reciprocity and symmetry conditions.<br>Network Functions: Network functions for one port and two port networks, driving point and transfer functions of ladder network, general network. Poles and zeros of network functions, time domain behaviour from pole - zero plot.</td></tr>
</table>

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Apply electrical engineering concepts to derive various parameters associated with two-port networks. (PI-1.4.1)*<br>*LO4.2 Apply fundamental engineering concepts to derive the network functions associated with two-port network. (PI-1.3.1)*<br>*LO4.3 Apply engineering mathematics and computations to solve for the poles and zeros associated with the network functions. (PI-2.4.1)*<br>*LO4.4 Identify location of poles and zero, from the network functions to comment on the stability of the system (PI-2.1.3)* | |
| **05.** | **Signals and Systems** | **6-8** |
| | ***Learning Objective/s:***<br>*To acquire information on fundamental classification and operations on signals and systems in the field of electrical engineering.* | |
| | **Contents:**<br>Classification of signals: Continuous time (CT) and Discrete Time (DT) signals, periodic & aperiodic signals, even and odd.<br>Classification of systems: Linear/ Non-Linear, time variant/invariant, causal /anti causal.<br>Basic operations on signals: Folding, scaling and time shifting. Introduction to convolution in signals and system. | |
| | ***Self-Learning Topics:***<br>*Energy and power signals, stable and unstable system, memory and memoryless system* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1 Apply mathematical techniques to model the mathematical expression of various standard signals in the time domain (PI-1.1.2)*<br>*LO5.2 Apply fundamental engineering concepts to differentiate periodic and aperiodic signals, even and odd signals, energy and power signals (PI-1.3.1)* | |
| **06.** | **Discrete Time Signal and z-transform** | **5-7** |
| | ***Learning Objective/s:***<br>*To apply Z-Transform technique to convert discrete time signal/system from time domain into Z domain and analyze the stability characteristics with pole zero plot.* | |
| | **Contents:**<br>Sampling theorem. Representation of discrete time signals. Z-transform of bilateral signal, Inverse Z-Transform. Stability analysis in Z plane with pole zero plot. Minimum phase, Maximum phase and Mixed phase system. Formation of difference equation, solution of difference equation using Z-transform. | |
| | ***Self-Learning Topics:***<br>*Definition of ROC, Properties of ROC, Properties of Z-transform* | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1 Use sampling theorem to convert continuous signals into discrete signals (PI-2.1.3)*<br>*LO6.2 Apply electrical engineering concepts to formulate the difference equation representation of signals/system. (PI-1.4.1)*<br>*LO6.3 Apply engineering mathematics to solve difference equations under various initial conditions. (PI-2.4.1)*<br>*LO6.4 Apply mathematical techniques such as calculus to convert discrete time domain signal representation of signals into z domain representation. (PI-1.1.1)* | |
| | **Course Conclusion**<br>The course will conclude with a mathematical modeling of an electrical system, analyze it with respect to the transient, steady state and stability behaviour emphasizing the fact that it is a foundation course in Electrical Engineering | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.2 | Apply advanced mathematical techniques to model and solve electrical engineering problems |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| 2.2.1 | Reframe complex problems into interconnected sub problems |
| 2.3.1 | Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy. |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models. |
| 2.4.4 | Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities |
| 5.2.2 | Demonstrate proficiency in using discipline specific tools |
| 5.3.1 | Discuss limitations and validate tools, techniques and resources |

**Course Outcomes:**

1. Apply the knowledge of fundamental network theorems, graph theory, two port network to solve a given electrical circuit. (*LO1.1, LO1.2, LO1.3, LO1.4, LO2.1, LO2.2, LO2.3, LO2.4, LO2.5)*
2. Formulate a mathematical model of an electrical network through differential equations and Laplace transforms to analyse the effect of switching transients.( *LO3.1, LO3.2, LO3.3, LO3.4, LO3.5, LO3.6, LO3.7*)
3. Formulate the transfer function and network parameters to analyse two port model of an electrical network.( *LO4.1, LO4.2, LO4.3, LO4.4*)
4. Differentiate types of signals/systems, apply Z- transform technique to convert discrete time signals to z domain and analyse the stability.( *LO5.1, LO5.2, LO6.1, LO6.2, LO6.3, LO6.4*)
5. Use IT tools to model and simulate electrical network.( *LO1.5, LO1.6, LO3.8, LO3.9, LO1.2, LO1.3)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC302.1 | 3 | 3 | | | | | | | | | |
| EEPCC302.2 | 3 | 3 | | | | | | | | | |
| EEPCC302.3 | 3 | 3 | | | | | | | | | |
| EEPCC302.4 | 3 | 3 | | | | | | | | | |
| EEPCC302.5 | 3 | 3 | | | 3 | | | | | | |
| **Average** | 3 | 3 | | | 3 | | | | | | |

**Text Books :**

1. Engineering Circuit Analysis, W H Hayt, S M Durbin, J E Kemmerly, 2013, Tata McGraw-Hill Education
2. Network Analysis, M. E. Van Valkenburg, 3rd Edition, PHI Learning
3. Digital Signal Processing, Salivahan S, Edition, Year, Publisher
4. Signals & Systems, Authors A. Nagoor Kani, 2010, Publisher McGraw-Hill Education (India) Pvt Limited
5. Networks and System, D. Roy Choudhury, 2nd Edition, New Age International.

**Reference Books :**

1. Network Analysis and Synthesis, F. F. Kuo, John Wiley and sons
2. Network Analysis and Synthesis, B. Somanathan Nair, Elsevier Publications
3. Digital Signal Processing, 2001, Mitra S.K, TMH Publication
4. Digital Signal Processing, Proakis & Manolakis, 1995, PHI Publication

**Other Resources :**

1. NPTEL/ Swayam Course: Basic Electric Circuits By Prof. Ankush Sharma, IIT Kanpur :- Web link - https://swayam.gov.in/nd1_noc19_ee36/preview
2. NPTEL Course: Basic Electrical Circuits by Prof. Nagendra Krishnapura, IIT Madras:- Web link - https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee64/

**IN-SEMESTER ASSESSMENT (75 Marks)**

### 1. Continuous Assessment (20+25@ Marks)

**Continuous Internal Assessment of Theory (20 marks)**

Class test 1: 5 Marks
Class test: 2 :5 Marks
Open notes test: 5 Marks
Regularity and attentiveness: 5 Marks

**Continuous Internal Assessment of Tutorial (25 marks)**

Minimum ten Tutorials: 20 Marks
Each tutorial consists of 5 questions which will be shared in advance. Doubts will be cleared during the tutorial session. Solution of the selected questions is to be submitted at the end of each session.
Regularity and attentiveness: 5 Marks

### 2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% of the syllabus

**END SEMESTER EXAMINATION (50 Marks)**

End semester examination will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC303 | ELEMENTS OF POWER SYSTEM | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. ESC102- Basic Electrical Engineering

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer and The World
4. PO 8: Individual and team work
5. PO 9: Communication

**Course Objectives:**

1. To impart the knowledge of electrical system, various energy sources towards its sustainability
2. To familiarize with transmission line parameters and formulate them for different power system configurations
3. To introduce the representation of power system network and model it to analyse its performance.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>Power System is the backbone of modern infrastructure. It is responsible for generation, transmission and distribution of electrical energy to residence, commercial and industrial establishments and even to agriculture. Studying this subject will give better insights how this critical infrastructure operates. As the demand for electricity continues to rise globally, ensuring energy security becomes increasingly important. The knowledge of power systems allows students to understand the challenges associated with meeting this demand and the strategies for ensuring a sustainability. | **01** |
| **01.** | **Introduction:** | **6-8** |
| | ***Learning Objective/s:***<br>*To gain the knowledge of both conventional and alternative energy sources utilized in power production, and to compare conventional methods with renewable ones in pursuit of sustainability, as well as to familiarize oneself with the economic terms associated with power system operations.* | |

| | | |
|---|---|---|
| | **Contents:**<br>Single line diagram of typical AC supply system, Conventional energy sources; Thermal power plant (block diagram, Rankine cycle), Hydro power plant (Schematic and types of HPP, Pumped storage power plant, Gas Turbine power plant (basic principle, types of GTP), Nuclear (Nuclear reactor, function of each component), Oil (Block diagram).<br>Review of Non-Conventional Energy Sources: Solar PV, Wind, Fuel Cell, and Geothermal energy. Co-relation of $CO_2$ emission with reference to conventional power plant<br>Economics of Power Generation: Connected load, maximum demand, demand factor, Average load, load factor, diversity factor, Load Curves and Selection of Generating Units | |
| | ***Self-Learning Topics:***<br>*Societal impact of renewable energy sources.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 To apply the knowledge of fundamental engineering to understand basic operation of various power plants. (P.I.-1.3.1)*<br>*LO1.2 To apply the electrical engineering concepts to understand general structure of power system network and economics of power generation. (P.I.-1.4.1)*<br>*LO1.3 To understand the relationship between fossil fuel consumption by conventional power plants and CO2 emissions. (P.I.-6.3.2)*<br>*LO1.4 Demonstrate the societal impact of renewable energy sources towards energy sustainability by presenting it as a group work. (P.I.- 8.3.1, 9.2.2)* | |
| **02.** | **Single Phase Transformer and Polyphase Circuits** | **8-10** |
| | ***Learning Objective/s:***<br>*To gain the knowledge of single-phase transformers and evaluate their performance through equivalent circuit parameters, and to grasp the concepts of three-phase networks and compute the three-phase power across various network configurations.* | |
| | **Contents:**<br>Working principle of single-phase transformer, EMF equation of a transformer, Transformer losses, Actual (practical) and ideal transformer, Phasor diagram (considering winding resistance and magnetic leakage), Equivalent circuit, Open-circuit test (no-load test), short circuit (SC) test, efficiency.<br>Generation of Three-Phase Voltages, voltage & current relationships in Star and Delta Connections, three phase power measurement. | |
| | ***Self-Learning Topics:***<br>*Condition for maximum efficiency and All day efficiency* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 To apply fundamental engineering concepts to understand the working principle of single phase transformer and transformer losses. (P.I.-1.3.1)*<br>*LO2.2 To apply the electrical engineering concepts to derive the EMF equation of transformer.(P.I.-1.4.1)*<br>*LO2.3 To identify the test to derive the equivalent circuit parameters of the transformer, and develop the equivalent circuit of the transformer.(P.I.-2.1.2)* | |

| | | |
|---|---|---|
| | *LO2.4 To identify phasor relationship for star and delta connected three phase network and calculate the power in three phase circuits.(P.I.-2.1.3)* | |
| **03.** | **Three Phase Transmission/Distribution Line and Its Components** | **6-8** |
| | ***Learning Objective/s:***<br>*To acquire the knowledge of different types transmission system and different types of overhead line insulator and apply non-uniform voltage distribution concept to analyze performance of insulator string* | |
| | **Contents:**<br>Three Phase transmission line (Symmetrical and Unsymmetrical spacing), Single Circuit and Double Circuit transmission line, Representation of three phase distribution line. Concept of Composite conductor, bundle conductor and their application. Types of overhead line insulator, potential distribution across insulator string, string efficiency, methods for improving string efficiency. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 To apply fundamental engineering concepts to identify different types of conductor and system and specify their role in transmission and distribution network. (P.I.-1.3.1)*<br>*LO 3.2 To apply electrical engineering concepts to identify different types of overhead line insulators and their applications in power system network. (P.I.-1.4.1)*<br>*LO3.3 To identify the knowledge of potential distribution across the insulator string to derive the expression for string efficiency. (P.I.-2.1.3)*<br>*LO3.4 To identify among the different methods to apply for the string efficiency improvement. (P.I.-2.2.3)* | |
| **04.** | **Transmission / Distribution Line Parameters** | **8-10** |
| | ***Learning Objective/s:***<br>*To acquire the skill, to identify the line parameters and derive expressions for transmission line parameters for different configurations of power system network* | |
| | **Contents:**<br>Definition of inductance, internal and external flux linkage of single conductor, inductance of single phase two wire line, inductance of three phase three wire line with symmetrical and unsymmetrical spacing, concept of GMR and GMD, inductance of three phase double circuit line, inductance of bundle conductor lines, Capacitance of transmission line, capacitance of single phase line, capacitance of three phase line with symmetrical and unsymmetrical spacing. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics:***<br>*Resistance of transmission line, skin effect, proximity effect*<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO4.1 To apply the fundamental engineering concepts to derive magnetic flux linkage with the conductor and electrostatic potential on the charged conductor. (P.I.-1.3.1)*<br><br>*LO4.2 To apply the knowledge electrical engineering to derive the expression of inductance and capacitance for different system configurations. (P.I.-1.4.1)*<br><br>*LO4.3 To identify the knowledge of transposition of conductors in three phase unsymmetrical spacing transmission line network to derive inductance and capacitance. (P.I.-2.1.3)*<br><br>*LO4.4 To identify and apply the system of GMR and GMD, to find the inductance of multi-conductor configurations of a transmission line. (P.I.-2.1.2)* | |
| **05.** | **Representation of Power System Components** | **3-5** |
| | ***Learning Objective/s:***<br>*To gain the knowledge to calculate the PU values of each power system components and apply it to get the simplified per unit impedance diagram of complex three phase network* | |
| | **Contents:**<br>Single phase solution of balanced three phase networks, one-line diagram and impedance or reactance diagram, Per Unit (PU) system, advantage of PU system, PU impedance diagram | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO5.1 To apply the concept of fundamental engineering to convert complex three phase network into simple single line diagram. (P.I.-1.3.1)*<br><br>*LO 5.2To apply the concept of electrical engineering to derive the per unit equivalent circuit of a transformer. (P.I.-1.4.1)*<br><br>*LO5.3 To identify the parameters of complex three phase network to calculate its equivalent per unit value on the base values. (P.I.-2.1.2)*<br><br>*LO5.4 To reframe complex three phase network into its equivalent per unit impedance diagram. (P.I.-2.2.1)* | |
| **06.** | **Performance of Transmission Line** | **6-8** |
| | ***Learning Objective/s:***<br>*To acquire the knowledge of modelling of transmission line concept to determine performance parameters of transmission line* | |
| | **Contents:**<br>Classification and modelling of short, medium and long lines, regulation and efficiency of short and medium transmission lines, evaluation and estimation of generalized circuit constant (ABCD) for short and medium lines. | |
| | ***Self-Learning Topics:***<br>*Ferranti effect* | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1 To apply the concept of electromagnetic wave propagation over a transmission line to model it into as short, medium and long transmission line. (P.I.-2.3.1)*<br>*LO6.2 To apply the knowledge of electrical engineering to solve short, medium and long transmission line models. (P.I.-2.4.1)*<br>*LO6.3 To identify the phasor relationship between the equivalent electrical parameters of short, medium transmission line to develop its phasor diagram. (P.I.-2.1.3)* | |
| | **Course Conclusion**<br>The conclusion of an Elements of Power System course would typically emphasize the foundational understanding gained in various aspects of power systems, including generation, transmission, and distribution. Additionally, it could stress the importance of sustainable and efficient energy generation to meet growing demands while minimizing environmental impact. It also could stress the significance of applying this knowledge to solve practical problems and design efficient and reliable power systems. Ultimately, the conclusion might encourage students to continue exploring advanced topics in power engineering and to contribute to the development of sustainable and resilient energy infrastructure. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply Electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, electrical engineering and other relevant knowledge that applies to a given problem |
| 2.2.1 | Reframe complex problems into interconnected sub problems |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.3.1 | Combine scientific principles and engineering concepts to formulate model/s (Mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy. |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models. |
| 6.3.2 | Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |
| 9.2.2 | Deliver effective oral presentations to technical and non-technical audiences. |

**Course Outcomes :**

1. To apply knowledge of electrical engineering to summarize the general structure of power system network and to calculate different terms related to economics of power system. *(LO1.1, LO1.2, LO3.1, LO3.2)*
2. To compare the societal impact of renewable sources with conventional energy sources towards sustainability and present it as group work. *(LO 1.3, LO 1.4)*
3. To analyze the performance of transformer and calculate the three phase power measurement. *(LO2.1, LO2.2, LO2.3, LO2.4)*

4. To analyze string efficiency of insulator string, identify different transmission line parameter and derive the expression for those parameters *(LO3.3, LO3.4, LO4.1, LO4.2, LO4.3, LO4.4)*
5. To apply per unit system representation of complex three phase network and model it as equivalent per unit impedance diagram. *(LO5.1, LO5.2, LO5.3, LO5.4)*
6. To determine the performance parameters of transmission line using modelling techniques. *(LO6.1, LO6.2, LO6.3)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC303.1 | 3 | | | | | | | | | | |
| EEPCC303.2 | | | | | | 3 | | 2 | 2 | | |
| EEPCC303.3 | 3 | 3 | | | | | | | | | |
| EEPCC303.4 | 3 | 3 | | | | | | | | | |
| EEPCC303.5 | 3 | 3 | | | | | | | | | |
| EEPCC303.6 | | 3 | | | | | | | | | |
| **Average** | **3** | **3** | | | | **3** | | **2** | **2** | | |

**Text Books :**

1. “Power System Analysis”, Grainger, J. J., Stevenson, W. D. (2016), McGraw-Hill.
2. “Modern Power System Analysis”, J. Nagrath, D. P. Kothari, 3rd Edition, 2003, Tata McGraw Hill Publishing Co. Ltd.
3. “Power System Analysis”, Saadat Hadi, 2010, TMH Publication.
4. “Electric Machinery”, Bimbhra P. S., 2003, Khanna Publisher
5. “Power Plant Engineering”, Fredrick T Morse, East-West Press Pvt Ltd

**Reference Books:**

1. “Elements of Power System Analysis”, W. D. Stevenson, 4 Edition, TMH Publication
2. “Electrical Power Systems”, Wadhwa C. L., Sixth Edition, New Age International
3. “Electrical Machines”, Nagrath and Kothari, Fifth Edition, TMH Publication

**Other Resources:**

1 NPTEL Course: Power System Engineering By Prof. Debapriya Das, Department of Electrical Engineering, IIT Kharagpur :-Web link- https://nptel.ac.in/courses/108105104/

2 NPTEL Course: Power System Analysis, By Prof. A.K. Sinha, Department of Electrical Engineering, IIT Kharagpur :-Web link- https://nptel.ac.in/courses/108105067/

**IN-SEMESTER ASSESSMENT (50 MARKS)**

**1. Continuous Assessment (20 Marks)**

***Suggested breakup of distribution***

Numerical Assignment/s (min. 20 problems) covering the entire syllabus: 05 Marks
Class test based on above numerical assignment: 05 Marks
Seminar on societal impact of renewable sources: 05 Marks
Regularity and active participation in class: 05 Marks

**2. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% of the syllabus

**END SEMESTER EXAMINATION (50 MARKS)**

End semester examination will be based on syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **PCC** | EEPCC304 | RENEWABLE SOURCES AND ENERGY STORAGE | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. ESC102- Basic Electrical Engineering

**Program Outcomes addressed:**

1. PO 2: Problem analysis
2. PO 3: Design/Development of Solutions
3. PO 7: Environment and sustainability

**Course Objectives:**

1. To review Conventional and Non-conventional energy sources.
2. To give the students basic knowledge of solar and wind energy system
3. To give the students basic knowledge about other renewable energy sources.
4. To explore the various energy storage technologies and their major applications
5. To increase awareness of ES suitability and capacity calculation for given application

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>In our rapidly evolving world, the quest for sustainable energy solutions has become more critical. Renewable energy sources are available in abundance to fuel our planet's future. However, unlocking the full potential of renewable energy requires overcoming challenges such as intermittency and variability. This is where energy storage technologies step in, providing the means to capture and store renewable energy. Together, renewable energy and energy storage is a path towards a greener, more resilient energy future. | **01** |
| **01.** | **Global & Indian Energy Sources: Production, Reserves, & Alternatives** | **2-4** |
| | ***Learning Objective/s:***<br>*To compare India's energy production and reserves with global trends, highlighting regional variations, energy security concerns, and implications for national energy policies and strategies.* | |
| | **Contents:**<br>Worlds and India’s production and reserves of commercial energy sources, energy alternatives, review of conventional and non-conventional energy sources. Statistic of net potential and current generation status of different energy alternatives | |
| | ***Self-Learning Topics:*** | |

| | | |
|---|---|---|
| | *Overview of Global and Indian Energy Landscape: Understand the current energy consumption patterns, sources, and trends both globally and within India.*<br>*Commercial Energy Sources: Study conventional energy sources such as coal, oil, natural gas, and nuclear energy,*<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 State the statistical potential and current generation status of different energy alternatives concerning sustainability goals. (PI 1.1.1, PI 11.2.1)*<br>*LO1.2 Identify various conventional and non-conventional energy sources used for power generation. (PI 1.2.1)*<br>*LO1.3 Compare and contrast the availability and utilization of commercial and non-commercial energy sources in India and the world. (PI 2.2.4)*<br>*LO1.4 Identify the role of energy alternatives in addressing energy security and sustainability. (PI 2.4.4, PI 6.3.2)* | |
| **02.** | **Solar & Wind Energy Technology** | **7-9** |
| | ***Learning Objective/s:***<br>*To identify the process of power generation through solar thermal, solar photovoltaic (PV), and wind energy system.* | |
| | **Contents:**<br>Solar Thermal applications -Review of solar thermal applications, solar thermal conversion devices and storage applications.<br>Solar Photovoltaic- Solar cell, Solar PV modules, MPPT algorithms, types of PV systems: standalone, grid connected systems; BOS of PV system, Battery charge controllers, Power Conditioning Unit, Solar PV Micro-inverters & Solar Plant design<br>Wind Energy Technology: Review of wind energy system and its components, types of wind turbines, characteristics, Power generation and control in wind energy systems, MPPT algorithm, performance calculations of wind energy systems. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Identify the fundamental principles, technologies and processes of power generation through solar and wind energy systems. (PI 1.2.1)*<br>*LO2.2 Apply concept of energy conversion in solar and wind energy technology to develop efficient renewable energy systems. (PI 1.4.1)*<br>*LO2.3 Investigate Maximum Power Point Tracking (MPPT) algorithms employed in solar photovoltaic and wind turbines to maximize power output under varying wind speeds and directions. (PI 2.2.3, PI 11.2.1)*<br>*LO2.4 Design methodology of standalone/ grid connected PV systems adhering to standards and regulations for public safety. (PI 3.1.6, PI 6.2.1)* | |
| **03.** | **Other Non-Conventional Energy Sources: Features and Applications** | **5-7** |
| | ***Learning Objective/s:***<br>*To identify the process of power generation of other non-conventional resources along with its features and application.* | |
| | **Contents:**<br>Review of other nonconventional sources, their features and applications; Biomass, Tidal, Ocean Thermal Electric Conversion, geothermal, and Micro-hydro. | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 Identify the process of power generation through biomass, tidal, ocean thermal electric conversion, geothermal, and micro-hydro system. (PI 1.3.1)*<br>*LO3.2 Identify emerging technologies and innovations in energy generation biomass, tidal, ocean thermal electric conversion, geothermal, and micro-hydro system (PI 1.4.1, PI 11.1.1)* | |
| **04.** | **Energy Storage Systems** | **6-8** |
| | ***Learning Objective/s:***<br>*To identify the significance of energy storage for future sustainability and investigate its potential to alter the energy sector.* | |
| | **Contents:**<br>Storage Needs, Variations in Energy Demand, Interruptions in Energy Supply, Demand for Portable Energy, Environmental and sustainability issues, Necessity of energy storage, different types of energy storage. | |
| | ***Self-Learning Topics:***<br>*Working principle of different energy storage systems*<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Identify the processes, principles, technologies, and applications of energy storage systems. (PI 1.3.1, PI 11.2.1)*<br>*LO4.2 Apply energy conversion and storage concepts to evaluate the effectiveness and reliability of energy storage system. (PI 1.4.1)*<br>*LO4.3 Compare different types of energy storage devices and identify the factors influencing fluctuations in energy demand to mitigate environmental impacts and promote sustainable energy practices. (PI 2.2.4, PI 6.3.2)* | |
| **05.** | **Design, Sizing and Applications of Energy Storage** | **7-9** |
| | ***Learning Objective/s:***<br>*To analyze design considerations for sizing energy storage systems across diverse applications* | |
| | **Contents:**<br>Design considerations for sizing of different types of energy storage systems for various applications, case studies, Battery sizing for stand-alone applications, small scale application- Portable storage systems.<br>E-mobility storage applications- Electric vehicle: V2X, G2V and V2G modes of operation. Hybrid Energy storage systems: configurations and applications, Charging methodologies. | |
| | ***Self-Learning Topics:***<br>*State of the art technology in energy storage* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1 Identify storage applications in e-mobility, including electric vehicles (EVs), and Vehicle-to-Everything (V2X) paradigm along with their implications for energy management and grid integration. (PI 2.3.2, PI 11.2.1)*<br>*LO5.2 Determine specific requirements and constraints for sizing energy storage systems across diverse applications, integrating considerations such as power demand, energy usage patterns, and environmental conditions. (PI 3.1.6, PI 6.3.1)* | |

| | | |
|---|---|---|
| **06.** | **Economic and Policy Considerations** | **10-12** |
| | ***Learning Objective/s:***<br>*To identify energy conversion calculations, energy auditing principles, and methods to improve energy efficiency.* | |
| | **Contents:**<br>Calculations related to energy conversion and energy auditing, and outline their underlying principles, outline the economic and environmental benefits of energy efficiency, current methods employed to improve energy efficiency in all areas of the energy supply sector, principles of distributed generation systems in relationship efficiency and renewable energy systems. | |
| | ***Self-Learning Topics:***<br>*Standards related to energy audit ISO 50002:2014*<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1 Identify the key concepts of energy conversion and energy auditing, including their fundamental principles and significance. (PI 1.3.1)*<br>*LO6.2 Identify the economic and environmental benefits of energy efficiency measures. (PI 6.3.2)*<br>*LO6.3 Identify methods employed to improve energy efficiency across all areas of the energy supply sectors. (PI 1.4.1, PI 11.2.1)* | |
| | **Course Conclusion**<br>In conclusion, renewable energy and energy storage stand at the forefront of the sustainable energy revolution. By harnessing the power of renewable resources and leveraging innovative energy storage technologies, we have the potential to transition towards a cleaner, more resilient energy future. However, realizing this vision requires collaborative efforts from policymakers, industry stakeholders, and the broader community to invest in research, development, and widespread adoption of renewable energy and energy storage solutions. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.1 | Apply statistical analysis to assess renewable energy systems. |
| 1.2.1 | Apply advanced mathematical techniques to model and solve problems in renewable energy systems. |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply Electrical engineering concepts to solve engineering problems. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 2.3.1 | Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy. |
| 2.3.2 | Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required. |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications. |

6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public

6.3.1 Identify risks/impacts in the life cycle of an engineering product or activity

6.3.2 Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability

11.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.

**Course Outcomes:**

1. Identify the fundamental principles, technologies and processes of renewable energy sources and energy storage systems. *(LO1.1, LO1.2, LO2.1, LO3.1, LO3.2, LO4.1, LO6.1)*
2. Apply energy conversion and storage concepts to assess the feasibility of integrating renewable energy systems. *(LO2.2, LO4.2)*
3. Analyse the role of energy storage systems in mitigating the intermittency of wind and solar power for grid stability and standalone applications. *(LO 1.3, LO 1.4, LO2.3, LO 4.3, LO5.1)*
4. Design a standalone/ grid-connected renewable energy system with/ without energy storage solution. *(LO2.4, LO5.2)*
5. Identify the environmental, economic, and sustainability aspects of integrating renewable energy and storage systems into existing energy infrastructure. *(LO1.4, LO2.4, LO4.3, LO5.2, LO6.2)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | P10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC304.1 | 3 | | | | | | | | | | 3 |
| EEPCC304.2 | 3 | | | | | | | | | | |
| EEPCC304.3 | | 3 | | | | 3 | | | | | 3 |
| EEPCC304.4 | | | 3 | | | 3 | | | | | |
| EEPCC304.5 | | 3 | 3 | | | 3 | | | | | |
| Average | 3 | 3 | 3 | | | 3 | | | | | 3 |

**Textbooks:**


1. Weber, Edward P. (Summer 2008). "Review of Alternative Energy: Political, Economic, and Social Feasibility". Washington State Magazine. Retrieved 2008-11-11.
2. Robert Huggins, Fundamentals, Materials and Applications Second Edition, Springer, 2016.
3. Dincer I., and Rosen M. A. (2011); Thermal Energy Storage: Systems and Applications, Wiley.
4. Ahmed Faheem Zobaa, Energy storage – Technologies and Applications, InTech Publication 2013.
5. K.T. Chau, Energy Systems for Electric and Hybrid Vehicles, IET, UK, 2016.


**Reference Books:**


1. Green M.A “Solar Cells”: Operating Principles, technology and System Applications, Prentice Hall Inc, Englewood Cliffs N.J, U.S.A, 1982.
2. Chetan Singh Solanki, Solar Photo Voltaics , PHI Learning Pvt Ltd., New Delhi,2009 Hashem Nehrir and Caisheng Wang, Modeling and control of fuel cells: Distributed Generation Applications, IEEE Press, 2009.
3. S. Chakraborty, M. G. Simões and W. E. Kramer, Power Electronics for Renewable and Distributed Energy System, Springer 2013.
4. N. Femia, G. Petrone, G. Spagnuolo and M. Vitelli, Power Electronics and Control Techniques for Maximum Energy Harvesting in Photovoltaic Systems, CRC Press, 2013.
5. J.F. Manwell and J.G. McGowan, Wind Energy Explained, theory design and applications, Wiley publication
6. Leo J.M.J. Blomen and Michael N. Mugerwa, “Fuel Cell System”, New York, Plenum Press, 1993.

7. Felix A. Farret and M. Godoy Simoes, Integration of Alternative Sources of Energy, 2006, John Wiley and Sons
8. M. Ehsani, Y. Gao, and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Second Edition, CRC Press.

**Other Resources:**

1. NPTEL Course: Renewable Energy Engineering by Prof. Vaibhav Vasant Goud, Prof. R. Anandalakshmi, IIT Guwahati: -Web link- https://nptel.ac.in/courses/103103206
2. NPTEL Course: Non-Conventional Energy Systems by Prof. L. Umanand, IISc-Bangalore: -Web link- https://nptel.ac.in/courses/108108078

**IN-SEMESTER ASSESSMENT (50 MARKS)**

1. Continuous Assessment (20 Marks)
   *Suggested breakup of distribution*
   Numerical Assignment/s (min 20 problems): 05 Marks
   Class test based on above numerical assignment: 05 Marks
   Think-pair-share worksheets: 05 marks
   Regularity & Active Participation: 5 marks

2. Mid Semester Exam (30 Marks)
   Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LBC | EELBC301 | ELECTRONICS LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **Practical /Oral** | **Total** |
| 25 | 25 | 50 |

**Pre-requisite :**

1. ESL206- Basic Electronics Engineering Laboratory
2. ECMDM3013 – Electronic Components and Circuits

**Program Outcomes addressed :**

1. PO2: Problem analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO8: Individual and team work

**Course Objectives :**

1. To develop skill to select appropriate engineering tools to design and implement electronic circuits.
2. To develop skill to use/represent the collected data to analyse the performance of electronic circuits.
3. To demonstrate effective individual and team based performance in implementing electronic circuits.

| Module | Details | Hrs |
|---|---|---|
| **01.** | ***Learning Objective/s:***<br>*Use various hardware tools to implement the BJT/MOSFET amplifier and analyze its performance as a team.* | **08** |
| | **Theme for designing multiple experiments:**<br>1. To conduct experiments on BJT/MOSFET amplifier to find gain and bandwidth by plotting the frequency response. | |
| | ***Self-Learning Topics:*** *Watch videos on the applications of BJT/MOSFET amplifiers*. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Identify various parameters required for analyzing the performance of voltage amplifiers(P.I.-2.1.2)*<br>*LO1.2 Use systematic techniques to implement the system and evaluate its operation as a team. (P.I.- 2.2.2, 8.2.1,.8.3.1)*<br>*LO1.3 Use a systematic approach to gather data using the hardware tools to analyze the system's performance across various parametric variations. (P.I.- 4.3.1)*<br>*LO1.4 Compare practical results with the theoretical one (P.I.-4.1.4)* | |

| | | |
|---|---|---|
| **02.** | ***Learning Objective/s:***<br>*To investigate the functioning of voltage regulator and 555 timer ICs and analyze its performance as a team.*<br><br>**Theme for designing multiple experiments:**<br>2. Implement a fixed/adjustable voltage regulator circuit to get a fixed/adjustable DC with suitable AC-DC conversion stage.<br>3. Implement Astable /Monostable multivibrator circuits using 555 timer IC. | **08** |
| | ***Self-Learning Topics:*** *Watch videos on the applications of voltage regulator and 555 timer ICs.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Implement the circuit as a team and use systematic procedures to gather the data using hardware tools for analyzing the performance of voltage regulator and timer ICs. (P.I.-4.3.1, 8.2.1,.8.3.1)*<br>*LO2.2 Identify various parameters required for analyzing the performance of regulator and timer ICs. (P.I.-2.1.2)*<br>*LO2.3 Use the collected data to produce valid results. (P.I.- 2.2.2)*<br>*LO2.4 Compare practical results with the theoretical one (P.I.-4.1.4)* | |
| **03.** | ***Learning Objective/s:***<br>*To investigate the functioning of op-amp 741IC and analyze its performance for linear and non-linear applications as a team.* | **08** |
| | **Theme for designing multiple experiments:**<br>4. Implement inverting/non-inverting amplifier, adder/ Subtractor, and Schmitt trigger/comparator circuits using op-amp. | |
| | ***Self-Learning Topics:*** *Watch videos on the applications of op-amp circuits.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 Implement the circuit as a team and use systematic procedures to gather the data using hardware tools for analyzing the applications of operational amplifiers. (P.I.- 4.3.1, 8.2.1,.8.3.1)*<br>*LO3.2 Identify various parameters required for analyzing the performance of op-amps (P.I.-2.1.2)*<br>*LO3.3 Use the collected data to evaluate its performance. (P.I.- 2.2.2)*<br>*LO3.4 Compare the practical results with the theoretical results ((P.I.- 4.1.4)* | |
| **04.** | ***Learning Objective/s:***<br>*Use appropriate hardware tools to design and investigate the performance of combinational and sequential digital circuits as a team.* | **06** |
| | **Theme for designing multiple experiments:**<br>5. Design and implement Adder/ Subtractor /decoder/ demultiplexer /mod N counters using gates and flip-flops. | |
| | ***Self-Learning Topics:*** *Watch videos on the applications of combinational circuits and sequential digital circuits.*<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Implement the digital circuit as a team and use systematic procedures to gather the data using hardware tools for analyzing the performance. (P.I.-4.3.1, 8.2.1,.8.3.1)*<br>*LO4.2 Identify various parameters required for analyzing the performance of op-amps. (P.I.-2.1.2)*<br>*LO4.3 Use the collected data to evaluate its performance. (P.I.- 2.2.2)* | |

| | | |
|---|---|---|
| | *LO4.4 Apply the K-map tool to simplify to design combinational and sequential circuit for various applications. (P.I.-3.2.1)*<br>*LO4.5 Develop the combinational circuit using the simplified result (P.I.-3.2.2)*<br>*LO4.6 Compare the practical results with the theoretical results ((P.I.- 4.1.4)* | |
| | **Minimum 02 experiments from each module, and total at least 10 experiments** | **30** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 4.1.4 | Establish a relationship between measured data and underlying physical principles. |
| 4.3.1 | Use appropriate procedures, tools and techniques to conduct experiments and collect data. |
| 3.2.1 | Apply formal idea generation tools to develop multiple engineering design solutions. |
| 3.2.2 | Build models/prototypes to develop a diverse set of design solutions. |
| 8.2.1 | Demonstrate effective communication, problem solving, conflict resolution and leadership skills |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts |

**Course Outcomes :**

1. Use appropriate hardware tools and techniques to conduct experiments and collect data to analyse the performance of analog and digital circuits. *(LO1.1, LO1.3, LO1.4, LO2.1, LO2.2, LO2.3, LO2.4, LO3.1,LO3.2, LO3.3, LO3.4,LO4.1,LO4.2,LO4.3,LO4.6)*
2. Apply the knowledge of logic gates and flip-flops to design and develop combinational and sequential logic circuits.*(LO4.4, LO4.5)*
3. To gain skill in demonstrating the performance as a team with individual contribution from all team members. *(LO1.2, LO2.1, LO3.1, LO4.1)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELBC301.1 | | 3 | | 3 | | | | 3 | | | |
| EELBC301.2 | | 3 | 3 | 3 | | | | 3 | | | |
| EELBC301.3 | | 3 | | 3 | | | | 3 | | | |
| **Average** | | 3 | 3 | 3 | | | | 3 | | | |

**Text Books :**


1. Electronic Devices and Circuit Theory, Robert Boylestad and Louis Nashelsky, 10th Edition, 2013, Pearson India Ltd.
2. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, 4th Edition, 2015, Pearson India Ltd.
3. Integrated Electronics, Millman and Halkias, 2nd Edition, 2007, McGraw Hill
4. Modern Digital Electronics, R.P.Jain, 4th Edition, 2009, McGraw Hill
5. Digital principal and Applications, Malvino & Leach, 8th Edition, 2014, McGraw Hill Education.


**Reference Books :**


1. Electronic Devices and Circuits, David A Bell, 5th Edition, 2017, Oxford University Press
2. Electronic Devices, Thomas L.Floyd, 10th Edition, 2021, Pearson Education

3. Electronic Devices and Circuits, S. Salivahanan and N. Suresh Kumar, 4th Edition, 2017, McGraw Hill Education.
4. Introduction to Logic Design, Alan b. Marcovitz, 3rd Edition, 2009, McGraw Hill Education.

**Other Resources :**

1. NPTEL Course: Analog Electronic Circuits By Prof. Shanti Pavan , Department of Electrical Engineering, IIT Madras :-Web link- https://archive.nptel.ac.in/courses/108/106/108106188/
2. NPTEL Course: Digital Electronic Circuits By Prof. Goutam Saha, Department of Electrical Engineering, IIT Kharagpur. Web link- https://archive.nptel.ac.in/courses/108/105/108105132/

## CONTINUOUS ASSESSMENT (25 Marks)

***Suggested breakup of distribution***

- Lab Experiments: 10 Marks
- Internal Assessment (10 marks)
  Evaluating proficiency in the field by assessing the candidate's capability to execute connections or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through data analysis during regular laboratory session.
- Observation & Active Participation: 5 marks

## END SEMESTER EXAMINATION (Practical/Oral Exam) (25 Marks)

**Practical and Oral Examination:**

Two examiners, one Internal and one External will do the evaluation.

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formula. It will be checked by the examiners and evaluated out of 05 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections and take readings. The connections and output are verified by the examiners. The weightage is 05 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LBC | EELBC302 | ELECTRICAL SYSTEM LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **Practical /Oral** | **Total** |
| 25 | 25 | 50 |

**Pre-requisite:**

1. ESC102-Basic Electrical Engineering

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct investigations of complex problems
4. PO5: Modern tool usage
5. PO8: Individual and team work

**Course Objectives:** To impart knowledge on

1. The choice of suitable tests to obtain performance curves of transformers, DC machines, and transmission lines.
2. Conduction of experiments on transformers, DC machines, and transmission lines to draw valid conclusions about the performance curves.
3. Derivation of steady state mathematical models of transformers and transmission lines based on the test data, and forecasting the performance curves.
4. Selection and usage of relevant hardware and software tools to analyse simple power system networks effectively.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>This is a laboratory course covering the fundamentals of single phase transformers, DC motors, and transmission lines which will play a vital role in the education of electrical engineering students by providing hands-on experience, reinforcing theoretical concepts, developing practical skills, and fostering teamwork with an introduction to safety awareness when working with high voltage equipment. | |
| **01.** | **Single Phase Transformer** | **10** |
| | ***Learning Objective:***<br>*To develop skill in obtaining and analyzing the performance curves of a given single-phase transformer by conducting suitable tests.* | |
| | **Content:**<br>Construction and operational principle of single-phase transformer, open-circuit (OC) and short-circuit (SC) tests, Sumpner's (back to back) test, equivalent circuit, parallel operation, and performance analysis of transformers | |

| | | |
|---|---|---|
| | **Theme for designing multiple experiments:**<br>1. Analyze various parts of transformers and comprehend the operational principle.<br>2. Derive the steady-state equivalent circuit and predict the performance curves of single-phase transformers through relevant tests.<br>3. Assess performance curves through direct load test on both isolated and parallel-connected single-phase transformers. | |
| | ***Self-Learning Topics:***<br>*Watch videos on constructional details and operational principle of single /three phase transformers to get valuable insight into their design and functionality.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: As a team, analyze the importance of the different elements in the magnetic, electric, and thermal circuits of a transformer, by applying the fundamental principles of energy transfer (1.3.1, 8.2.2).*<br>*LO 1.2: Select suitable meters and perform open circuit (OC) and short circuit (SC) tests on single phase transformer (4.1.3).*<br>*LO 1.3: Develop the steady-state mathematical model of single phase transformers, outlining the underlying assumptions (2.3.1).*<br>*LO 1.4: Predetermine, plot and analyze the performance curves obtained from the OC & SC test data of transformer (4.3.3).*<br>*LO 1.5: Perform Sumpner's test on single-phase transformers taking care of safety aspects, then compare it with OC and SC tests to assess their applicability in various situations. (2.2.4, 6.1.1).*<br>*LO 1.6: Conduct load test on single phase transformer, analyze and interpret the results obtained and correlate them with theoretical principles) (4.1.4).*<br>*LO 1.7: Conduct polarity test to ensure safe connection when paralleling two transformers, highlighting its necessity for the proper functioning (1.4.1, 6.1.1).*<br>*LO 1.8: As a team, establish parallel connection between two single-phase transformers, ensuring all necessary conditions are met, and then individually analyze the power distribution between them (2.4.4, 8.2.1).* | |
| **02.** | **DC Motors** | **10** |
| | ***Learning Objective:***<br>*To develop skill in analyzing the performance and speed control methods of a given DC motor by conducting suitable tests.* | |
| | **Content:**<br>Electromechanical Energy Conversion, Principle, Energy stored in magnetic field, Field and co energy, Force and torque equations, Torque in singly and doubly excited systems. Construction of DC machine, Commutator and brushes, Back EMF, Torque equations, Types of DC machines, Armature reaction, Characteristics (Speed-Torque & Performance) of DC motors. Necessity of starter/soft starting, Speed control and braking methods, Swinburne's test. | |
| | **Theme for designing multiple experiments:**<br>1. Analyze various parts of DC motors and comprehend the operational principle.<br>2. Analyze the performance characteristics of DC motor by conducting direct and indirect tests.<br>3. Conduct various speed control methods and electrical braking methods of DC motors. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics:***<br>*Watch videos on constructional details and operational principle of DC motors to get valuable insight into their functionality.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: As a team, identify the key components of DC machines and clarify the roles of each part. (1.3.1, 8.2.2).*<br>*LO 2.2: Ensure safety precautions, then demonstrate the conversion of electrical energy into linear mechanical motion using a basic electromechanical system (1.4.1, 6.1.1).*<br>*LO 2.3: Predetermine and plot the efficiency curve of a DC shunt/compound motor by conducting suitable test and compare the results with that of direct load test (2.2.3, 4.3.3).*<br>*LO 2.4: As a team, conduct load tests on different types of DC motors to gather their performance data and assess their suitability for diverse applications (2.2.3, 8.2.1).*<br>*LO 2.5: Use armature and field control to adjust the speed of a DC motor, analyze their speed ranges, and ensure safety precautions are followed. (2.4.4, 6.1.1).*<br>*LO 2.6: Test different electrical braking methods on a DC motor, assess the stopping time for each approach, and document safety precautions implemented throughout the testing process. (2.4.4, 6.1.1).* | |
| **03.** | **Transmission Lines** | **10** |
| | ***Learning Objectives:***<br>*To analyze simple power system networks using hardware/software tools.* | |
| | **Content:**<br>Classification and modelling of short, medium and long lines, regulation and efficiency of short and medium lines, Ferranti effect, estimation of generalized circuit constant (ABCD) for short and medium line, VAR compensation (only basics), Introduction to Power System Analyzer software (like ETAP, PSS Sincal). | |
| | **Theme for designing multiple experiments:**<br>1. Conduct suitable tests on the given transmission line model and obtain the ABCD parameters.<br>2. Predetermine the voltage regulation of transmission line for various power factor loads using the test data<br>3. Analyze the effect of basic VAR compensation on receiving end voltage profile.<br>4. Use power system analyzer software for simple basic power system analysis | |
| | ***Self-Learning Topics:***<br>*Watch videos on different software available for power system analysis to get valuable insight into their functionality.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Conduct tests on the given transmission line model to obtain the A, B, C, D parameters stating the assumptions made (2.3.1).*<br>*LO 3.2: Predetermine, plot and analyze the voltage regulation of transmission line for various power factor loads using the test data (4.3.3).*<br>*LO 3.3: Observe and analyze Ferranti effect in transmission line (2.2.2).*<br>*LO 3.4: Analyze the effect of basic VAR compensation on receiving end voltage profile of distribution line (2.2.3).*<br>*LO 3.5: Use power system analyzer software for simple basic power system analysis (5.1.1).* | |
| | **Minimum 03 experiments from each module, and total at least 10 experiments** | **30** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 2.3.1 | Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy. |
| 2.4.4 | Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |
| 4.1.3 | Apply appropriate instrumentation and/or software tools to make measurements of physical quantities |
| 4.1.4 | Establish a relationship between measured data and underlying physical principles. |
| 4.3.3 | Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions. |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities. |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level |
| 8.2.1 | Demonstrate effective communication, problem-solving, conflict resolution and leadership skills. |
| 8.2.2 | Treat other team members respectfully |

**Course Outcomes:** Learner will be able to

1. Choose suitable tests, conduct experiments on transformers and DC machines as a team, while prioritizing safety measures, and collect the necessary data to derive the performance curves. *(LO 1.1, LO 1.2, LO 1.7, LO 2.1, LO 2.2, LO 2.4)*
2. Develop mathematical models for transformers and transmission lines in steady state to derive the performance curves.*(LO 1.3, LO 1.4, LO 3.1)*
3. Apply fundamental concepts of transformers, DC machines, and transmission lines to analyse the performance curves and draw valid conclusions.*(LO 1.5, LO 1.6, LO 1.8, LO 2.3, LO 2.5, LO 2.6, LO 3.2, LO 3.3)*
4. Utilize appropriate hardware and software tools to analyse fundamental power system networks effectively. *(LO 3.4, LO 3.5)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELBC302.1 | 3 | 2 | | 2 | | 3 | | 3 | | | |
| EELBC302.2 | | 3 | | 2 | | | | | | | |
| EELBC302.3 | | 3 | | 3 | | 3 | | 2 | | | |
| EELBC302.4 | | 2 | | | 2 | | | | | | |
| **Average** | **3** | **2.5** | | **2.3** | **2** | **3** | | **2.5** | | | |

**Text Books :**

1. Electric Machinery, Bimbhra P.S., Seventh Edition, 1990, Reprint: 2018, Khanna Publisher

2. Power System Engineering, D. P. Kothari, I. J. Nagrath, Third Edition, 2019, Mc Graw Hill

**Reference Books :**


1. Performance and Design of Alternating Current Machines, M.G. Say, First Edition, 2002, CBS.
2. Electric Machines, Ashfaq Husain, Haroon Ashfaq, Third Edition, 2016, Dhanpat Rai and Co.
3. Electric Machinery, A.E. Fitzgerald, Kingsly, Stephen, Sixth Edition, 2002, McGraw-Hill Education
4. Elements of Power System, W. D. Stevenson, Fourth Edition, 1982, McGraw-Hill


**Other Resources :**

1. NPTEL Course: Electrical Machines by Prof. G. Bhuvaneshwari, Dept. of Electrical Engineering, IIT-Delhi. Weblink:- https://nptel.ac.in/courses/108/102/108102146/
2. Course: Power System Analysis by Prof. Debapriya Das, Dept. of Electrical Engineering, IIT, Kharagpur. Weblink: - https://swayam.gov.in/nd1_noc19_ee62/preview

## CONTINUOUS ASSESSMENT (25 Marks)

***Suggested breakup of distribution***

- Practical Exercises - 10 Marks (Readiness to perform experiment (2 Marks), Performance (2 Marks), Report writing (2 Marks), Interpretation of result (2 Marks), Regularity in Submission (2 Marks))
- Internal Assessment - 10 Marks

  Evaluating proficiency in the field by assessing the candidate's capability to execute connections or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through data analysis during regular laboratory session.
- Regularity and active participation – 5 Marks

## END SEMESTER EXAMINATION (25 Marks)

**Two examiners, one Internal and one External will do the evaluation.**

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formulae. It will be checked by the examiners and evaluated out of 05 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections and take readings. The connections and output are verified by the examiners. The weightage is 05 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
- Students will then be appearing for Oral test in front of both Internal and External examiners. The weightage of Oral test will be of 10 Marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| SBL | EESBL301 | PYTHON LABORATORY | 02 |

| Examination Scheme | | |
|---|---|---|
| Continuous Assessment | End Semester Examination (ESE) | Total |
| 50 | 50 | 100 |

**Pre-requisite :**

1. BSC101- Engineering Mathematics-I
2. ESL103- Programming Laboratory-I (C)
3. ESL205- Programming Laboratory-II (Java)
4. BSC204- Engineering Mathematics - II

**Program Outcomes addressed :**

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Modern tool usage
6. PO8: Individual and team work

**Course Objectives :**

1. Tools used for Python programming and error debugging.
2. Fundamentals concepts of python operators, math functions, flow control instructions, libraries, GUI toolkits, database operations in different types of applications.
3. Fundamental concepts and applications of object oriented programming concepts using Python.
4. Representation, visualization and analysis of data using arrays and advanced Python libraries.
5. Development of GUI using Tkinter and database operations.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>This is a foundation course on Python. Python is widely used across various industries and domains due to its versatility, simplicity, and the vast ecosystem of libraries and frameworks available. Here are some real-world applications of Python: Web Development, Data Science and Machine Learning, Artificial Intelligence, Scientific Computing, Automation and Scripting, Finance and Trading, Game Development, Education, Healthcare, Internet of Things (IoT) and many more.<br>**Python's versatility allows it to be applied in almost any domain where programming is involved. Its rich ecosystem and active** | **01** |

| | | |
|---|---|---|
| | **community ensure that it remains a top choice for developers across various industries.** | |
| **01.** | **Introduction to Python**<br>***Learning Objective:*** *To acquire knowledge and skill on adaption of suitable tool, fundamental concepts of variables and identifiers, and error debugging to develop a Python program*.<br>**Contents:**<br>History, features and applications in electrical engineering, how to run Python programs. Identifiers, reserved keywords, variables, comments in Python. Indentation, multiline statements, quotes. Input, output, and import functions, Operators in Python.<br>**Theme for designing multiple experiments:**<br>1. Download and install software tools required for writing and executing Python programs.<br>2. Write and execute simple Python programs to understand different operators, variables, quotes, comments, indentation, input, and output functions in Python.<br>***Self-Learning Topics: History of Python, Applications in Electrical Engineering Field***<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Apply knowledge of mathematics and write Python programs to solve simple problems. (1.1.1, 8.2.1, 8.3.1)*<br>*LO 1.2: Apply fundamental concepts of Python programming to solve engineering problems. (1.3.1, 8.2.1, 8.3.1)*<br>*LO 1.3:Identify keywords, operators, and software libraries to write/ execute Python programs to solve problems. (2.1.2, 8.2.1, 8.3.1)*<br>*LO 1.4: Identify the mathematical and other relevant knowledge to write/execute Python programs and apply to a given problem. (2.1.3, 8.2.1, 8.3.1)*<br>*LO 1.5: Identify tools/techniques to build a Python code for solving engineering problem. (5.1.1, 8.2.1, 8.3.1)*<br>*LO 1.6: Adapt suitable programming techniques to build a Python code for engineering problem. (5.1.2, 8.2.1, 8.3.1)* | **04** |
| **02.** | **Data Types, Operators, Flow Control Instructions**<br>***Learning Objective:*** *To acquire knowledge and skill on fundamentals concepts of data types, operators, math functions, flow control instructions, and representation/analysis of data to build a Python program.*<br>**Contents:**<br>Data types, number formats, basic math operations, built in math functions.<br>Data Structures: Lists, Tuples, Sets, and Dictionaries.<br>String operations: If-else, if-elif-else, for loop, while loop, Exception handling, try-except, break-continue, functions.<br>**Theme for designing multiple experiments:**<br>3. Perform math operations using built in functions. | **12** |

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4. Apply flow control instructions to write/execute Python programs for a specific application.
5. Write and execute Python programs to understand operational functionalities of Lists, Tuples, Sets, and Dictionaries.

***Self-Learning Topics: Complete exercies from w3schools.com based on above topics.***

***Learning Outcomes:***
*A learner will be able to*

*LO 2.1: Apply fundamentals concepts of math, cmath libraries, and flow control instructions to solve engineering problems and also execute error debugging. (1.3.1, 8.2.1, 8.3.1)*
*LO 2.2: Apply mathematical techniques using Python to solve engineering problems. (1.1.1,8.2.1, 8.3.1)*
*LO 2.3: Identify suitable function, parameters, and flow control instructions to write/execute and debug Python programs. (2.1.2, 8.2.1, 8.3.1)*
*LO 2.4: Identity relevant knowledge of flow control instructions, exception handling, and data structures applicable to a given problem. (2.1.3, 8.2.1, 8.3.1)*
*LO 2.5: Represent, analyze data using formats/tools such as lists, tuples, sets, and dictionaries. (4.3.3, 8.2.1, 8.3.1)*
*LO 2.6: Synthesize information from raw data using data structures such as lists, tuples, dictionaries. (4.3.4, 8.2.1, 8.3.1)*
*LO 2.7: Identify different libraries and resources for building a Python code to perform mathematical computations and data analysis. (5.1.1, 8.2.1, 8.3.1)*
*LO 2.8: Create/adapt mathematical tools to solve engineering problems. (5.1.2, 8.2.1, 8.3.1)*

</td><td></td></tr>
<tr><td>**03.**</td><td>

**Object Oriented Programming using Python:**

***Learning Objective:*** *To acquire knowledge and skill on fundamental OOP concepts and exception handling to create engineering application using Python programming.*

**Contents:**

Creating class and objects, self-variables, constructors, methods. Inheritance and polymorphism, encapsulation. Assertion, types of exception and exception handling in Python.

**Theme for designing multiple experiments:**

6. Develop a Python code to create an application using object oriented programming concepts.

***Self-Learning Topics: Identify and analyze case studies on OOP aaplications in real world.***

***Learning Outcomes:***
*A learner will be able to*

*LO 3.1: Apply knowledge of mathematics with object oriented programming to solve problems. (1.1.1, 8.2.1, 8.3.1)*
*LO 3.2: Apply fundamental object oriented programming concepts and develop software tools to solve engineering problems. (1.3.1, 8.2.1, 8.3.1)*
*LO 3.3: Identify variables, parameters, and adapt suitable software tools/techniques in OOP to solve engineering problem demonstrating effective communication, conflict resolution and leadership skills. (2.1.2, 8.2.1, 8.3.1)*
*LO 3.4: Identify the mathematical, engineering knowledge to develop application using OOP. (2.1.3, 8.2.1, 8.3.1)*
*LO 3.5: Build a software model using OOP Python with alternate design solutions. (3.2.2, 8.2.1, 8.3.1)*

</td><td>**12**</td></tr>
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| | | |
|---|---|---|
| | *LO 3.6: Identify suitable criteria to build a software model using Python. (3.2.3, 8.2.1, 8.3.1)*<br>*LO 3.7: Use appropriate procedures, tools and techniques to build an application using OOP Python to conduct experiments and collect data. (4.3.1, 8.2.1, 8.3.1)*<br>*LO 3.8: Represent and analyze data to create mathematical or engineering tools to solve engineering problems in a team. (4.3.2, 8.2.1, 8.3.1)* | |
| **04.** | **Data Visualization, and Analysis using Advanced Python Libraries** | **20** |
| | ***Learning Objectives:*** *To acquire knowledge and skill on advanced mathematical computation, representation, visualization, and analysis of data using Matplotlib and Pandas, Numpy, and SciPy libraries of Python to develop applications for solving engineering problem.* | |
| | **Contents:**<br>Visualization using Matplotlib: working with plots (line plot, bar graph, histogram, scatter plot, area plot, pie chart etc.), working with multiple figures.<br>Data manipulation and analysis using Pandas: Introduction to Pandas, importing data into Python, series, data frames, indexing data frames, basic operations with data frame, filtering, combining and merging data frames, Removing Duplicates.<br>Introduction to Objects and Functions of<br>Numpy - core library for scientific computing<br>SciPy - ecosystem of open-source software for mathematics, science, and engineering<br>**Theme for designing multiple experiments:**<br>7. Perform computations and analyze statistical data by using functionalities of advanced Python libraries such as Matplotlib, Pandas, Numpy, and SciPy. | |
| | ***Self-Learning Topics: Identify online data resources for performing intended actions and apply the same base on syllabus.*** | |
| | ***Learning Outcomes:*** | |
| | *A learner will be able to*<br>*LO 4.1: Apply fundamental knowledge of mathematical techniques along with advanced Python libraries to develop data analysis tools. (1.1.1, 8.2.1, 8.3.1)*<br>*LO 4.2: Apply fundamental concepts of advanced Python libraries to solve engineering problems. (1.3.1, 8.2.1, 8.3.1)*<br>*LO 4.3: Identify/adapt suitable tool/library to build programs to develop diverse design solution. (2.1.2, 8.2.1, 8.3.1)*<br>*LO 4.4: Identify relevant knowledge of advanced Python libraries applicable to a given problem. (2.1.3, 8.2.1, 8.3.1)*<br>*LO 4.5: Build data models using advanced Python libraries satisfying suitable criteria. (3.2.2, 8.2.1, 8.3.1)*<br>*LO 4.6: Identify suitable criteria for visualization and analysis of data for evaluation of alternate design solutions. (3.2.3, 8.2.1, 8.3.1)*<br>*LO 4.7: Use appropriate library tools to collect and analyze data for a specific engineering application. (4.3.1, 8.2.1, 8.3.1)*<br>*LO 4.8:Represent, visualize, and analyze data using Matplotlib and Pandas, Numpy, and SciPy libraries. (4.3.3, 8.2.1, 8.3.1)*<br>*LO 4.9: Identify different libraries and resources for building a Python code to perform mathematical computations and data analysis. (5.1.1, 8.2.1, 8.3.1)* | |

| | | |
|---|---|---|
| | *LO 4.10: Create applications using Python libraries to solve Engineering problem. (5.1.2, 8.2.1, 8.3.1)* | |
| **05.** | **GUI Programming and Database Operations.**<br>***Learning Objective/s:*** *To acquire knowledge and skill on creating an application/simulator using GUI programming to solve engineering problem and applying database operations to modify data in a particular application.*<br><br>**Contents:**<br>**Content:**<br>GUI Programming - Writing a GUI with Python: GUI Programming Toolkits, Creating GUI Widgets with Tkinter, Creating Layouts, Radio Buttons and Checkboxes, Dialog Boxes.<br>Creating a simulator for small electrical or electronic system.<br>Database Access - Python's Database Connectivity, Types of Databases Used with Python, MySQL database Connectivity with Python, Performing Insert, Deleting & Update operations on database<br><br>**Theme for designing multiple experiments:**<br>8. Write and execute simple Python programs to develop GUI and perform different database operations.<br><br>***Self-Learning Topics: Study applications of Tkinter GUI in Electrical Engineering Field using case studies or research papers.***<br><br>***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Apply knowledge of mathematical techniques to build a Python GUI to solve mathematical problems. (1.1.1, 8.2.1, 8.3.1)*<br>*LO 5.2: Apply fundamentals of GUI programming and database operations to solve engineering problems. (1.3.1, 8.2.1, 8.3.1)*<br>*LO 5.3: Build a Tkinter GUI program to develop diverse design solutions. (3.2.2, 8.2.1, 8.3.1)*<br>*LO 5.4: Identify criteria and develop alternate design solutions for GUI development. (3.2.3, 8.2.1, 8.3.1)*<br>*LO 5.5: Identify GUI library and its resources for engineering activities. (5.1.1, 8.2.1, 8.3.1)*<br>*LO 5.6: Create an application using Tkinter for particular application. (5.1.2, 8.2.1, 8.3.1)* | **10** |
| | **Course Conclusion**<br>The course emphasizes the development of problem-solving capabilities through structured modules that align with both individual and team-based work. This structure ensures that students are not only familiar with Python's technical aspects but also gain experience in applying Python to solve engineering and mathematical problems effectively. With a strong foundation in Python programming and its libraries, students will be equipped with the knowledge and skills to contribute to a wide range of industries, including electrical engineering, data science, automation, and more. | **01** |
| | **Total** | **60** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.1.1 | Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems. |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem. |
| 3.2.2 | Build models/prototypes to develop a diverse set of design solutions. |
| 3.2.3 | Identify suitable criteria for the evaluation of alternate design solutions. |
| 4.3.1 | Use appropriate procedures, tools and techniques to conduct experiments and collect data. |
| 4.3.2 | Analyze data for trends and correlations, stating possible errors and limitations |
| 4.3.3 | Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions. |
| 4.3.4 | Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions. |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities. |
| 5.1.2 | Adapt the tools and techniques to solve engineering problems. |
| 8.2.1 | Demonstrate effective communication, problem solving, conflict resolution and leadership skills. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |

**Course Outcomes:** A learner will be able to -

1. Identify tools and techniques to write/execute and debug Python programs. *(LO 1.3, LO 1.4, LO 1.5, LO 1.6, LO 2.3, LO 2.4, LO 2.7, LO 3.3, LO 3.4, LO 3.6, LO 3.7, LO 4.3, LO 4.4, LO 4.6, LO 4.7, LO 4.9, LO 5.4, LO 5.5)*
2. Apply fundamental concepts of python operators, math functions, flow control instructions, libraries, GUI toolkits, database operations in specific application. *(LO 1.1, LO 1.2, LO 2.1, LO 2.2, LO 3.1, LO 3.1, LO 4.1, LO 4.2, LO 5.1, LO 5.2)*
3. Create an application using concepts of Object Oriented Programming and database operations in Python. *(LO 2.8, LO 3.5, LO 4.5, LO4.10, LO 5.3, LO 5.6 )*
4. Represent, visualize and analyze data using arrays and advanced Python libraries such as Matplotlib, Pandas, Numpy, and SciPy. *(LO 2.5, LO 3.8, LO 4.8)*
5. Develop a GUI using Tkinter and database operations in Python for a specific application. *(LO 5.3, LO 5.6)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EESBL301.1 | 3 | 3 | | | 3 | | | 3 | | | |
| EESBL301.2 | 3 | 3 | | | 3 | | | 3 | | | |
| EESBL301.3 | 3 | 3 | 3 | | 3 | | | 3 | | | |
| EESBL301.4 | 3 | 3 | 3 | 3 | 3 | | | 3 | | | |
| EESBL301.5 | 3 | 3 | 3 | | 3 | | | 3 | | | |
| **Average** | | | | | | | | | | | |

**Text Books :**

1. "Core Python Programming", Dr. R. Nageswara Rao, Dreamtech Press.
2. "Beginning Python: Using Python 2.6 and Python 3.1", James Payne, Wrox Publication.
3. "Python Programming", Anurag Gupta, G. P. Biswas, McGraw-Hill.
4. "Introduction to computing and problem-solving using python", E Balagurusamy, McGraw Hill Education.

**Reference Books :**

1. "Learning Python", Mark Lutz, O Reily, 4thEdition, 2009.
2. "Programming Python", Mark Lutz, O Reily, 4thEdition, 2010.
3. "Python 3 for Absolute Beginners", Tim Hall and J-P Stacey, 2009.
4. "Beginning Python: From Novice to Professional", Magnus Lie Hetland, , 2nd Edition, 2009.
5. "Core Python Programming", Wesley J. Chun, Second Edition, Pearson.
6. "Taming Python by Programming", Jeeva Jose, Khanna Publishing House.
7. Introduction to Computing and Problem Solving with Python, J. Jose, Khanna Publications.
8. "Python Programming", Seema Thareja, Pearson.

**Other Resources :**

1. Python 3.4.3, By Prof Kannan Moudgalya, Indian Institute of Technology Bombay, Python 3.4.3 - Course (swayam2.ac.in)
2. Python Tutorial, Website link: https://www.w3schools.com/python/default.asp

**CONTINUOUS ASSESSMENT (50 Marks)**
***Suggested breakup of distribution***

- **Laboratory Exercises: 15 Marks**
- **Internal Assessment: 10 Marks**
  As a part of Internal Assessment, students will do course mini project as a team to inculcate teamwork. Students will be tasked with developing a small-scale system using Python. This project-based assessment will require students to apply their knowledge and skills gained throughout the course to design and implement a functional system using Python programming language.
  Course Project Rules in Python:
  1. Group Size: Groups of 2 to 4 members allowed.
  2. Project Proposal: Detailed proposal with scope, objectives.
  3. Project Requirements:
     Develop using Python.
     Encouraged to use relevant libraries and show core concepts understanding.
  4. Presentation:
     Present project features, challenges faced, and solutions.
     Q&A session for evaluation.
  5. Evaluation Criteria:
     Adherence to requirements and objectives.
  Code quality, readability, and organization.
  Functionality, UI/UX (if applicable), and error handling.
  Effective presentation and Q&A skills.

- **Regularity and active participation: 05 Marks**

- **Practical Test: (20 Marks)**

The practical test will be conducted after completion of 50% of laboratory exercises.

- The allocation of laboratory exercises for testing programming and problem-solving skills will be randomized, with each student receiving two or more programs from the exercise list.
- Students will have a designated 2-hour timeframe for code development. After the first hour, an internal examiner will review the progress, offering suggestions for program enhancement to evaluate programming skill. Additionally, problem-solving skill will be assessed.
- During the practical assessment or at its conclusion, students will be queried to evaluate their conceptual understanding, ensuring comprehension.

**END SEMESTER ASSESSMENT (Practical/Oral Exam) (50 Marks)**

For the End semester exams, practical examination will be conducted. The detail of the end-sem evaluation is as follows. It will consist of three sections.

**Practical Examination (20 Marks)**

The section one will have practical exam based on the laboratory exercises conducted during the term. The assessment criteria will be similar to Internal Practical Test.

**Debugging and Output Prediction Exercise (20 Marks)**

The second section involves questions problems such as providing partial code segments with bugs and asking students to identify and correct the errors, predict the output of the corrected code, complete the code, identify the appropriate library etc. This option is designed to prepare students for placements or industry roles by testing their ability to debug and understand code in real-world scenarios.

**Oral (10 Marks)**

Two examiners, one Internal and one External will do the evaluation.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **MNP** | **EEMNP301** | **Mini Project- 1A** | **02 each** |

**Program Outcomes addressed:**

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO3 : Design/Development of Solutions
4. PO4 : Conduct investigations of complex problems
5. PO5 : Modern Tool Usage
6. PO6 : The Engineer the world
7. PO7 : Ethics
8. PO8 : Individual & team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

**Course Objectives**

1. To familiarize students about available infrastructure at Department/Institute level, online resources, plagiarism, expectations from MP 1A and 1B, etc.
2. To guide students in identifying societal or research needs and formulating them into problem statements.
3. To facilitate problem-solving in group settings.
4. To apply basic engineering principles to address identified problems.
5. To foster self-learning and research skills.

**Course Outcomes**

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

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
    - Research/white paper/article/blog writing/publication, etc.
    - Business plan for entrepreneurship product creation
    - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

**Guidelines for the Mini Project**

- At the beginning of semester-III, project guides are required to conduct around 4 hours' orientation sessions including following topics:
  - Familiarizing students about infrastructure available at Department/Institute level and how to use it.
  - How to identify societal problems and formulate project problem statement.
  - How to carry out literature survey.
  - What is plagiarism and what care needs to be taken while writing a report.
  - What is project report template and how it should be used.
  - What are expectations from mini-projects 1A and 1B.
- Mini project may be carried out in one or more form of following:
  Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

**In-Semester Continuous Assessment and End-Semester Examination Guidelines**

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester III (50 marks):

- o 10 marks for the Topic Approval Presentation in front of the progress monitoring committee
- o 15 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
- o 25 marks for the Final Report & Presentation

- Continuous Assessment marks distribution in semester IV (50 marks):
  - o 15 marks for the In-Semester Two Presentations
  - o 10 marks for the Participation in Project Competitions, TPP, etc.
  - o 25 marks for the Final Report & Presentation

The review/progress monitoring committee will assess projects based on the following criteria.

**Semester III:**

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
  - o The first review will focus on finalizing the problem statement (topic approval).
  - o The second review will focus on finalizing the proposed solution.

**Semester IV:**

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
  - o The first review will assess the readiness to build a working prototype.
  - o The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to the above-mentioned points, the following performance criteria shall be included during the in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentations/project competitions/hackathon competitions, etc.

**End-Semester Examination in Semester IV (50 marks):**

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| HSS | HSS301 | PRODUCT DESIGN | 02 |

**Program Outcomes addressed**:

1. PO2 : Problem Analysis
2. PO3 : Design/Development of Solutions
3. PO5 : Engineering Tool Usage
4. PO6 : The Engineer & The World
5. PO7 : Ethics
6. PO10: Project Management & Finance
7. PO11: Life-long learning

**Course Objectives:**

1. Understand the product design process and its user-centered principles.
2. Apply fundamental design principles to create innovative product designs.
3. Demonstrate proficiency in generating and evaluating design concepts through ideation techniques.
4. Evaluate and synthesize sustainable and user-centric design practices in product development.

| Module | Details |
|---|---|
| 01. | **Introduction to Product Design**<br>Overview of product design process, Importance of user-centred design, Design thinking methodologies, Case studies of successful product designs, Introduction to design tools and software (e.g., Sketch, Adobe XD) |
| 02. | **Design Principles and Fundamentals**<br>Understanding design principles (e.g., balance, hierarchy, contrast), Human factors in design (ergonomics, anthropometrics), Material selection and properties, Basics of aesthetics and styling, Hands-on exercises in sketching and prototyping |
| 03. | **Concept Generation and Ideation**<br>Techniques for brainstorming and idea generation, Sketching and visualization techniques, Developing design briefs and specifications,<br>Evaluating and selecting design concepts, Rapid prototyping methods (e.g., 3D printing, CNC machining) |
| 04. | **Renewable energy & Energy efficiency**<br>Detailed overview of the product development lifecycle, Design for manufacturability (DFM) considerations, Cost estimation and budgeting, Collaborative design tools and project management<br>Regulatory and compliance requirements (e.g., safety standards) |
| 05. | **User Experience (UX) Design**<br>Understanding user needs and behaviour, Usability testing and feedback gathering, |

| | |
|---|---|
| | Wire framing and prototyping for digital products, Iterative design process, Accessibility and inclusive design principles |
| 06. | **Sustainability in Product Design**<br>Environmental impact assessment in product design, Sustainable materials and manufacturing processes, Design for disassembly and recycling, Circular economy principles Case studies of eco-friendly product designs |
| **Total No. of Hours: 30** | |

**Course Outcomes :**

1. Apply design thinking methodologies effectively to solve design problems.
2. Demonstrate proficiency in utilizing design tools and techniques for product development.
3. Communicate and collaborate effectively for interdisciplinary teamwork.
4. Create functional and aesthetically pleasing product designs.
5. Integrate sustainable and user-centric design principles into product development processes.

**Text Books :**

1. "Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger, published by McGraw-Hill Education; 7th edition (January 25, 2021).
2. "Engineering Design: A Project-Based Introduction" by Clive L. Dym and Patrick Little, published by Wiley; 4th edition (August 26, 2015).
3. "Universal Principles of Design" by William Lidwell, Kritina Holden, and Jill Butler, published by Rockport Publishers; Revised and updated edition (January 1, 2010).

**Reference Books :**

1. "Sketching: Drawing Techniques for Product Designers" by Koos Eissen and Roselien Steur, published by BIS Publishers; 2nd edition (March 1, 2011).
2. "Materials and Design: The Art and Science of Material Selection in Product Design" by Mike Ashby and Kara Johnson, published by Butterworth-Heinemann; 3rd edition (October 10, 2014).
3. "The Design of Everyday Things" by Don Norman, published by Basic Books; Revised and expanded edition (November 5, 2013).

**Other Resources:**

1. NPTEL Course: Product Design and Development , Prof. Inderdeep Singh, IIT Roorkee
   Weblink:- https://onlinecourses.nptel.ac.in/noc21_me83/preview

2. NPTEL Course: Product Design and Innovation, By Prof. Supradip Das, Prof. Swati Pal, Prof. Debayan Dhar, IIT Guwahati, IIT Guwahati,
   Web link- https://onlinecourses.nptel.ac.in/noc21_de01/preview

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC405 | ENGINEERING MATHEMATICS-IV | 03+01* |

| | Examination Scheme | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20+25@ | 30 | 50 | 1.5 | 2 | 125 |

**Pre-requisite :**

1. BSC101- Engineering Mathematics-I
2. BSC204- Engineering Mathematics-II
3. EEPCC301-Engineering Mathematics-III

**Program Outcomes addressed :**

1. PO1: Engineering knowledge
2. PO2: Problem analysis

**Course Objectives:**

1. To provide the basic knowledge on the concepts of Mathematics in the field of Engineering.
2. To build a foundation to the methodology necessary for solving problems by applying the knowledge of Mathematics to the field of Engineering.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Engineering Mathematics IV is often a foundational course designed to provide students with the mathematical tools and concepts essential for various engineering disciplines. Engineering Mathematics IV has many applications in Electrical engineering such as<br>• Application of in Probability in control systems, communication system and power system.<br>• Application of in Correlation and Regression in Deep learning.<br>• Application of numerical methods used in optimization, simulation and modeling.<br>• Concept of complex numbers and variables provides a knowledge to solve electrical engineering problems. | **01** |
| **01.** | **Probability Theory and Random Variable** | **6-8** |
| | ***Learning Objective/s:***<br>*To analyze random variables using the basic theory of probability and will be able to apply various mathematical techniques in determining probability functions.* | |
| | **Contents:**<br>Conditional Probability, Bayes Theorem, Total Probability Theorem, Definition of Random Variable. Types of Random Variable: Discrete and Continuous, Probability Mass and Density Function. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics:***<br>*Cumulative Distribution and Density Function.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1: Apply mathematical techniques of union, intersection and addition of sets, numbers for finding probabilities of events using Bayes' Theorem and Total Probability Theorem. (P.I.-1.1.1)*<br>*LO1.2: Apply mathematical techniques of integration and summation for finding Expectation, Variance, Probability density function and Probability distribution function. (P.I.-1.1.2)*<br>*LO1.3: Identify if a given Random variable is Discrete or continuous in nature using existing definitions and formulas from Probability. (P.I.-2.1.2)*<br>*LO1.4: Identify independents sets and disjoint sets and use its knowledge in the context of conditional probability. (P.I.-2.1.3)* | |
| **02.** | **Probability Distribution** | **6-8** |
| | ***Learning Objective/s:***<br>*To analyze and identify standard probability distribution functions and apply the knowledge of distribution for finding probabilities of various events.* | |
| | **Contents:**<br>Measures of Central Tendency and Dispersion, Binomial distribution, Poisson Distribution ,Fitting of a Poisson Curve, Gaussian Distribution, Normal Distribution (Standard Normal distribution, Reverse problem of Normal distribution) | |
| | ***Self-Learning Topics:***<br>*Joint Probability Distribution.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Apply mathematical techniques of exponents, algebra and basic probability for finding the probabilities of various events using Binomial, Poisson and Normal Distribution. (P.I.-1.1.1)*<br>*LO 2.2: Apply the advance mathematical techniques of statistics to find the probabilities the random variable (P.I. -1.1.2)*<br>*LO 2.3: Identify the area under a Standard Normal Curve (bounded or unbounded) and use its knowledge in the context of Normal Distribution. (P.I.-2.1.3)*<br>*LO 2.4: Identify whether Poisson distribution or Normal Distribution is applicable to a given problem using basic definitions of distribution and the data inferred from the problem. (P.I.-2.1.1)* | |
| **03.** | **Numerical Methods-I** | **7-9** |
| | ***Learning Objective/s:***<br>*To analyze and apply the appropriate numerical method to solve Numerical differentiation and integration problems.* | |
| | **Contents:**<br>Introduction to Difference Formula, Newton Backward Difference Formula and Newton Forward Difference Formula, Newton Cote Formula, Stirling's Formula, Trapezoidal Rule , Simpson's 1/3rd and Simpson's 3/8th rule | |
| | ***Self-Learning Topics:***<br>*Analysis of numerical errors in differentiation and integration.* | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Apply the Numerical techniques to solve definite integral problems. (P.I.-1.1.1)*<br>*LO 3.2: Apply analytical methods to solve the numerical problems. (P.I.-1.1.3)*<br>*LO 3.3: Identify Analytical method to determine value of definite integral and determine error. (P.I.-2.2.4)*<br>*LO 3.4: Identify the appropriate methods of difference formula to solve interpolation. (P.I.-2.1.3)*<br>*LO 3.5: Identify the numerical differentiation and integration methods to solve various functions and data set in engineering field. (2.2.3)* | |
| **04.** | **Numerical Methods -II** | **7-9** |
| | ***Learning Objective/s:***<br>*To analyze and apply the appropriate numerical method to solve transcendental equation and system of simultaneous equations.* | |
| | **Contents:**<br>Solution of Transcendental Equations: Newton Raphson method, Regula – Falsi Method, Solution of system of linear algebraic equations, Gauss Jacobi Iteration Method, Gauss Seidel Iteration Method. | |
| | ***Self-Learning Topics:***<br>*Bisection Method, Gauss Elimination Method.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Apply Newton Raphson method and Regula Falsi method to solve the transcendental equation. (P.I.-1.1.1)*<br>*LO 4.2: Apply Gauss Jordan or Gauss Siedel Iterative method to solve the system of equations. (P.I.-1.1.2)*<br>*LO 4.3: Identify the appropriate numerical method to solve the system of equation. (P.I.-2.1.3)*<br>*LO 4.4: Examine the limitation for the convergent solution of system of equation using iterative method.( P.I.-2.4.3)* | |
| **05.** | **Correlation and Regression** | **5-7** |
| | ***Learning Objective/s:***<br>*To analyze the mathematical dataset given and apply techniques of correlation and regression to identify the relationships between variables from the dataset.* | |
| | **Contents:**<br>Correlation, Karl Pearson's coefficients of correlation(r), Spearman's Rank correlation coefficient (R): Repeated Rank, Non-repeated rank, Regression, Line of regression, Curve fitting: Linear and Second-Degree Curves. | |
| | ***Self-Learning Topics: Fitting of an exponential Curve*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 5.1: Apply basic mathematical techniques from algebra in finding the lines of regression and regression coefficients. (P.I.-1.1.1)*<br>*LO 5.2: Apply Least Square Method to fit a particular to the given data (P.I.-1.1.2)*<br>*LO 5.3: Identify whether a linear degree curve or a quadratic degree curve is to be fit for the given data set based on the knowledge of Curve Fitting (P.I.-2.2.2)* | |

| | | |
|---|---|---|
| | ***LO 5.4: Identify whether Karl Pearson's or Spearman's coefficient of correlation is to be used in establishing relationship between two variables depending on the dataset given. (P.I.- 2.1.3)*** | |
| **06.** | **Complex Variables-II** | **6-8** |
| | ***Learning Objective/s:***<br>*To analyze if a given function has its harmonic conjugate and apply it for finding the Orthogonal Trajectories of a given mathematical function using the concept of Complex Variables.* | |
| | **Contents:**<br>Milne-Thomson method:<br>Determine analytic function f(z) when real part (u) is given, Determine analytic function f(z) when imaginary part (v) is given, Determine the analytic function when the combination of Real and Imaginary part is given, Harmonic function , and Harmonic conjugate, Orthogonal trajectories. | |
| | ***Self-Learning Topics:***<br>*Linear mapping, bilinear mapping, cross ratio, fixed points.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: To apply the mathematical techniques of calculus and algebra for determining the analytic function using Milne Thomson Formula. (P.I.-1.1.1)*<br>*LO 6.2: To apply the fundamental concept of complex Variables to solve engineering problems. (P.I.-1.3.1)*<br>*LO 6.3: Identify the harmonic function and determine its harmonic conjugate. (P.I.-2.1.2)*<br>*LO 6.4: Identify the analytic functions to solve orthogonal trajectory.(P.I.-2.1.3)* | |
| | **Course Conclusion**<br>Engineering Mathematics provides the problem solving skills necessary for electrical engineering to design, analyze and optimize system and device across a wide range of applications. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.1 | Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems |
| 1.1.2 | Apply advanced mathematical techniques to model and solve engineering problems |
| 1.1.3 | Apply advanced mathematical techniques such as integral and differential equations to describe/solve/construct a mathematical model. |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 2.1.1 | Articulate problem statements and identify objectives |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| 2.2.3 | Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions. |
| 2.2.4 | Compare and contrast alternative solutions to select the best methodology |
| 2.4.3 | Identify sources of error in the solution process, and limitations of the solution. |

**Course Outcomes:** A learner will be able to

1. Analyse random variables and apply the concepts of probability for getting the spread of data.*(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Analyse the mathematical problem given and apply the concepts of distribution in finding probabilities.*(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Identify and apply appropriate numerical methods to solve numerical differentiation, integration and System of equations.*(LO 3.1, LO3.2, LO 3.3, LO 3.4, L 3.5, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Analyse and interpret the data using Correlation and Regression.*(LO5.1, LO5.2, LO5.3, LO5.4)*
5. Apply the concept of complex variables to analyze the function is Harmonic or not, and also determine orthogonal trajectory. *(LO 6.1, LO 6.2, LO6.3, LO 6.4)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC405.1 | 3 | 2 | | | | | | | | | |
| EEPCC405.2 | 3 | 2 | | | | | | | | | |
| EEPCC405.3 | 3 | 2 | | | | | | | | | |
| EEPCC405.4 | 3 | 2 | | | | | | | | | |
| EEPCC405.5 | 3 | 2 | | | | | | | | | |
| **Average** | 3 | 2 | | | | | | | | | |

**Text Books :**

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced engineering mathematics, H.K. Das, S. Chand, Publications

**Reference Books :**

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
2. Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
3. Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
4. Laplace transforms, Murray R. Spiegel, Schaum's Outline Series

**Other Resources :**

1. NPTEL Course: Probability and Statistics By Dr. Somesh Kumar, Department of Mathematics, IIT Kharagpur :-Web link- https://youtu.be/VVYLpmKRfQ8?si=Gh3EtQrLSrEFZMNo
2. NPTEL Course: Complex Analysis by Prof. P. A. S. Sree Krishna, Department of Mathematics, IIT Guwahati :-Web link https://youtu.be/Mwpz1zjPlzI?si=JU090YU2-MxJOXJD

## IN-SEMESTER ASSESSMENT (75 Marks)

### 1. Continuous Assessment (45 Marks)

**Continuous Internal Evaluation of Theory (20 Marks)**
Numerical Assignments: 5 Marks
Class test based on above numerical Assignment: 5 Marks
Team-pair- Solo: 5 Marks
Regularity and attentiveness: 5 Marks
**Continuous Internal Evaluation of Tutorial (25 Marks)**
Minimum six Tutorials: 20 Marks
Regularity and attentiveness: 5 Marks
Students must be encouraged to write at least 6 class tutorials. At least 6 Class tests will be conducted based on class tutorials on entire syllabus. Each class tests carries 20 Marks. Average will be taken of all class tests.

2. **Mid Semester Exam (30 Marks)**
   Mid semester examination will be based on 40% to 50% of the syllabus

**END SEMESTER EXAMINATION (50 Marks)**
End semester examination will be based on the syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC406 | CONTROL SYSTEM | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. EEPCC301- Engineering Mathematics-III
2. EEPCC302-Circuit and Signal Analysis

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis

**Course Objectives:**

1. To impart the knowledge to differentiate real-life applications as open loop or closed loop systems and to obtain mathematical models of the systems.
2. To impart the knowledge to perform time response analysis of the model to predict the system's behaviour.
3. To introduce root locus technique and use this tool to analyse systems for transient and stability.
4. To introduce various frequency-domain techniques to analyse the systems for stability.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>History, importance of control system, analysis and design objectives, control system design process. | **01** |
| **01.** | **Fundamentals of Control System** | **02-04** |
| | ***Learning Objective:***<br>*To apply the fundamentals of control system to identify suitable open loop or closed loop systems for real life applications.* | |
| | **Contents:**<br>Concept of transient, steady state and stability, classifications of control system, concept of feedback, open loop and closed loop system properties. open loop and closed loop example with electrical systems. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1: Apply electrical engineering concepts to identify different components of control system with its significance. (P.I.-1.3.1)*<br>*LO1.2: Use core principles of engineering to understand the importance of Feedback in control system. (P.I.-1.4.1)*<br>*LO1.3: Differentiate open loop and closed loop systems, use this knowledge to identify a suitable system for real life applications. (P.I.-2.1.2)*<br>*LO1.4: Identify major performance criteria for the design of control system. (P.I.-2.1.3)* | |

| | | |
|---|---|---|
| **02.** | **Mathematical Modelling** | **07-09** |
| | ***Learning Objective:***<br>*To formulate transfer function models for complex electrical systems by breaking them down into smaller components or constructing signal flow graphs using electrical and mechanical engineering concepts.* | |
| | **Contents:**<br>Mathematical modelling of electro-mechanical systems, transfer functions, block diagrams, block diagram reductions, signal flow graph, signal flow graphs of electrical circuits, conversion of block diagram to signal flow graph, Mason's gain formula. | |
| | ***Self-Learning Topics:***<br>*Mathematical modelling of mechanical system with and without gears and its Electric Circuit Analog.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1: Formulate the transfer function model for electromechanical system by applying basic concepts in mechanical/electrical engineering. (P.I.-1.3.1)*<br>*LO2.2: Reframe the complex systems into interconnected subsystems, construct transfer function for each subsystem, then reduce to a single transfer function model for the entire system. (P.I.-1.4.1)*<br>*LO2.3: Use electrical engineering concepts to construct signal flow graphs for electrical systems and then to formulate the transfer function model using Mason's rule. (P.I.-2.3.1)*<br>*LO2.4: Apply fundamental engineering concepts to convert transfer function to SFG.(P.I.-2.2.1)* | |
| **03.** | **Time Response Analysis** | **10-12** |
| | ***Learning Objective:***<br>*To analyze the transient, steady state and stability behavior of the system using the time domain specifications.* | |
| | **Contents:**<br>Poles and zeros of the transfer function and their effects on response, step response of standard first order and second order systems, time-domain specifications, effect of addition of poles and zeros, static error coefficients, concept of stability, Bounded Input Bounded Output stability, Routh stability criterion. | |
| | ***Self-Learning Topics:***<br>*Derivation of closed loop transient parameter formula for the second order under damped system with ramp input.* | |
| | ***Learning Outcomes:***<br>***A learner will be able to***<br>*LO3.1: Identify poles and zeros of a system from its transfer function and then analyze it to determine the time response. (P.I.-2.1.2)*<br>*LO3.2: Solve the given transfer function to determine the damping ratio, natural frequency and static error coefficients of a system and use this information to analyze the transient and steady state behavior of the system. (P.I.-2.4.1)* | |

| | | |
|---|---|---|
| | *LO3.3: Construct and interpret a basic Routh array to analyze the system for its stability. (P.I.-2.4.2)* | |
| **04.** | **Root Locus Technique** | **06-08** |
| | ***Learning Objective:***<br>*Use the root locus tool to analyze the transient response and stability of the given systems.* | |
| | **Contents:**<br>Definition and properties of root locus, rules for plotting root locus, impact of gain on root locus, stability analysis using root locus. active and passive compensators in control system. impact of different compensators through root-locus. | |
| | ***Self-Learning Topics:***<br>*Realization of active and passive compensators* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1: Use engineering mathematics and computations to sketch the root locus from the given transfer function model. (P.I.-2.1.2)*<br>*LO4.2: Identify the coordinates of points on the root locus alongside their corresponding gains to analyze the transient behavior and stability of the system. (P.I.-2.4.1)*<br>*LO4.3: Analyze the effect of adding active and passive compensators in control system using root locus. (P.I.-2.4.2)* | |
| **05.** | **Frequency Response Analysis** | **07-09** |
| | ***Learning Objective:***<br>*To analyze the given system for its stability using various techniques in frequency domain such as Bode and Nyquist plots.* | |
| | **Contents:**<br>Bode plot, asymptotic Bode plot, determination of steady state error coefficients, stability analysis using Bode plot, mapping theorem, Nyquist plot, stability analysis using Nyquist plot. | |
| | ***Self-Learning Topics:***<br>*Relation Between Closed-Loop Transient and Closed-Loop Frequency Responses, Relation Between Closed-Loop Transient and Open-Loop Frequency Responses* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1: Use engineering mathematics to sketch the Bode and Nyquist plot, from the given transfer function model. (P.I.-2.1.2)*<br>*LO5.2: Identify the gain, phase margins and cross over frequencies from the Bode and Nyquist plot to analyze the system stability. (P.I.-2.4.1)*<br>*LO5.3: Determine the steady-state error coefficients by sketching Bode plot to analyze the system's steady-state error characteristics. (P.I.-2.4.2)* | |
| **06.** | **State Variable Analysis** | **05-07** |
| | ***Learning Objective:*** | |

| | | |
|---|---|---|
| | *To formulate the state variable models, identify the eigen values and use it to analyze the system behaviour* | |
| | **Contents:**<br>State variable representation of electrical systems, different state space realizations. conversion of state variable models to transfer functions, conversion of transfer functions to state variable models, significance of eigen values, stability analysis. | |
| | ***Self-Learning Topics:***<br>*Solution of state equation using Laplace transform* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1: Formulate the state space model for electrical system by applying linear algebra and the basic concepts in electrical engineering. (P.I.-1.1.1)*<br>*LO6.2: Use engineering mathematics to determine various state space representations for the given system from its transfer function model. (P.I.-1.4.1)*<br>*LO6.3: Identify the Eigen values from the state space model to analyze the system for its stability. (P.I.-2.1.2)* | |
| | **Course Conclusion**<br>The course will conclude with the importance of circuit and signal analysis, for understanding electric power systems, design of electrical system, their behavior, and optimization in various applications, emphasizing the fact that it is a foundation course in Electrical Engineering. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.1.1 | Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| 2.2.1 | Reframe complex problems into interconnected sub problems |
| 2.3.1 | Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy. |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models. |
| 2.4.2 | Produce and validate results through skilful use of contemporary engineering tools and models |

**Course Outcomes:**

1. Apply the fundamentals of engineering to identify a suitable control system for the given application. *(LO1.1, LO1.2, LO1.3, LO1.4)*
2. Formulate mathematical models for control system using transfer function and state space techniques. *(LO2.1, LO2.2, LO2.3, LO2.4, LO6.1, LO6.2)*

3. Apply engineering mathematics to identify the time domain specifications of the given control system, facilitating the analysis of its stability, transient and steady-state behaviour. *(LO3.1, LO3.2, LO3.3, LO6.3)*
4. Analyse the transient behaviour and stability of the system for change in parameters using root locus. *(LO4.1, LO4.2, LO4.3)*
5. Identify the steady state error and stability parameters from the Bode plot to analyse the system behaviour. *(LO5.1, LO5.2, LO5.3)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC406.1 | 3 | 3 | | | | | | | | | |
| EEPCC406.2 | 3 | 3 | | | | | | | | | |
| EEPCC406.3 | 3 | 3 | | | | | | | | | |
| EEPCC406.4 | | 3 | | | | | | | | | |
| EEPCC406.5 | | 3 | | | | | | | | | |
| **Average** | 3 | 3 | | | | | | | | | |

**Text Books:**

1. Control Systems Engineering, Norman S. Nise, Seventh Edition, 2015, John Wiley & Sons
2. Control Systems Engineering, I. J. Nagrath. M. Gopal, Seventh Edition, 2021, New Age International Publisher
3. Modern Control System Engineering, K. Ogata, Fifth Edition, 2010, Prentice Hall.
4. Modern Control Systems, Richard C Dorf, Robert H Bishop, Twelfth edition, 2021, Pearson.
5. Feedback control of Dynamic System, G.F. Franklin, Eighth Edition, 2021, Pearson higher education

**Reference Books:**

1. Control System Engineering, Shivanagraju S. Devi L., 2010, New Age International
2. Control Systems Technology, Curtis Johnson, Heidar Malki, 2002, Pearson
3. Control Systems Engineering, S. K. Bhattacharya,Second Edition, 2015, Pearson.
4. Control Systems, Theory and applications, Smarajit Ghosh, 2013, Pearson

**Other Resources:**

1. NPTEL Course: Control Engineering By Prof. S.D. Agashe, Department of Electrical Engineering, IIT Bombay :-Web link- https://nptel.ac.in/courses/108/101/108101037/
2. NPTEL Course: Control Engineering By Prof. Ramkrishna Pasumarthy, Department of Electrical Engineering, IIT Madras :-Web link- https://nptel.ac.in/courses/108/106/108106098/
3. NPTEL Course: Control Systems By Prof. C.S. Shankar Ram, Department of Design Engineering, IIT Madras :- Web link- https://nptel.ac.in/courses/107/106/107106081/

## IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

*Suggested breakup of distribution*

01 MCQ test strictly as per GATE exam pattern / level: 05 Marks
01 Class test: 05 Marks
Open book test/ Open notes test: 05 Marks
Regularity and active participation: 05 Marks

Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC407 | POWER ELECTRONICS | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. EEPCC302- Circuit and Signal Analysis

**Program Outcomes addressed :**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO4: Conduct investigations of complex problems
5. PO9: Communication

**Course Objectives :**

1. To learn the operation of various power electronic devices and auxiliary circuits needed for power conversion and select them for suitable application.
2. To analyse various power electronic converters and select for an application.
3. To build a strong foundation for further study and implementation of power electronic circuits and systems.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction:** Concept of power electronics, power conversion & its significance, power electronics as an enabling technology in various applications of our day to day life. | **01** |
| **01.** | **Power Semiconductor Devices** | **7-9** |
| | ***Learning Objective/s:*** *Learner will acquire knowledge of various power electronic devices and its features, analyze data sheet and its losses to select a suitable device for power conversion..* | |
| | **Contents:** Characteristics & features of power diode, SCR, power BJT, power MOSFET, IGBT, Safe Operation Area (SOA), understanding datasheet of devices. Wide band gap devices, SiC & GaN and its applications. Comparison & selection of devices. Device losses: Conduction & Switching losses. **Self-Learning Topics:** Solve simple sums to enhance the understanding. | |
| | ***Learning Outcomes :*** | |

| | | |
|---|---|---|
| | *A learner will be able to*<br>*LO1.1 Apply fundamental concepts to plot the characteristics and identify the features of switching devices to select a device (PI-1.3.1).*<br>*LO1.2 Apply electrical engineering concepts to find conduction and switching losses in devices (PI-1.4.1).*<br>*LO1.3 Identify parameters and compare devices to choose them based on the requirements demanded by application (PI-2.1.2).*<br>*LO1.4 Identify information from data sheets of switching devices to understand their operational limits(PI-2.2.2).* | |
| **02.** | **Auxiliary Circuits:** | **6-8** |
| | ***Learning Objective/s:***<br>*Learner will be able to demonstrate the ability to use and design various auxiliary circuits needed for the implementation of power electronic circuits..* | |
| | **Contents:**<br>Need for gate driver circuits, design of Driver ICs, understanding its datasheets, floating power supply, level shifters, bootstrap drivers, isolated gate drivers, voltage & current sensing methods. Need for snubber circuits and its design, Heat sinks and EMI. | |
| | ***Self-Learning Topics:*** *Design of another other suitable driver ICs.* | |
| | *Learning Outcomes :*<br>*A learner will be able to*<br>*LO2.1. Apply fundamental concepts to identify the functions of gate driver circuits to select suitable gate driver circuit (PI-1.3.1).*<br>*LO2.2. Apply electrical engineering concepts to select parameters of gate driver circuits and snubber circuits to meet the specific requirements (PI-1.4.1).*<br>*LO2.3 Identify parameters of sensing circuits for sensing voltage and current to select appropriate sensing circuit for an application (PI-2.1.2).*<br>*LO2.4 Identify and interpret data sheet parameters of driver ICs to select suitable driver IC (PI-2.2.2).* | |
| **03.** | **AC to DC Converters (Controlled Rectifiers)** | **6-8** |
| | ***Learning Objective/s:***<br>*Learner will be able to demonstrate the ability to analyze AC to DC power conversion circuits.* | |
| | **Contents:**<br>Single phase, fully controlled full wave bridge rectifiers for R and R-L load, derivation of output voltage, two quadrant operation, issues of harmonics & poor power factor, relevant standards, concept of freewheel diode, need for PWM rectifier, working principle and applications, PWM Rectifier in traction. | |
| | ***Self-Learning Topics****: Other applications of controlled rectifiers.* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO3.1 Apply mathematical methods to derive the output voltage and current of controlled rectifiers (PI-1.1.1).* | |

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|---|---|---|
| | *LO3.2 Apply electrical engineering concepts and describe the working and draw output waveforms of controlled rectifiers (PI-1.4.1).*<br><br>*LO3.3 Extract the requirements from relevant standards related to power factor and harmonics in the input current of controlled rectifiers (PI-3.1.4).*<br><br>*LO3.4 Identify the criteria to improve to power factor and harmonics in line with the limits given by relevant standards (PI-3.2.3).* | |
| **04.** | **DC-DC Converters** | **7-9** |
| | ***Learning Objective/s:***<br>*Learner will be able to analyze DC to DC power conversion circuits and its applications.* | |
| | **Contents:**<br><br>Switched mode power supply and comparison with linear power supply, PWM operation, Buck, Boost, Buck-Boost dc to dc converters with resistive load and continuous conduction mode, Bidirectional dc to dc converters and its applications, DC-DC converter in power supply applications. | |
| | ***Self-Learning Topics:*** *Synchronous dc-dc converters.* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br><br>*LO4.1 Apply fundamental engineering concepts to identify the working and features of dc-dc converters(PI-1.3.1).*<br><br>*LO4.2 Apply engineering concepts to derive the input to output voltage relation and understand various waveforms (PI-1.4.1).*<br><br>*LO4.3 Identify various parameters to select energy storage elements in DC-DC converter (PI-2.1.2).*<br><br>*LO4.4 Identify the features of DC-DC conversion to select them to meet the given requirements (PI-2.2.4).* | |
| **05.** | **DC–AC Converters** | **6-8** |
| | ***Learning Objective/s:***<br>*Learner will be able to understand and analyze DC to AC power conversion circuits.* | |
| | **Contents:**<br><br>Single phase and Three phase voltage source Inverters, Square wave and sinusoidal PWM operation, concept of dead time, Harmonics in the inverter output voltage, Total Harmonic Distortion, relevant standards, Single phase current source inverters (CSI), comparison of VSI and CSI. Concept of multi-level inverter. Inverter in Uninterrupted Power supply. | |
| | ***Self-Learning Topics:*** *Multiple pulse PWM technique and comparison with SPWM.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO5.1 Apply mathematical methods to derive the output voltage and current of inverters (PI-1.1.1).*<br><br>*LO5.2 Apply electrical engineering concepts and describe the working and draw output waveforms of inverters (PI-1.4.1).*<br><br>*LO5.3 Extract the requirements from relevant standards related to power factor and harmonics in the input current of inverters (PI-3.1.4).*<br><br>*LO5.4 Identify the criteria to improve to power factor and harmonics in line with the limits given by relevant standards (PI-3.2.3).* | |

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|---|---|---|
| **06.** | **Case Studies** | **5-7** |
| | ***Learning Objective/s:***<br>*To demonstrate the knowledge to analyse the given requirements, select suitable power electronic device and converter and communicate the selection to others effectively.* | |
| | **Contents:**<br>Assimilate the information obtained about devices, auxiliary circuits and converters to do a case study of Power Factor Correction Circuits, DC-DC converter in portable equipment, Solar Power Conditioning unit, LED lamp driver circuits, any other power electronic application. | |
| | ***Self-Learning Topics:*** *Literature survey* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO6.1 Examine the requirements of the problem and methods to suggest various techniques for the solution (PI-4.1.2).*<br>*LO6.2 Analyse various techniques to conclude the solution for the problem (PI-4.3.4).*<br>*LO6.3 Analyse related information to choose the converters and energy storage elements (PI-9.1.1)*<br>*LO6.4 Create a presentation and present it with proper justification (PI-9.1.3).* | |
| | **Course Conclusion**<br>Course will conclude with the understanding of various power electronic devices, converters, systems and case studies. Emphasizing the fact that how this is a foundation course for so many other courses in Electrical Engineering. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.1 | *Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems* |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 3.1.4 | Extract engineering requirements from relevant engineering Codes and Standards such as IEEE,IEC etc. |
| 3.2.3 | Identify suitable criteria for the evaluation of alternate design solutions. |
| 4.1.2 | Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation. |
| 4.3.4 | Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions. |
| 9.1.1 | Read, understand and interpret technical and non-technical information. |
| 9.1.3 | Create flow in a document or presentation - a logical progression of ideas so that the main point is clear. |

**Course Outcomes:**

1. Apply the knowledge of various switching devices and interpret datasheets to select a suitable device for an application. LO1.1, LO1.2, LO1.3, LO1.4.
2. Identify the requirements and select auxiliary circuits of power electronic systems such as gate driver circuit, snubber circuits and sensing circuits. LO2.1, LO2.2, LO2.3, LO2.4.
3. Analyse the working of various power conversion circuits from AC to DC and DC to AC and its applications. LO3.1, LO3.2, LO3.3, LO3.4, LO5.1, LO5.2, LO5.3, LO5.4

4. Analyse the working of DC to DC power conversion and its applications. LO4.1, LO4.2, LO4.3, LO4.4.
5. Identify the requirements to select power electronic converters for various applications. LO6.1, LO6.2, LO6.3, LO6.4.

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC407.1 | 3 | 3 | | | | | | | | | |
| EEPCC407.2 | 3 | 3 | | | | | | | | | |
| EEPCC407.3 | 3 | | 3 | | | | | | | | |
| EEPCC407.4 | 3 | 3 | | | | | | | | | |
| EEPCC407.5 | | | | 3 | | | | | 3 | | |
| **Average** | 3 | 3 | 3 | 3 | | | | | 3 | | |

**Text Books :**

1. N. Mohan, T. M. Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design", Wiley India.
2. Joseph Vithayathil, "Power Electronics: Principles & Applications", McGraw Hill.
3. P.S. Bimbhra, "Power Electronics", Khanna Publishers.
4. M. H. Rashid, "Power Electronic: Circuits, Devices & Applications", Pearson education.
5. Daniel W. Hart, "Power Electronics", Mc GrawHill.

**Reference Books :**

1. R. W. Erickson and D Maksimovic, "Fundamental of Power Electronics", Springer, 2nd Edition.
2. P.C. Sen, "Power Electronics", Mc GrawHill.
3. M. H. Rashid, "Hand book of Power Electronics", PHI.
4. L. Umanand, "Power Electronics: Essentials & Applications", Wiley.

**Other Resources :**

1. NPTEL Course on Power Electronics, , Prof. B.G. Fernandes, Prof. Kishore Chatterjee, IIT Bombay https://nptel.ac.in/courses/108101038
2. NPTEL Course on Power Electronics, Prof. G.Bhuvaneshwari, Department of Electrical Engineering IIT Delhi https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee97/

**IN-SEMESTER ASSESSMENT (50 MARKS)**

1. **Continuous Assessment (20 Marks)**
   Suggested breakup of distribution
   01 MCQ test strictly as per GATE exam pattern / level + 1 Class test **(10 Marks)**
   Seminar: 05 Marks
   Regularity and active participation: 05 Marks

**2. Mid Semester Exam (30 Marks)**
Mid semester examination will be based on 40% to 50% syllabus

**END SEMESTER EXAMINATION (50 MARKS)**
End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC408 | POWER SYSTEM ENGINEERING | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. EEPCC303- Elements of Power System

**Program Outcomes addressed:**

1. PO1-Engineering knowledge
2. PO2-Problem analysis
3. PO5-Engineering tool usage
4. PO6: The engineer and the world

**Course Objectives:**

1. To impart knowledge on symmetrical and unsymmetrical faults in power system.
2. To impart knowledge on power system transients due to switching in transmission line.
3. To introduce Insulation coordination to decide the lightning arrestor rating.
4. To introduce corona in transmission line.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Power Systems Engineering course deals with short circuit analysis, which provides currents and voltages in a power system during the fault condition. This information is needed to determine the required interrupting capacity of the circuit breakers and to design proper relaying system. It will ensure that personnel and equipment are protected from faults otherwise, it can be a serious threat to human life and can cause injury, extensive equipment damage, and costly downtime. Hence, the fundamental concepts of this course are essential for designing the electrical systems. | 01 |
| 01. | **Symmetrical Fault Analysis** | 8-10 |
| | ***Learning Objective/s:***<br>*To apply knowledge of short circuit on synchronous machine and transmission line to analyse symmetrical faults in power system and perform simulation using modern tools* | |
| | **Contents:**<br>Introduction to synchronous machine, basic construction, operation and equivalent circuit diagram, short circuit of synchronous machine: no load and loaded machine, transient on a transmission line, Selection of Circuit Breaker, short circuit MVA, Algorithm for short circuit studies, Z Bus formulation, symmetrical fault analysis using Z-bus. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics: Simulate symmetrical faults using software tools and analyze the results.*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1: Apply electrical engineering concepts to obtain equivalent circuit of synchronous machine and Z-bus of given power system (PI-1.3.1)*<br>*LO1.2: Use basic principles of electrical engineering to solve short circuit problems in no-load and loaded condition of synchronous machine (PI-1.4.1)*<br>*LO1.3: Identify and analyse symmetrical faults for a given power system network (PI-2.1.2)*<br>*LO1.4: Formulate Z-bus model of power system to analyse symmetrical faults (PI-2.3.1)*<br>*LO1.5: Identify modern engineering tools for modeling and analysis of symmetrical faults in power system (PI-5.1.1)* | |
| **02.** | **Symmetrical Components** | **4-6** |
| | ***Learning Objective/s:***<br>*To derive sequence components and draw sequence networks of transmission line, synchronous machine and transformer using symmetrical component technique* | |
| | **Contents:**<br>Introduction, Symmetrical component transformation, sequence impedances and sequence network of transmission line, synchronous machine and transformer, power invariance, construction of sequence network of a power system | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1: Apply basic concepts in electrical engineering to formulate the symmetrical components of currents and voltages to solve problems in unbalanced power system (PI-1.3.1)*<br>*LO2.2: Apply principles of symmetrical components to construct sequence networks of transmission line, synchronous machine and transformer for solving the problems in unbalanced power system. (PI-1.4.1)* | |
| **03.** | **Unsymmetrical Fault Analysis** | **9-11** |
| | ***Learning Objective/s:***<br>*To derive sequence network model and analyse different types of unsymmetrical faults in power system and simulate using modern tools* | |
| | **Contents:**<br>Types of unsymmetrical faults, Analysis of shunt type unsymmetrical faults: single line to ground (SLG) fault, line to line (L-L) fault, double line to ground (LLG) fault | |
| | ***Self-Learning Topics: Simulate unsymmetrical faults using software tools and analyse results.*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1: Apply symmetrical components technique to solve problems of unsymmetrical faults in power system (PI-1.3.1)*<br>*LO3.2: Apply basic principles to solve problems of unsymmetrical faults in power system (PI-1.4.1)*<br>*LO3.3: Identify and analyse unsymmetrical faults in power system using symmetrical components (PI-2.1.2)* | |

| | | |
|---|---|---|
| | *LO3.4: Formulate model and analyse unsymmetrical faults in power system (PI-2.3.1)*<br>*LO3.5: Identify modern engineering tools for modeling and analysis of unsymmetrical faults (PI-5.1.1)* | |
| **04.** | **Sources of Power System Transients** | **7-9** |
| | ***Learning Objective/s:***<br>*To apply concepts of transients in power system and analyse arcing grounds, capacitance switching, current chopping and travelling waves* | |
| | **Contents:**<br>Review of transients in simple circuits, recovery transient due to removal of short circuit, arcing grounds, capacitance switching, current chopping phenomenon. Travelling waves on transmission lines, wave equation, reflection and refraction of waves, typical cases of line terminations, attenuation, Bewley lattice diagram | |
| | ***Self-Learning Topics: ABCD parameters of transmission line*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1: Apply fundamental knowledge to solve problems due to transients in power system (PI-1.3.1)*<br>*LO4.2: Apply basic concepts of electrical engineering to derive travelling wave equation for obtaining reflection and refraction waves in transmission line (PI-1.4.1)*<br>*LO4.3: Identify and analyse arcing grounds, capacitance switching and current chopping in transmission line (PI-2.2.3)*<br>*LO4.4: Formulate models to analyse typical cases of line terminations in transmission line (PI-2.3.1)* | |
| **05.** | **Lightning and Insulation Coordination** | **5-7** |
| | ***Learning Objective/s:***<br>*To analyse over voltages due to lightning and to find the rating of surge arrester to protect against lightning surges using insulation coordination in power system.* | |
| | **Contents:**<br>**Lightning:**<br>Shape of Lightning voltage wave, over voltages due to Lightning, Lightning protection problem, significance of tower footing resistance in relation to Lightning, insulator flashover and withstand voltages, protection against surges, surge arresters, surge capacitor, surge reactor and surge absorber, Lightning arrestors and protective characteristics, dynamic voltage rise and arrester rating.<br>**Insulation Coordination:** - Volt time curve, basic approach to insulation co-ordination in power system, over voltage protection, ground wires, insulation coordination based on lightning, surge protection of rotating machines and transformers. | |
| | ***Self-Learning Topics:***<br>*Lightning phenomenon- mechanism of Lightning stroke* | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1: Identify and analyse over voltages due to lightning surge on transmission line (PI-2.2.3)*<br>*LO5.2: Determine the tower footing resistance and rating of surge arrestor using insulation coordination to analyse protection of transmission line (PI-2.4.4)*<br>*LO5.3: Identify tower footing resistance and rating of surge arrestor for public protection and safety. (PI-6.1.1)* | |
| **06.** | **Corona** | **4-6** |
| | ***Learning Objective/s:***<br>*To apply concept of electric discharge in air for understanding corona formation and calculate corona loss in transmission line* | |
| | **Contents:**<br>Phenomenon of corona, Disruptive critical voltage, Visual critical voltage, corona loss, factors affecting corona loss, Radio interference due to corona, practical considerations of corona loss, corona in bundled conductor lines, corona ring | |
| | ***Self-Learning Topics: Nil*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1: Apply basic laws of engineering to calculate disruptive critical voltage, visual critical voltage during corona formation (PI-1.2.1)*<br>*LO6.2: Use engineering concepts to calculate corona loss in transmission line and Identify factors affecting corona in transmission line (PI-1.4.1)* | |
| | **Course Conclusion**<br>Calculation of symmetrical and unsymmetrical fault currents is important in selecting the circuit breaker rating in power system for protection. The knowledge of power system transients, insulation coordination and corona will be useful to build high voltage DC and AC transmission systems. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem. |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.3.1 | Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy. |
| 2.4.4 | Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level |

**Course Outcomes:**

1. Apply basic principles to obtain equivalent circuit of synchronous machine and Z-bus for symmetrical fault analysis in power system *(LO1.1, LO1.2, LO1.3, LO1.4)*
2. Apply concepts of symmetrical components to construct sequence networks *(LO2.1, LO2.2).*
3. Identify and analyse unsymmetrical faults in power system using sequence networks *(LO3.1, LO3.2, LO3.3, LO3.4).*
4. Apply basic concepts to obtain travelling wave equation and line terminations in transmission line *(LO4.1, LO4.2, LO4.3, LO4.4)*
5. Identify and analyse insulation coordination to determine the lightning arrestor rating for protection of transmission line and calculate corona loss (LO5.1,LO5.2, LO5.3, LO6.1, LO6.2)
6. Identify modern engineering tools for modeling and analysis of symmetrical and unsymmetrical faults in power system *(LO1.5, LO3.5)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC408.1 | 3 | 3 | | | | | | | | | |
| EEPCC408.2 | 3 | | | | | | | | | | |
| EEPCC408.3 | 3 | 3 | | | | | | | | | |
| EEPCC408.4 | 3 | 3 | | | | | | | | | |
| EEPCC408.5 | | 3 | | | | 2 | | | | | |
| EEPCC408.6 | | | | | 3 | | | | | | |
| **Average** | 3 | 3 | | | 3 | 2 | | | | | |

**Text Books:**

1. D. P. Kothari, I. J. Nagrath, "Power System Engineering", 3e, Mc Graw Hill
2. Hadi Saadat, Power System Analysis, TMH publications
3. Stevenson and Grainger, Modern power system analysis, TMH publication, 1ed

**Reference Books:**

1. Turan Gonen, Modern power system analysis, Wiley
2. Power System Analysis by Arthur Bergen and Vijay Vittal
3. Power System Analysis and Design by J. Duncan Glover, M. S. Sarma and Thomas J. Overbye

**Other Resources:**

1. NPTEL Course on Power System Engineering by Prof. Debpriya Das, IIT Kharagpur, Link: https://nptel.ac.in/courses/108/105/108105104/
2. NPTEL Course on Power System Analysis by Dr. A.K. Sinha, IIT Kharagpur, Link: https://nptel.ac.in/courses/108/105/108105067/
3. NPTEL Course on Power System Generation, Transmission and Distribution by Prof. D.P. Kothari, IIT Delhi. Link: https://nptel.ac.in/courses/108102047

**IN-SEMESTER ASSESSMENT (50 MARKS)**

**1. Continuous Assessment (20 Marks)**

*Suggested breakup of distribution*

Numerical Assignment/s (min 20 problems): 05 Marks
Class test based on above numerical assignment: 05 Marks
Technical report writing/open book test: 05 marks

Regularity and Active Participation: 05 marks

**2. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LBC | EELBC403 | POWER ELECTRONICS LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **Practical /Oral** | **Total** |
| 25 | 25 | 50 |

**Pre-requisite :**

1. EELBC301 - Electronics Lab
2. EEPCC407 - Power Electronics

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO8: Individual and Collaborative Team work
4. PO11: Life Long Learning

**Course Objectives:**

1. To impart knowledge on various parameters and characteristics of power electronic switching devices used for power conversion.
2. To provide skills to select parameters, implement and analyse the performance of auxiliary circuits needed for power electronic converters.
3. To provide skills to select parameters, implement and analyse the performance of various power electronic converters.

| Module | Details | Hrs |
|---|---|---|
| **01.** | ***Learning Objective/s:***<br>*To identify various parameters from datasheets of power electronic switching devices, plot the characteristics and analyse the features.* | **6** |
| | **Theme for designing multiple experiments:**<br>1. Test various power electronic switching devices, plot their characteristics and analyse their features. | |
| | ***Self-Learning Topics:*** *Watch videos on power electronic switching devices* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Identify various parameters required for analyzing the performance of switching devices as a team (P.I.-2.1.2,8.2.2)*<br>*LO1.2 Use systematic approach to implement the test circuit and evaluate its parameters as a team (PI-2.2.2, 8.2.2).*<br>*LO1.3 Plot and analyze characteristics of switching devices such as power MOSFET, IGBT, WBG devices etc. (P.I.- 4.3.3)*<br>*LO1.4 Compare the results obtained with the theoretical principles (P.I.-4.1.4)* | |
| **02.** | ***Learning Objective/s:***<br>*To investigate the functioning of auxiliary circuits needed for the implementation of power electronic converters.* | **6** |
| | **Theme for designing multiple experiments:**<br>Implement auxiliary circuits such as gate driver circuits, Snubber circuits etc. | |
| | ***Self-Learning Topics:*** *Watch videos on auxiliary circuits of power electronic converters* | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Identify the parameters to meet the requirements of auxiliary circuits such as gate driver circuits and snubber circuits (P.I.-2.1.2).*<br>*LO2.2 Evaluate the requirements to select the parameters of the auxiliary circuit as a team (P.I.-2.2.2,8.3.1).*<br>*LO2.3 Implement auxiliary circuit as a team, analyze the performance and draw conclusions as a team (P.I.-4.3.3,8.3.1)*<br>*LO2.4 Compare the results obtained with the theoretical principles (P.I.-4.1.4)* | |
| **03.** | ***Learning Objective/s:***<br>*To provide skills to implement and analyze the performance of various power electronic converters.* | **12** |
| | **Theme for designing multiple experiments:**<br>1.Implement power electronic converters to convert AC to DC and analyse the performance.<br>2.Implement power electronic converters to convert DC to AC and analyse the performance.<br>3.Implement power electronic converters to convert DC to DC and analyse the performance. | |
| | ***Self-Learning Topics:*** *Watch videos of different power electronic converters* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 Identify the parameters to meet the requirements of AC to DC or DC to AC or DC to DC converter (P.I.- 2.2.2).*<br>*LO3.2 Evaluate the requirements to select the parameters of the converter (P.I.- 2.2.2,8.3.1).*<br>*LO3.3 Implement the converter as a team and use systematic procedures for collecting the required data. (P.I.- 4.3.1,8.3.1)*<br>*LO3.4 Represent the collected data to evaluate its performance across parameter variations. (P.I.- 4.3.3).* | |
| **04.** | ***Learning Objective/s:***<br>*To impart knowledge of a practical power electronic converter through demonstration of a hardware set up or simulate a power electronic converter.* | **06** |
| | **Theme for designing multiple experiments:**<br>1.Demonstration of hardware set up of any power electronic application and measurement of physical quantities.<br>2. Simulation of any power electronic converter. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Identify parameters to solve the problem (PI-2.1.2,11.2.2).*<br>*LO4.2 Identify and evaluate information (PI-2.2.2,11.3.1)*<br>*LO4.3 Apply appropriate instrumentation to make measurements of practical power electronic application such as LED driver circuits, regulated power supply etc. (PI-4.1.3)*<br>*LO 4.4 Use an appropriate tool for the simulation of a power electronic converter and analyze its performance (PI- 4.1.3).* | |
| | **Minimum 2 experiments/demo/simulation from each module, and total at least 10 experiments/demonstration/simulation.** | **30** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 4.1.3 | Apply appropriate instrumentation and/or software tools to make measurements of physical quantities. |
| 4.1.4 | Establish a relationship between measured data and underlying physical principles. |
| 8.2.2 | Treat other team members respectfully. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |
| 11.2.2 | Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |

**Course Outcomes**: Learner will be able to

1. Use appropriate techniques to collect data to plot the characteristics and analyse the features of various power electronic switching devices. (LO1.1, LO1.2, LO1.3, LO1.4)
2. Apply the knowledge of auxiliary circuits to implement and analyse auxiliary circuits needed for power electronic converters. (LO2.1, LO2.2, LO2.3, LO2.4, LO3.1, LO3.2, LO3.3, LO3.4)
3. Analyse the requirements, select parameters, simulate and implement power electronic converters as a team. (LO4.1, LO4.2, LO4.3, LO4.4)

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELC403.1 | | 3 | | 3 | | | | 3 | | | |
| EELC403.2 | | 3 | | 3 | | | | 3 | | | |
| EELC403.3 | | | | 3 | | | | 3 | | | 3 |
| **Average** | | 3 | | 3 | | | | 3 | | | 3 |

**Text Books**


1. Ned Mohan, Power Electronic Converters, John Wiley & sons.

2. P.S. Bimbhra, Power Electronics, Khanna Publishers.


**Reference Books**


1. Power Electronics Essentials and Applications, L. Umanand, Wiley
2. Data sheet of switching devices
3. Data sheet of ICs


**Other Resources**

1. Design and Simulation of Power Conversion Using Open Source Tools", Prof.L.Umanand, IISC, Bangalore https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee12/
2. Multisim software for simulation https://education.ni.com/teach/resources/967/power-electronics

## CONTINUOUS ASSESSMENT (25 Marks)

***Suggested breakup of distribution***

- Lab Experiments: 10 Marks
- Internal Assessment: 10 marks

  Evaluating proficiency in the field by assessing the candidate's capability to execute connections or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through data analysis during regular laboratory session.

- Observation & Active Participation: 5 marks

**END SEMESTER EXAMINATION (Practical/Oral Exam) (25 Marks)**
**Practical and Oral Examination:**

Two examiners, one Internal and one External will do the evaluation.

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formula. It will be checked by the examiners and evaluated out of 05 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections and take readings. The connections and output are verified by the examiners. The weightage is 05 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LBC | EELBC404 | CONTROL SYSTEM LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **Practical /Oral** | **Total** |
| 25 | 25 | 50 |

**Pre-requisite:**

1. EEPCC301- Engineering Mathematics-III
2. EEPCC302-Circuit and Signal Analysis

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Engineering tool usage
4. PO8: Individual and Collaborative Team work:

**Course Objectives:**

1. To impart the knowledge on various components of closed loop control systems.
2. To impart the knowledge on modelling and transient and steady state analysis of closed loop control systems.
3. To impart the knowledge on the analysis of control system using Root-locus and Bode-plot technique with simulation platform.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>This foundation course provides a comprehensive understanding of the basic principles and methodologies essential for designing, analyzing, and implementing control systems in various engineering applications. | |
| **01.** | ***Learning Objective:***<br>*To investigate the functioning of various components of the given control system as a team.* | **06** |
| | **Theme for designing multiple experiments:**<br>1. Analyze the functioning of various components of the given open loop or closed loop control system | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1: Identify various components required for a control system, use systematic techniques to implement the system and evaluate its operation as a team. (P.I.-2.1.2, 2.2.2, 8.2.1,.8.3.1)*<br>*LO1.2: Use a systematic approach as a team to gather data and analyze the system's performance across various parametric variations. (P.I.-4.1.4, 4.3.1)*<br>*LO1.3: Formulate a mathematical model by observing and plotting the response with various inputs. (P.I.-4.1.4)* | |
| | ***Learning Objective:*** | |

| | | |
|---|---|---|
| **02.** | *To investigate the behavior of the given control system as a team and to formulate an appropriate model of the system by examining its response.*<br><br>**Theme for designing multiple experiments:**<br><br>2. Implement the given electrical system and analyze the transient and steady state behavior for various test input<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1: Implement the circuit and use systematic procedures to determine the transient and steady state parameters from the response as a team. (P.I.-4.3.1, 8.2.1,.8.3.1)*<br>*LO2.2: Formulate the transfer function model from the response and compare the transfer function with the transfer function constructed from the circuit.(P.I.-2.3.1, 2.4.1, 4.1.4)*<br>*LO2.3: Systematically analyze the response with change in parameters. (P.I.-4.1.4, 4.3.1)* | **10** |
| **03.** | ***Learning Objective:***<br>*To identify computational tool to sketch root locus and frequency response plots for the given system and analyze its behavior.*<br><br>**Theme for designing multiple experiments:**<br><br>3. Use a simulation software to analyze the behavior of the given system utilizing various system models and computational tools, including analysis with and without compensator.<br><br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1: Use suitable simulation software to implement transfer function model for the given system and analyze its behavior for change in pole location, addition of poles and zeros, change in time domain specifications etc. (P.I.-2.4.1,5.1.1, 5.1.2)*<br>*LO3.2: Develop a program algorithm to plot root locus, Bode plot, or Nyquist plot by coding the transfer function of the provided system directly, allowing for thorough system analysis. (P.I.-2.4.2)*<br>*LO3.3: Construct state space model from transfer function, determine the eigen values and analyze the system for stability. (P.I.-2.4.1)*<br>*LO3.4: Formulate transfer function model for the given electrical system, implement the transfer function, include a suitable compensator and analyze the performance using a suitable simulation tool. (P.I.-2.4.1, 2.4.2, 5.1.1, 5.1.2)* | **14** |
| | **Minimum 2 experiments from each module, and total at least 10 experiments** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 2.3.1 | Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy. |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models. |

2.4.2 Produce and validate results through skillful use of contemporary engineering tools and models
4.1.4 Establish a relationship between measured data and underlying physical principles

4.3.1 Use appropriate procedures, tools and techniques to conduct experiments and collect data

5.1.1 Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities
5.1.2 Adapt the tools and techniques to solve engineering problems

8.2.1 Demonstrate effective communication, problem solving, conflict resolution and leadership skills
8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

**Course Outcomes:**

1. Investigate the given system, employ systematic data collection methods, and analyze the functioning of various components of the control system for the specific application as a team.*(LO1.1, LO1.2, LO1.3)*
2. Analyze the transient and steady state behavior of physical systems to standard test inputs. *(LO2.1, LO2.2, LO2.3)*
3. Use an appropriate simulation tool to analyze the behavior of the specified system, employing root locus and frequency response plots. *(LO3.1, LO3.2, LO3.3, LO3.4)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELBC404.1 | | 3 | | 3 | | | | 3 | | | |
| EELBC404.2 | | 3 | | 3 | | | | 3 | | | |
| EELBC404.3 | | 3 | | | 3 | | | | | | |
| **Average** | | 3 | | 3 | 3 | | | 3 | | | |

**Text Books:**

1. Control Systems Engineering, Norman S. Nise, Seventh Edition, 2015, John Wiley & Sons
2. Control Systems Engineering, I. J. Nagrath. M. Gopal, Seventh Edition, 2021, New Age International Publisher
3. Control Systems Engineering, Norman S. Nise, Seventh Edition, 2015, John Wiley & Sons

**Reference Books:**

1. Control Systems Engineering, S. K. Bhattacharya,Second Edition, 2015, Pearson.
2. Control Systems, Theory and applications, Smarajit Ghosh, 2013, Pearson

**Other Resources:**

1. NPTEL Course: Control Engineering By Prof. S.D. Agashe, Department of Electrical Engineering, IIT Bombay :-Web link- https://nptel.ac.in/courses/108/101/108101037/
2. Control Engineering By Prof. Ramkrishna Pasumarthy, Department of Electrical Engineering, IIT Madras :-Web link- https://nptel.ac.in/courses/108/106/108106098/

**CONTINUOUS ASSESSMENT (25 Marks)**

*Suggested breakup of distribution*

- Lab Experiments: 10 Marks
- Internal Assessment (10 marks)
  Evaluating proficiency in the field by assessing the candidate's capability to execute connections or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through data analysis during regular laboratory session.
- Observation & Active Participation: 5 marks

**END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)**

Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit/block diagram, observation table and write relevant formula. It will be checked by the examiners (Internal and External) and evaluated out of 05 Marks.

Then the student will be allowed to start with the performance of the experiment.

- Students will be allocated 1 hour to complete the circuit connections and take readings. The connections and output is then checked by both the examiners for its correctness. The weightage is 05 Marks
- Students will do sample calculations, draw graph if required and write conclusion of the experiment. It will be checked by the examiners (Internal and External) and evaluated out of 05 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **LBC** | EELBC405 | MEASUREMENT AND INSTRUMENTS LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **Practical /Oral** | **Total** |
| 25 | 25 | 50 |

**Pre-requisite :**

1. ESC102-Basic Electrical Engineering
2. ESC203- Basic Electronics Engineering

**Program Outcomes addressed:**

1. PO2: Problem Analysis
2. PO4: Conduct investigations of complex problems
3. PO8: Individual and Collaborative Team work:

**Course Objectives:**

1. Provide hands on experience to use sensors, transducers and laboratory instruments for testing and measurement.
2. Develop the ability to identify, select and integrate suitable sensor/ transducers for any given applications.
3. Impart knowledge of measurements based on the sensors / transducers and the relevant instrumentation for practical purpose.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Sensors, transducers, and measuring instruments are indispensable tools for electrical engineers, enabling them to acquire data, control systems, ensure safety, improve efficiency, conduct research, maintain quality, and monitor the environment across a wide range of applications. | **02** |
| **01.** | **Sensors/ Transducers** | **08** |
| | ***Learning Objective/s:***<br>*Identify the various types of sensors/ transducers commonly used in practice based on their specifications, analyse and select the suitable one for specific application.* | |
| | **Content:**<br>**Sensors/ transducers**<br>Types of Sensors/ transducers for measurement of various electrical/ non electrical parameters used in practice. Datasheet of sensors/ transducers, Understanding the specifications, Characterization / calibration of sensors/ transducers. Types / variants in sensors/ transducers for any parametric measurements, Selection and suitability of sensors/ transducers for given application(Sensors / Transducers used for Current (AC/DC), Voltage (AC/DC), L/C/R/Q, Temperature, Speed, Pressure etc.) | |

| | | |
|---|---|---|
| | **Theme for designing multiple experiments:**<br>1. Demonstration of various sensors/ transducers, applications based on them, characterization of the sensor using measuring lab instruments.<br>2. Testing of sensors/ transducers for a given application.<br>3. Characterization / calibration of sensors/ transducers<br>4. Selection of sensors/ transducers for a given application | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Identify different sensors/ transducers for an application. (PI-2.1.2,8.2.1)*<br>*LO1.2 Select sensors/ transducers for an application. (PI-2.2.2,8.2.1)*<br>*LO1.3 Interpret the specifications, datasheet parameters of sensors/ (PI-4.1.3,8.2.2)*<br>*LO1.4 Characterize/calibrate of sensors/ transducers for given application using measuring laboratory instruments (PI-4.1.4,8.2.2)* | |
| **02.** | **Measuring Instruments** | **08** |
| | ***Learning Objective/s:***<br>*To identify the various types of measuring instruments commonly used in practice based on their specifications, analyze and select the suitable one for specific application.* | |
| | **Content:**<br><br>**Use of Lab Equipment:**<br>Standard Lab Instruments: Multi-meter, Power Supply, Function Generator, Tachometer, thermometer, clamp-on meter, DSO etc. (Study at least 2 such equipment) Special Measuring Instruments: True RMS multi-meter, Lux meter, Megger, LCRQ meter, Power Meter, Thermal Analyzer, Anemometer, Humidity Meter, Earthling Resistance meter, Insulation Resistance meter etc. (Study at least 2 such equipment) Special Lab Equipment: High Power DC Supply, Isolated DSO, Power Analyzer, Emulators etc. (Study at least one of such equipment) Students should be trained to use these classes of lab equipment with good expertise achieved. Students should clearly understand and differentiate the situations in which use of each of these equipment is best suitable. Identify, use and practice the measurement instruments using Standard Lab Equipment, Special Measuring Instruments and Special Lab Equipment.<br><br>**Theme for designing multiple experiments:**<br>5. Identify, use and practice the measurement using Standard Lab Equipment.<br>6. Identify, use and practice the measurement using Special Measuring Instruments.<br>7. Identify, use and practice the measurement using Special Lab Equipment. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Select measuring instruments for an application. (PI-2.1.2,8.2.1)*<br>*LO2.2 Use measuring instruments for laboratory experiments (PI-2.2.2,8.2.1)*<br>*LO2.3 Measure electrical parameters using appropriate instruments. (PI-4.1.3,8.2.2)*<br>*LO2.4 Compare the same parameter using different measuring instruments. (PI-4.1.4,8.2.2)* | |

| | | |
|---|---|---|
| **03.** | **Instrumentation** | **12** |
| | ***Learning Objective/s:***<br>*To demonstrate the skill to identify suitable instrumentation for the given application and analyse its performance.* | |
| | **Content:** | |
| | Voltage /Current (AC/DC) measurement with suitable sensor/ transducer and signal processing circuits with measurement of temperature/pressure /speed using with suitable sensor/ transducer and signal processing circuits and measurement of R/L/C using a bridge technique<br><br>**Theme for designing multiple experiments:**<br>8. Measurement Voltage /Current (AC/DC) with suitable sensor/ transducer and signal processing circuits.<br>9. Measurement of temperature/pressure /speed with suitable sensor/ transducer and signal processing circuits.<br>10. Measurement of R/L/C using a bridge technique<br>11. Measurement of any one selected parameter of above experiments to implements in an application using sensors and measuring instruments. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 Identify the required sensor/ transducer from datasheet parameters for an application. (PI-4.1.3,8.2.2)*<br>*LO3.2 Select suitable sensor/ transducer and measuring instruments for an application. (PI-2.1.2,8.2.1)*<br>*LO3.3 Implement the circuit and measure the parameters using appropriate measuring instruments. (PI-2.2.2,8.2.1)*<br>*LO3.4 Collect, characterize and analyze the result observed. (PI-4.1.4,8.2.2)* | |
| | **Minimum 03 experiments from each module and total at least 10 experiments** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 4.1.3 | Apply appropriate instrumentation and/or software tools to make measurements of physical quantities |
| 4.1.4 | Establish a relationship between measured data and underlying physical principles |
| 8.2.1 | Demonstrate effective communication, problem-solving, conflict resolution and leadership skills |
| 8.2.2 | Treat other team members respectfully |

**Course Outcomes:** Learner will be able to

1. To select and use sensors/transducers for testing and measurement. *(LO1.1, LO1.3, LO1.4, LO2.1, LO2.2, LO2.3, LO2.4)*
2. To select and use measuring instruments for testing and measurement. *(LO1.1, LO1.3, LO1.4, LO2.1, LO2.2, LO2.3, LO2.4)*
3. To implement instrumentation for a selected application. ( *LO3.1,LO3.2, LO3.3, LO3.4)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELC405.1 | | 3 | | 3 | | | | 3 | | | |
| EELC405.2 | | 3 | | 3 | | | | 3 | | | |
| EELC405.3 | | 3 | | 3 | | | | 3 | | | |
| **Average** | | 3 | | 3 | | | | 3 | | | |

**Text Books:**

1. Electrical & Electronic Measurements and Instrumentation, AK Sawhney,18th edition,2001, Dhanpat Rai & Sons
2. Modern Electronic Instrumentation and Measurement Techniques, Helfric and Cooper,3rd edition,1985, PHI
3. Electronic Instrumentation, H.S.Kalsi,Third Edition, 2006, Tata McGraw Hill

**Reference Books:**

1. Principle of Measurement & Instrumentation, Alan.S.Moris,3rd edition,2001,Prentice Hall of India
2. Electrical Measurement & Instrumentation, RS Sirohi & Radhakrisnan,4th edition,2005, New Age International
3. Sensors Handbook, Second Edition, RS Sirohi & Radhakrisnan, 2nd edition,2008, McGraw Hill

**Other Resources :**

1. Virtual Lab An Initiative of Ministry of Education Under the National Mission on Education through ICT http://vlab.co.in/broad-area-electronics-and-communications

**CONTINUOUS ASSESSMENT (25 Marks)**

***Suggested breakup of distribution***

- Lab Experiments: 10 Marks
- Internal Assessment (10 marks)
  Evaluating proficiency in the field by assessing the candidate's capability to execute connections or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through data analysis during regular laboratory session.
- Observation & Active Participation: 5 marks

**END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)**

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table and write relevant formula. It will be checked by the examiners (Internal and External) and evaluated out of 05 Marks.

  Then the student will be allowed to start with the performance of the experiment.

- Students will be allocated 1 hour to complete the circuit connections and take readings. The connections and output is then checked by both the examiners for its correctness. The weightage is 05 Marks

- Students will do sample calculations, draw graph if required and write conclusion of the experiment. It will be checked by the examiners (Internal and External) and evaluated out of 05 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| SBL | EESBL402 | PCB FABRICATION AND CIRCUIT TESTING LABORATORY | 02 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **End Semester Examination (ESE)** | **Total** |
| 50 | 50 | 100 |

**Pre-requisite:**

1. ESC102- Basic Electrical Engineering
2. ESC203- Basic Electronics Engineering
3. EEPCC407- Power Electronics

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO3: Design solutions for complex engineering problems
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering tool usage
6. PO6: The Engineer and The World
7. PO10: Project Management and Finance
8. PO11: Life-Long Learning

**Course Objectives:**

1. To develop the skill set to work on real-life projects and its design.
2. To develop the required skill set to design, develop and assemble the PCB using the CAD tools.

| Module | Detailed Contents | Hrs. |
|---|---|---|
| | **Course Introduction**<br>This course is designed to provide a comprehensive understanding of the principles and practices involved in the design and fabrication of Printed Circuit Boards (PCBs). Through a combination of theoretical lectures, hands-on laboratory sessions, and practical projects, students will gain proficiency in using CAD software tools for design and simulation. Additionally, through project work, students will have an opportunity to apply their knowledge to different scenarios, fostering creativity, innovation, and problem-solving abilities. | **01** |
| **01.** | **Types of PCB** | **10** |
| | ***Learning Objective/s:***<br>*To compare the characteristics and applications of common PCB materials and difference between single-sided and multi-layer PCBs.* | |
| | **Content:**<br>Types of PCBs: Single Sided (Single Layer), Multi-Layer (Double Layer)<br>PCB Materials: Standard FR-4 Epoxy Glass, Multifunctional FR-4, Tetra Functional FR-4, NelcoN400-6, BT Epoxy Glass, Teflon , IPC Standard for PCB Materials | |

| | | |
|---|---|---|
| | **Theme for designing multiple experiments:**<br>1. Demonstration of PCB fabrication facility. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Identify different PCB materials such as FR-4 epoxy glass, Teflon, and NelcoN400-6 etc. (PI 1.3.1)*<br>*LO1.2 Identify various types of PCB: single-sided, double-sided, and multi-layer PCBs, based on their structural characteristics and layout complexities. (PI 1.4.1)* | |
| **02.** | **Components and its Categories** | **10** |
| | ***Learning Objective/s:***<br>*To identify and categorize electronic components based on their functionality and application.* | |
| | **Content:**<br>Types of Components: Active Components: Diode, Transistor, MOSFET/IGBT, LED, SCR, Integrated Circuits (IC's)<br>Passive Components: Resistor, Capacitor, Inductor, Transformer, Speaker/Buzzer<br>Component Package Types: Through Hole Packages, Axial lead, Radial Lead, Single Inline Package (SIP), Dual Inline Package (DIP), Transistor Outline (TO), Pin Grid Array (PGA), Metal Electrode Face (MELF), Leadless Chip Carrier (LCC), Small Outline Integrated Circuit (SOIC), Quad Flat Pack (QPF) and Thin QFP (TQFP), Ball Grid Array (BGA), Plastic Leaded Chip Carrier (PLCC). | |
| | **Theme for designing multiple experiments:**<br>2. Use of videos/ photographs & actual components to show electrical/ electronic components used in practice.<br>3. Identification of components, reading data sheets and handling components. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Identify and classify electronic components, such as passive components, active components, and electromechanical components. (PI 1.3.1)*<br>*LO2.2 Classify electronic components based on different component package type. (PI 1.4.1)*<br>*LO2.3 Select appropriate component types and package styles based on circuit design requirements and space constraints. (PI 3.2.1, PI 11.2.1)* | |
| **03.** | **Introduction to CAD Tools** | **08** |
| | ***Learning Objective/s:***<br>*To gain proficiency in utilizing both open-source and commercial software for PCB design and simulation.* | |
| | **Content:**<br>Introduction to open source and commercial software like: Proteus, Altium, Eagle, OrCAD, KiCAD, easy EDA etc. | |
| | **Theme for designing multiple experiments:**<br>4. Demonstration of CAD software tool for PCB design. | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 Demonstrate the ability to create and modify schematic designs and PCB layouts using the CAD software tool. (PI 3.3.1, PI 5.1.2)*<br>*LO3.2 Check for the suitability of different PCB design tools for specific project requirements.(PI 5.3.1, PI 11.2.1)* | |
| **04.** | **PCB Basic Artwork Designing** | **15** |
| | ***Learning Objective/s:***<br>*To develop the ability to create precise and optimized PCB layouts, incorporating component placement, routing techniques, and other design considerations.* | |
| | **Content:**<br>Keywords & Their Description: Footprint, Vias, Tracks, PCB Track width/ size calculation formula, Schematic Entry, Net listing, PCB Layout Designing<br>Description of PCB Layers:<br>Electrical Layers: Top Layer, Bottom Layer<br>Mechanical Layers: Board Outlines and Cutouts, Drill Details<br>Documentation Layers: Components Outlines, Reference Designation, Text<br>Prototype Designing: Design Rule Check (DRC), Electronic rule checking (ERC)<br>Rules for Track: Track Length, Track Angle, Vias, Track Size. | |
| | **Theme for designing multiple experiments:**<br>5. Create a simple schematic layout to glow an LED using CAD software.<br>6. Create a schematic layout to achieve the desired voltage at the output using CAD software. (voltage divider network).<br>7. Draw a schematic & board layout of a low pass filter circuit using CAD software.<br>8. Design a 2-layer schematic & board layout for gate driver circuit using CAD software**.** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Identify key PCB design terms such as footprint, vias, tracks, schematic entry, net listing, and PCB layout design while adhering to industry standards. (PI 3.1.6, PI 6.2.1, PI 11.2.1)*<br>*LO4.2 Identify the different PCB layers, including electrical layers, mechanical layers, and documentation layers, in compliance with industry standards. (PI 6.1.1, PI 1.4.1)*<br>*LO4.3 Apply knowledge of PCB design for track width/size calculation to design optimized PCB layouts. (PI 3.2.2)*<br>*LO4.4 Analyze the importance of Design Rule Check (DRC) and Electronic Rule Check (ERC) in prototype PCB design.(PI 3.3.1)* | |
| **05.** | **Advanced PCB Artwork Design, Fabrication and Testing** | **16** |
| | ***Learning Objective/s:***<br>*To gain proficiency in advanced PCB design concepts and fabrication techniques adhering to IPC standards.* | |
| | **Content:**<br>Creating Library & Components.<br>Auto routing: Setting up Rules, Defining Constraints, Auto router Setup<br>Post Designing & PCB. | |

| | | |
|---|---|---|
| | Fabrication Process: Printing the Design, Etching, Drilling, Interconnecting and Packaging Electronic Circuits (IPC) Standards, Gerber file Generation, Soldering and De-soldering, Component Mounting PCB and Hardware Testing. IPC Standard for PCB Fabrication. | |
| | **Theme for designing multiple experiments:**<br>9. Create a component library (any one component mentioned by the subject In Charge)<br>10. Design a schematic & board layout of a 15 V regulator circuit using LM317.<br>11. Design a schematic & board layout of a DC-DC buck/ boost converter circuit.<br>12. Design, fabrication, and testing of a 12V dual power supply circuit using 7812 & 7912 voltage regulators.<br>13. Use the given components to design a PCB board for the given microcontroller/ DSP Board. (any other design details to be given by subject in charge) | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1 Apply post-design processes such as Gerber file generation. (PI 3.2.2, PI 11.2.1)*<br>*LO5.2 Collaborate in teams to fabricate PCB circuits. (PI 10.3.1, PI 2.4.4)*<br>*LO5.3 Work in teams to diagnose and resolve circuit faults using testing tools, ensuring reliability and timely completion (PI 2.4.3, PI 10.3.2)* | |
| | **Minimum 03 experiments from 3, 4, 5 modules, and total at least 10 experiments** | **60** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems |
| 1.4.1 | Apply Electrical engineering concepts to solve engineering problems. |
| 2.4.3 | Identify sources of error in the solution process, and limitations of the solution. |
| 2.4.4 | Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications |
| 3.2.1 | Apply formal idea generation tools to develop multiple engineering design solutions |
| 3.2.2 | Build models/prototypes to develop a diverse set of design solutions |
| 3.3.1 | Apply formal decision-making tools to select optimal engineering design solutions for further development |
| 5.1.2 | Create/adapt/modify/extend tools and techniques to solve engineering problems |
| 5.3.1 | Discuss limitations and validate tools, techniques and resources |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level |
| 6.2.1 | Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public |
| 10.3.1 | Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks. |
| 10.3.2 | Use project management tools to schedule an engineering project, so it is completed on time and on budget. |
| 11.2.1 | Identify historic points of technological advance in engineering that required |

practitioners to seek education in order to stay current

**Course Outcomes:**

1. Identify various types of Printed Circuit Boards (PCBs) and their materials based on fundamental principles of PCB design. *(LO1.1, LO1.2, LO4.2)*
2. Classify different electrical and electronic components along with their packages and footprints. *(LO2.1, LO2.2)*
3. Use of CAD tools and select suitable components and incorporate them into schematic and PCB layouts *(LO2.3, LO3.1, LO3.2)*
4. Analyse PCB layouts for precision, optimization, and compliance with standards. *(LO4.1, LO4.3, LO5.1)*
5. Work collaboratively in teams to demonstrate proficiency in PCB fabrication, testing, and debugging. *(LO5.2, LO5.3)*

| CO-ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EESBL402.1 | 3 | | | | | | | | | | |
| EESBL402.2 | 3 | | | | | | | | | | |
| EESBL402.3 | | | 3 | | 3 | 3 | | | | | 3 |
| EESBL402.4 | | | 3 | | | | | | | | |
| EESBL402.5 | | 3 | | | | | | | | 3 | |
| Average | 3 | 3 | 3 | | 3 | 3 | | | | 3 | 3 |

**Text Books:**

1. Simon Monk, Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards, 1st Edition, McGraw-Hill Education
2. Matthew Scarpino, Designing Circuit Boards with EAGLE: Make High-Quality PCBs at Low Cost, 1st Edition Prentice Hall.
3. Archambeault and Drewniak James, PCB Design for Real-World EMI Control, Springer Publications

**Reference Books:**

1. P. Horowitz and W. Hill, The Art of Electronics, 3 Edition, Cambridge University Press.

**Other Resources:**

1. Electronic Packaging and Manufacturing by Prof. A Bhattacharya, Prof. Goutam Chakraborty, IIT Kharagpur :-Web link- https://nptel.ac.in/courses/112105267

**CONTINUOUS ASSESSMENT (50)**

1. **Continuous Assessment (20 Marks)**

   *Suggested breakup of distribution*

   1. Task assigned during Lab session: 5 Marks
   2. Internal Assessment: 10 marks

      To develop schematic circuit design, wherein the basic circuit details will be given prior. Students are expected to research and collect required resources.

They can use the resources and complete the assigned work on the given date and time within the Institute premises in presence of faculty member.

3. Regularity and active participation: 5 marks

**2. Practical Test (30 Marks)**

1. Identify type of PCB single sided (single layer), multi-layer (double layer) /different materials (standard FR-4 epoxy glass, NelcoN400-6). (10 marks)
2. Identify various electrical/electronic components and their packages/ footprints. (10 marks): split up of marks is mentioned below:
    a. Active components (4 marks)
    b. Passive components (3 marks)
    c. Component package type (3 marks)
3. Demonstrate component selection from libraries in schematic editor/ CAD software tool and its interconnection. (10 marks): split up of marks is mentioned below
    a. Selection of appropriate components and their packages/ footprints. (5 marks)
    b. Connection of component with other circuit elements. (5 marks)

**END SEMESTER ASSESSMENT (Pract. / Oral Exam) (50 Marks)**
**(Pract. (25 marks) + Oral (25 marks) = 50 marks**

**1. Practical (25 marks)**

For the End semester exams, practical examination will be conducted. The detail of the end-semester evaluation is as follows.

**a. Design Task**

Students will be provided with the circuit requirement. They will be asked to create a detailed PCB design including schematic, component placement, and routing using software tools like Eagle **(15 marks).**

**b. Simulation and Analysis**

To evaluate their ability to interpret simulation results, identify potential issues, and optimize the design, they will be asked to create a PCB Layout using the given circuit diagram based on following instructions. **(10 marks)**

1. Use dimensions as 4x3 inches.
2. Calculate the track width and then proceed with routing.
3. Avoid jumper wires
4. Observe proper placement of components.
5. Label each component.

**2. Oral (25 marks)**

**1. Conceptual Understanding (15 marks)**

To evaluate the conceptual understanding, questions based on topics such as PCB materials, layers, routing techniques and other such design considerations will be asked. Also their ability to explain complex concepts clearly and connect theoretical knowledge to practical applications will be tested

**2. Problem-solving Scenarios (10 marks)**

Problem solving approach is evaluated based on critical thinking skills, and ability to propose effective solutions for the given problem. Two examiners, one Internal and one External will do the evaluation.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **MNP** | **EEMNP402** | **Mini Project- 1B** | **02 each** |

**Program Outcomes addressed:**

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO3 : Design/Development of Solutions
4. PO4 : Conduct investigations of complex problems
5. PO5 : Engineering Tool Usage
6. PO6 : The Engineer the world
7. PO7 : Ethics
8. PO8 : Individual and Collaborative Team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

**Course Objectives**

1. To familiarize students about available infrastructure at Department/Institute level, online resources, plagiarism, expectations from MP 1A and 1B, etc.
2. To guide students in identifying societal or research needs and formulating them into problem statements.
3. To facilitate problem-solving in group settings.
4. To apply basic engineering principles to address identified problems.
5. To foster self-learning and research skills.

**Course Outcomes**

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

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
    - Research/white paper/article/blog writing/publication, etc.
    - Business plan for entrepreneurship product creation
    - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

**Guidelines for the Mini Project**

- At the beginning of semester-III, project guides are required to conduct around 4 hours' orientation sessions including following topics:
    - o Familiarizing students about infrastructure available at Department/Institute level and how to use it.
    - o How to identify societal problems and formulate project problem statement.
    - o How to carry out literature survey.
    - o What is plagiarism and what care needs to be taken while writing a report.
    - o What is project report template and how it should be used.
    - o What are expectations from mini-projects 1A and 1B.
- Mini project may be carried out in one or more form of following:
  Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

**In-Semester Continuous Assessment and End-Semester Examination Guidelines**

- o The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- o Assessment will be based on individual contributions, understanding, and responses to questions asked.

- Continuous Assessment marks distribution in semester III (50 marks):
- 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
- 15 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
- 25 marks for the Final Report & Presentation
- 05 marks for Regularity and Active participation

- Continuous Assessment marks distribution in semester IV (50 marks):
- 15 marks for the In-Semester Two Presentations
- 05 marks for the Participation in Project Competitions, TPP, etc.
- 25 marks for the Final Report & Presentation
- 05 marks for Regularity and Active participation

The review/progress monitoring committee will assess projects based on the following criteria.

**Semester III:**

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
- The first review will focus on finalizing the problem statement (topic approval).
- The second review will focus on finalizing the proposed solution.

**Semester IV:**

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
- The first review will assess the readiness to build a working prototype.
- The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to the above-mentioned points, the following performance criteria shall be included during the in-semester continuous assessment:

- Quality of survey and need identification.
- Clarity and innovativeness in problem definition and solutions.
- Requirement gathering feasibility study, cost-effectiveness, and societal impact of proposed solutions.
- Completeness and full functioning of the working model.
- Effective use of skill sets and engineering norms.
- Verification & validation of the solutions/test cases.
- Individual contributions to the group.
- Clarity in written and oral communication.
- Participation in technical paper presentations/project competitions/hackathon competitions, etc.

**End-Semester Examination in Semester IV (50 marks):**

- Presentation and demonstration to internal and external examiners: 20 marks.

- Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks**.**

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| VEC | VEC402 | ENVIRONMENT & SUSTAINABILITY | 02 |

**Program Outcomes addressed**:

1. PO2 : Problem Analysis
2. PO6 : The Engineer & The World
3. PO7 : Ethics
4. PO11: Life-long learning

**Course Objectives :**

1. To provide students with foundational knowledge and understanding of environmental science principles and concepts.
2. To explore the principles of sustainability and their applications in various domains of engineering and technology.
3. To familiarize students with the legal and ethical considerations associated with environmental management and sustainability practices.
4. To equip students with practical skills and strategies for promoting renewable energy, energy efficiency, waste management, and environmental impact assessment.

| Module | Details |
|---|---|
| **01.** | **Foundations of Environmental Sciences**<br>Introduction to Environmental Science, Earth's Systems: Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecological Principles: Energy flow, Nutrient cycling, Biodiversity, Environmental Degradation: Pollution, Deforestation, Habitat loss, Environmental Monitoring and Data Analysis. |
| **02.** | **Sustainability Basics**<br>Concepts of Sustainability and Sustainable Development, Sustainable Resource Management: Water, Air, Land, Sustainable Agriculture and Food Systems, Sustainable Transportation and Urban Planning, Sustainable Business Practices and Corporate Social Responsibility |
| **03.** | **Legal & Ethical Considerations**<br>Environmental Laws and Regulations: National and International Perspectives, Environmental Policies and Governance Frameworks, Ethical Issues in Environmental Decision Making, Environmental Justice and Equity, Corporate Ethics and Environmental Responsibility |
| **04.** | **Renewable energy & Energy efficiency**<br>Introduction to Renewable Energy Sources: Solar, Wind, Hydro, Biomass, Geothermal, Energy Conversion Technologies and Systems<br>Energy Efficiency Measures and Strategies, Policy Support for Renewable Energy Deployment, Economic and Environmental Impacts of Renewable Energy |

| | |
|---|---|
| **05.** | **Waste management & recycling**<br>Solid Waste Management: Collection, Treatment, Disposal, Recycling Processes and Technologies, E-waste Management and Hazardous Waste Handling, Circular Economy Principles, Waste Reduction Strategies: Source Reduction, Reuse, Repair |
| **06.** | **Environmental Impact Assessment**<br>Introduction to Environmental Impact Assessment (EIA), EIA Process: Screening, Scoping, Impact Assessment, Mitigation, Monitoring, Methods and Tools for Impact Assessment: GIS, LCA, Risk Assessment, Case Studies of EIA in Various Sectors: Infrastructure, Energy, Mining, Construction, Role of Stakeholders in EIA Process |
| **Total no. of hours**: **30** | |

**Course Outcomes :**

1. Gain a comprehensive understanding of key environmental science principles and their relevance to engineering disciplines.
2. Apply principles of sustainability to analyse and address environmental challenges in engineering projects and processes.
3. Demonstrate awareness of legal and ethical considerations in environmental decision-making and management practices.
4. Develop proficiency in implementing renewable energy technologies and energy-efficient practices in engineering designs and operations.
5. Acquire knowledge and skills in waste management, recycling, and circular economy principles for sustainable resource utilization.
6. Apply environmental impact assessment methods to evaluate and mitigate the environmental impacts of engineering projects and activities.

**Text Books :**


1. Environmental Science: Toward a Sustainable Future by Richard T. Wright and Dorothy F. Boorse (Publisher: Pearson Education)
2. Introduction to Environmental Engineering and Science by Gilbert M. Masters and Wendell P. Ela (Publisher: Pearson Education)
3. Renewable and Efficient Electric Power Systems by Gilbert M. Masters (Publisher: Wiley)


**Reference Books :**


1. Environmental Law Handbook by Thomas F. P. Sullivan, David R. Buente Jr., and Sally Fairfax, Bernan Press
2. Sustainability Science by Bert J. M. de Vries, Springer
3. Environmental Impact Assessment: Theory and Practice by Peter Wathern, Routledge


**Other Resources:**

1. NPTEL Course: Introduction to Environmetal Engineering & Science- Fundamental & Sustainability Concepts, Prof.Brajesh Kumar Dubey, Department of Multidisciplinary IIT Kharagpur :-Web link https://archive.nptel.ac.in/courses/127/105/127105018/

2. NPTEL Course: Environment And Development, By Prof. Ngamjahao Kipgen, IIT Guwahati, Web link- https://onlinecourses.nptel.ac.in/noc23_hs133/preview

# H. Syllabi
# Third Year

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC509 | ELECTRICAL MACHINES | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. ESC102 - Basic Electrical Engineering
2. EEPCC303-Elements of Power System

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct Investigations of Complex Problems
4. PO6: The Engineer and The World
5. PO9: Communication

**Course Objectives:**

1. Comprehend electromechanical energy conversion in electrical machines.
2. Study analysis of different connections and performance of transformer under different operating conditions.
3. Study Performance and operation of Synchronous motors and Asynchronous motors under different operating conditions.
4. Comprehend Transformation of induction machine voltage equations to direct and quadrature axis variables.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>AC machines include transformers and AC rotating machines. Transformers are used to step up or step-down voltage levels in power transmission and distribution systems, ensuring efficient energy transfer. AC rotating machines, such as motors and generators, convert electrical energy to mechanical energy and vice versa, crucial for powering appliances and generating electricity. These machines are essential for electrical power systems, ensuring efficient energy conversion, transmission, and utilization. | **01** |
| **01.** | **Fundamentals of Rotating AC Machines**<br>***Learning Objective:***<br>*To impart knowledge on the essential basics of rotating AC machines.*<br>**Content:**<br>Recent trends in research and developments in electrical machines, Principle of electromechanical energy conversion. Field energy and mechanical force in a singly excited system. Introduction to doubly excited systems, Double layer | **05-06** |

| | | |
|---|---|---|
| | lap winding in three phase AC machines, Rotating magnetic field in three phase AC machines. | |
| | **Learning Outcomes:**<br>*A learner will be able to*<br>*LO 1.1: Apply basic concepts of magnetism in electrical machines. (PI-1.3.1)*<br>*LO 1.2: Apply basic electrical and mechanical engineering concepts to interpret the electromechanical energy conversion. (PI-1.4.1)*<br>*LO 1.3: Draw the winding diagram of a double layer lap winding according to the given specifications. (P.I.2.1.2)*<br>*LO 1.4: Analyze the formation of a rotating magnetic field and identify the conditions required for the same. (PI 2.1.3)* | |
| **02.** | **Three Phase Transformer** | **07-08** |
| | ***Learning Objective:***<br>*To comprehend knowledge on the construction and operation of three phase transformers.* | |
| | **Content:**<br>Constructional details, Principle of operation, Connections and Phasor (Vector) groups, Parallel operation, Excitation phenomenon in three phase transformer, Oscillating neutral phenomenon, Switching in transient phenomenon. | |
| | **Learning Outcomes:**<br>*A learner will be able to*<br>*LO 2.1: Apply fundamental engineering concepts to identify the conditions necessary for any interconnection of transformers. (PI-1.3.1)*<br>*LO 2.2: Apply fundamental electrical engineering concepts to draw phasor diagrams of three phase transformers of different vector groups. (PI-1.4.1)*<br>*LO 2.3: Compare phasor groups of three phasor transformers and find the one which is generally used in distribution side. (PI 2.2.4)*<br>*LO 2.4: Analyze the power sharing through parallel operation and switching in transient phenomenon of three phase transformers. (PI 2.1.3)* | |
| **03** | **Three Phase Induction Motor** | **08-10** |
| | ***Learning Objective:***<br>*To comprehend knowledge on construction and operation of three phase Induction motor.* | |
| | **Content:**<br>Constructional details and Principle of operation, Slip, Rotor emf and frequency, current and power, Power stages, Phasor diagram, Equivalent circuit, Torque-speed characteristics in braking, motoring and generating regions, Losses and efficiency, No load and blocked rotor test, Need of starter, Types of starters: Direct On Line (DOL) starter, Autotransformer starter, Star delta starters, Rotor resistance starter, Speed control: Stator voltage control, Frequency control, Concept of soft starter in 3ϕ IM. | |

| | | |
|---|---|---|
| | **Learning Outcomes:**<br>*Learner will be able to*<br>*LO 3.1: Apply fundamental concepts of electrical engineering to interpret constructional details of 3 phase induction motor. (PI-1.3.1)*<br>*LO 3.2: Apply basic concepts of phasors to draw phasor diagram of 3 phase induction motor for different loading conditions. (PI-1.4.1)*<br>*LO 3.3: Recognize need for starters in induction motor operation and identify suitable one for engineering system. (PI-2.1.2)*<br>*LO 3.4: Determine losses and efficiency of three phase induction motor using suitable test data. (PI-2.1.3)*<br>*LO 3.5: Demonstrate legislation, regulations, codes, and safety standards followed by the industry to manufacture 3 phase I.M. (P.I. 6.1.1) (P.I.6.2.1)*<br>*LO 3.6: Comprehend and integrate practical insights from induction motor observations in the manufacturing industry and produce a clear, well-structured, and well-supported report. (P.I.9.1.2) (P.I.9.2.1)* | |
| **04.** | **Single phase Induction Motor** | **07-09** |
| | ***Learning Objective:***<br>*To study the selection of suitable single phase induction motors for different applications by analyzing its speed-torque characteristics.* | |
| | **Content:**<br>Principle of operation, Double field revolving theory, Equivalent circuit of single phase induction motor, Staring methods, Split phase starting- Resistance spilt phase, Capacitor split phase, Capacitor start and run, Shaded pole starting, Applications of single phase IM. | |
| | ***Learning Outcomes:***<br>*LO 4.1: Apply fundamental concepts of engineering to interpret the constructional details of single phase induction motor. (PI-1.3.1)*<br>*LO 4.2: Apply basic concepts of phasors to draw phasor diagram of different types of single phase induction motor. (PI-1.4.1)*<br>*LO 4.3: Compare characteristics of different single phase induction motors to select suitable one for specific application. (PI-2.2.4)*<br>*LO 4.4: Use double field revolving theory to examine the operation of single phase induction motor during starting and running conditions. (PI-2.4.4)* | |
| **05.** | **Synchronous Machines** | **10-11** |
| | ***Learning Objective:***<br>*To learn constructional details of synchronous machines and analyze their performance under different operating conditions.* | |
| | **Content:**<br>Construction, Operation, Winding factor, E.M.F. equation, Armature reaction, Phasor diagrams of cylindrical rotor synchronous generator, No load (OC) and SC test, Voltage regulation, Power flow equations, Parallel operation, Salient pole synchronous generator: Concept of direct and quadrature reactance, Blondel's two reaction theory, Phasor diagram of salient pole machine.<br>**Synchronous Motor:** Principle of operation, Self-starting methods, Phasor diagram, V and Inverted V curves. | |
| | **Learning Outcomes:**<br>*Learner will be able to*<br>*LO 5.1: Apply basic concepts of phasors in armature reaction of synchronous machine and phasor diagram for different loading conditions. (PI-1.3.1)*<br>*LO 5.2: Apply fundamental concepts of electrical engineering to interpret constructional details of Synchronous machines. (PI-1.4.1)* | |

| | | |
|---|---|---|
| | *LO 5.3: Recognize the need of starting methods for synchronous motors and identify remedies to solve the problem. (PI 2.1.2)*<br>*LO 5.4: Determine voltage regulation of synchronous machines using different method. Compare their results and find best method. (PI-2.2.4)*<br>*LO 5.5: Analyze different voltage regulations methods of synchronous generators and state limitations of each one. (P.I.4.3.2)*<br>*LO 5.6: Use O.C., S.C. and Z.P.F. test data of synchronous generator to plot graph showing open circuit, short circuit and zero power factor characteristics and determine voltage regulation by different methods. Analyze voltage regulation obtained by different methods. (P.I.4.3.3)* | |
| **06.** | **Modelling of 3 phase induction Machines**<br>***Learning Objective/s:***<br>*To impart knowledge on the dynamic modelling of induction machines*<br>**Content:**<br>The ideal induction machine, Voltage equations, Transformation to direct and quadrature axis variables, Basic machine relations in dq variables, Dynamic dq equivalent circuit of induction motor in synchronously rotating reference frame.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: Apply fundamental knowledge of 3 phase induction motor to draw its primitive model. (P.I.1.4.1)*<br>*LO 6.2 Identify the mathematical knowledge to derive the basic machine relations in dq variables. (PI-2.1.3)*<br>*LO 6.3: Formulate the dynamic dq model of three phase induction motor in synchronously rotating reference frame.(PI-2.3.1)* | **06-07** |
| | **Course Conclusion:**<br>Electrical machines are fundamental to the operation of modern electrical systems, from power generation to industrial applications. The knowledge and skills gained in this course provide a solid foundation for understanding and working with these critical components. As technology evolves, the principles learned here will continue to be relevant, forming the basis for future innovations and developments in electrical engineering. | **01** |
| **Total** | | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions. |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 2.3.2 | Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required. |
| 2.4.4 | Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |

4.3.2 Analyze data for trends and correlations, stating possible errors and limitations.

4.3.3 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions.

6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level.

6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public.

9.1.2 Produce clear, well-constructed, and well-supported written engineering Document.

9.2.1 Listen to and comprehend information, instructions, and viewpoints of others

**Course Outcomes:** Learner will be able to

1. Apply fundamental understanding of electromechanical energy conversion and analyse the formation of rotating magnetic fields for efficient machine operation. (LO 1.1, LO 1.2, LO 1.3, LO 1.4)
2. Analyse the operation and performance for various types of connections in three phase transformers. (LO 2.1, LO 2.2, LO 2.3, LO 2.4)
3. Determine the equivalent circuit parameters, formulate the dynamic dq model and analyse the performance characteristics of a 3 phase induction motor. (LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 6.1, LO 6.2, LO 6.3)
4. Analyse the speed-torque characteristics of different types of single phase induction motors and identify the suitable one for specific application. (LO 4.1, LO 4.2, LO 4.3, LO 4.4)
5. Analyse the operating characteristics and performance characteristics of synchronous machines. (LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6)
6. Apply safety guidelines and best practices observed during industrial visits and produce a clear, well-structured, and well-supported report based on observations and technical insights gained during an industrial visit.( LO 3.5, LO 3.6)

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPC509.1 | 3 | 3 | | | | | | | | | |
| EEPC509.2 | 3 | 3 | | | | | | | | | |
| EEPC509.3 | 3 | 3 | | | | | | | | | |
| EEPC509.4 | 3 | 3 | | | | | | | | | |
| EEPC509.5 | 3 | 3 | | 3 | | | | | | | |
| EEPC509.6 | | | | | | 3 | | | 3 | | |
| **Average** | 3 | 3 | | 3 | | 3 | | | 3 | | |

**Text Books :**


1. Bimbhra P.S., Electric Machinery , Khanna Publisher
2. Bimbhra P.S., Generalized Machine Theory, Khanna Publisher
3. D.P.Kothari, I.J. Nagrath, Electrical Machines, Tata McGraw Hill Education Private Limited


**Reference Books :**


1. M.G. Say, Performance and Design of Alternating Current Machines, CBS Pub.
2. Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.
3. A.E. Fitzgerald, Kingsly, Stephen., Electric Machinery, Tata McGraw Hill

**Other Resources :**

1. NPTEL Course: Electrical Machines-II By Prof. Krishna Vasudevan, Prof. G. Sridhara Rao, Prof. P. Sasidhara Rao, IIT-Madras Weblink: https://nptel.ac.in/courses/108/106/108106072/
2. NPTEL Course: Electrical Machines By Prof. G. Bhuvaneshwari, Dept. of Electrical Engineering ,IIT-Delhi. Weblink:- https://nptel.ac.in/courses/108/102/10810214
3. NPTEL Course: Electrical Machines-II By Prof. Tapas Kumar Bhattacharya, Dept. of Electrical Engg. ,IITKharagpur. Weblink:- https://nptel.ac.in/courses/108/105/108105131/

## IN-SEMESTER ASSESSMENT (50 MARKS)

**1.** Continuous Assessment (20 Marks)

*Suggested breakup of distribution*

MCQ test strictly as per GATE exam pattern / level): 05 Marks
One Class test: 05 marks
Open book test:05 Marks
Regularity and active participation: 05 Marks

**2.** Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus

## END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination(MSE) carrying 20% weightage, and the syllabus covered from MSE to ESE carrying 80% weightage

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC510 | PROTECTION AND SWITCHGEAR | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite :**

1. ESC102 -Basic Electrical Engineering
2. EEPCC408-Power System Engineering
3. EEPCC509-Electrical Machines

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design and development of solution
4. PO6: The Engineer and The World
5. PO11: Life-long learning

**Course Objectives:**

1. Comprehend the basic principles and concepts of electrical switchgear and protection systems.
2. Study various components of switchgear, such as circuit breakers, relays, fuses, and protective devices.
3. Comprehend different protection schemes used in power systems, including overcurrent, differential, distance, and earth fault protection.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>This course provides a comprehensive understanding of the principles, applications, and operation of switchgear and protection systems in electrical power networks. It covers the fundamental concepts and advanced techniques used to ensure the safety and reliability of electrical systems, focusing on the devices and schemes employed to detect and mitigate faults. | **01** |
| **01.** | **Introduction to Switchgear:** | **04-06** |
| | ***Learning Objective/s:***<br>*1. To comprehend the functions, and operation of various substation equipment and switching devices effectively, ensuring safe and efficient electrical power transmission and distribution.*<br>*2. To provide the knowledge necessary to effectively utilize the instrument transformers for accurate measurement and reliable protection in electrical systems.* | |
| | **Contents**<br>Switchgear-Definition, Types, Location of switchgear in typical power system, single line diagram to show the measuring and protection scheme Switching Devices- Isolator & Earthing switch (Requirements & definitions, types and construction, Pantograph Isolators, Ratings), Load break switches- Ratings and | |

| | | |
|---|---|---|
| | applications; Contactors- Basic working principle, Terms & Definitions, applications.<br>Instrument Transformers: Introduction to C.T., Potential transformer. Role of instrument transformers in measuring and protection, difference between measuring and protection CTs, selection of technically suitable instrument transformers; | |
| | ***Self-Learning Topics:*** *C.T. and P.T equivalent circuit & Ferro resonance, C.T. saturation and dc offset current* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1: Apply electrical engineering concepts to define switchgear functions, create single-line diagrams for protection schemes, and identify isolator and earthing switch requirements. (PI 1.4.1, PI.6.1.1)*<br>*LO1.2: Apply advanced mathematical techniques to model and solve electrical engineering problems in current and potential transformer. (PI 1.1.2)*<br>*LO1.3: Determine design objectives in measuring transformer and functional requirements and arrive at specifications. (PI 3.1.6)*<br>*LO1.4: Recognize the need of selecting suitable CT for the protection purpose. (PI 3.1.1)* | |
| **02.** | **Circuit Breakers and Fuses** | |
| | ***Learning Objectives:***<br>*1. To analyse the operation, ratings and application of circuit breaker and fuse.*<br>*2. To Apply industry standards and regulations in the selection and implementation of switchgear and protection equipment.* | **10-12** |
| | **Contents:**<br>Circuit Breakers: arc voltage, arc interruption, Re-striking voltage, RRRV, Recovery voltage, resistance switching, interruption of capacitive and inductive current, circuit breaker ratings, classification of C.B, types of CB, L.T. switchgear: - MCB, MCCB, ELCB, HRC fuses, types, construction, characteristics, and application. | |
| | ***Self-Learning Topics:*** *Testing and performance Standards* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Apply electrical engineering concepts to understand circuit breakers and fuses, identify switchgear components for public protection, and interpret relevant standards. (PI-1.4.1, PI.6.1.1, PI-6.2.1)*<br>*LO2.2 Apply fundamental engineering concepts to solve the physics of arc phenomena (PI-1.3.1)*<br>*LO2.3 Apply engineering mathematics and computations to analyse arc models in CB. (PI- 2.4.1)*<br>*LO2.4 Identify and analyse existing processes methods for solving the problem of arc quenching in CB and switching capacitive and inductive loads with a CB . (PI-2.2.3)*<br>*LO2.5 Review at least one research paper and applies the knowledge to solve the problems in power system. (PI 11.3.2)* | |
| **03.** | **Introduction to Protective relaying** | **08-10** |
| | *Learning Objective:* | |

| | | |
|---|---|---|
| | *To become acquainted with the operation of different types of relays and their applications within power systems, and to analyze and adjust their settings according to specific applications.* | |
| | **Contents:**<br>Review of calculation of fault currents, over current protection, desirable qualities of protective relaying, PSM & TSM (Importance, Different types of Time-current characteristics and application), working principle of Electromagnetic Induction disc Relays, Thermal, bimetal relays, Frequency relays, under/over voltage relays, DC relays, Earth fault protection using over current relays, introduction to directional over-current relays, distance protection **,** Working Principle and application of Impedance relay, Causes and remedies of Over reach-under reach, Reactance and Mho relay, Power swing blocking relay. | |
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO3.1 Identify and analyse causes and effect of fault (PI-2.1.2)*<br>*LO3.2 Analyse different type of time current characteristics and select suitable relay setting for specific application (PI-2.2.3)*<br>*LO3.3 Apply engineering concepts to derive the torque equation for different types of relay. (PI 1.3.1)*<br>*LO3.4Apply Electrical engineering concepts to define the types and operation of various relays. (PI 1.4.1)* | |
| **04.** | **Introduction Numerical Relays:** | **04-06** |
| | ***Learning Objective:***<br>*To comprehend the concepts of electrical engineering to understand the functions of numerical relay, PMU and communication protocols in power systems.* | |
| | Contents: Numerical relaying fundamentals, sampling theorem, anti-aliasing filters, least square method for estimation of phasors, Implantation of numerical relays. Introduction to the concept of Phase Measurement Unit. Communication protocols in protection systems. | |
| | ***Self-Learning Topics:***<br>*Static relay, regulatory requirements* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Apply engineering concepts to understand the operation of numerical relay. (PI 1.3.1)*<br>*LO4.2 Apply Electrical engineering concepts to define the functions and operation of various components of Phasor Measuring Unit. (PI 1.4.1)*<br>*LO4.3 Submits a report or delivers a presentation analyzing at least one emerging technology in the field of Numerical Relay/PMUs , including its impact on engineering and society. (PI 11.3.1)* | |
| **05.** | **Protection Schemes Provided for major Apparatus:** | **06-08** |
| | ***Learning Objective:***<br>*To equip protection concepts and choose the appropriate protection mechanism for different components of the power system based on fault types, and to analyse its performance.* | |
| | **Contents:** | |

| | | |
|---|---|---|
| | **Generators -** Stator side (Differential, Restricted Earth fault, protection for 100% winding, Negative phase sequence, Reverse power, turn-turn fault), Rotor side (Field suppression, field failure, Earth fault, turn to turn fault)<br>**Transformers-**Differential protection for star delta Transformer, Harmonic restraint relay, REF protection, Protection provided for incipient faults (Gas actuated relay).<br>**Induction motors -** Protection of motor against over load, short circuit, earth fault, single phasing, unbalance, locked rotor, phase reversal, under voltage, winding temperature, Protection co-ordination | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1 Apply fundamental engineering concepts to understand the causes of faults in power system components (PI-1.3.1)*<br>*LO5.2 Apply basic principles of Electrical Engineering to select suitable protection methods based on faults (PI-1.4.1)*<br>*LO5.3 Identify and analyse existing processes to protect the generator, transformer and induction motor from various faults. (PI-2.2.3)*<br>*LO5.4 Apply engineering mathematics and computations to analyse differential protection's performance for internal and external faults in generator and transformer. (PI- 2.4.1)* | |
| **06.** | **Protection of Transmission Lines:** | **05-07** |
| | ***Learning Objective/s:***<br>*To equip the concepts of protections and select the suitable one for transmission line according to the type of fault and analyse its performance.* | |
| | **Contents:**<br>Feeder protection - Time grading, current grading, combined time & current grading protection provided for Radial, Ring Main, Parallel, T- Feeder.<br>Bus Zone Protection - Differential protection provided for different types of bus zones. LV, MV, HV Transmission Lines - Protection provided by over current, earth fault, Differential and Stepped distance protection.<br>EHV & UHV Transmission lines - Type and nature of faults, Need for auto-reclosure schemes,<br>Carrier aided distance protection (Directional comparison method), Power Line Carrier Current protection (Phase comparison method).<br>Introduction to the concept of Islanding | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1 Apply fundamental engineering concepts to understand the causes of faults in transmission line (PI-1.3.1)*<br>*LO6.2 Apply Electrical Engineering concepts to select suitable protection methods based on faults (PI-1.4.1)*<br>*LO6.3 Identify and analyse existing processes to protect a feeder and long transmission line. (PI-2.2.3)*<br>*LO6.4 Apply engineering mathematics and computations to analyse transmission line differential protection. (PI- 2.4.1)* | |

| | | |
|---|---|---|
| | *LO6.5 Submits a report or delivers a presentation analyzing at least one emerging technology in the field of transmission line protection, including its impact on engineering and society. (PI 11.3.1)* | |
| | **Course Conclusion**<br>The study of switchgear and protection systems equips students with the knowledge to ensure the safe and reliable operation of electrical power networks through the effective management of faults and protection schemes, contributing to the stability and efficiency of power systems. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.1.2 | Apply advanced mathematical techniques to model and solve electrical engineering problems |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 3.1.1 | Recognize that need analysis is key to good problem definition |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level |
| 6.2.1 | Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public |
| 11.3.2 | Analyze sourced technical and popular information for feasibility, viability, sustainability, etc. |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |

**Course Outcomes:**

Learner will be able to

1. Apply basic principles to identify and select the appropriate switching/protecting devices and design measurement schemes while ensuring safety. (*LO1.1, LO1.2, LO1.3, LO1.4)*
2. Analyze circuit breaker and fuse concepts to select the appropriate one for a specific application, following standards and ensuring safety. (*LO2.1, LO2.2, LO2.3, LO2.4)*
3. Identify suitable relay and adjust its setting based on application and analyse its operation. (*LO3.1, LO3.2, LO3.3, LO3.4, LO4.1, LO4.2)*
4. Select suitable protection required for power system components and transmission line according to the type of fault and analyse its performance. (*LO5.1, LO5.2, LO5.3, LO5.4, LO6.1, LO6.2, L6.3, LO6.4)*
5. Analyze emerging technologies and their impact on engineering and society while demonstrating independent learning through literature survey and assignments (*LO 2.5, LO4.3, LO6.5)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC510.1 | 3 | | 3 | | | 2 | | | | | |
| EEPCC510.2 | 3 | 3 | | | | 3 | | | | | |
| EEPCC510.3 | 3 | 3 | | | | | | | | | |
| EEPCC510.4 | 3 | 3 | | | | | | | | | |
| EEPCC510.5 | | | | | | | | | | | 3 |
| **Average** | 3 | 3 | 3 | | | 3 | | | | | 3 |

**Text Books :**

1. Switchgear & Protection by Sunil.S.Rao, Khanna Publications
2. Fundamentals of power system protection by Y. G. Paithankar, S. R. Bhide., Prentice hall, India, second edition, 2010.
3. Power system Protection & Switchgear by Badriram Vishwakarma, TMH
4. Power System Protection And Switchgear by Bhuvanesh A O, Nirmal CN, Rashesh PM, Vijay HM, Mc Graw Hill Reference Books:

**Reference Books :**

1. Fundamentals of protection by Paithanker & Bhide.S.R, P.H.I
2. Static Relays by Madhava Rao, TMH
3. A text book on Power System Engineering by Soni, Gupta, Bhatnagar & Chakraborthi, Dhanpat Rai & Co
4. Protective Relaying by Lewis Blackburn, Thomas.J.Domin
5. Power System Protection by P.M. Anderson, Wiley Interscience
6. Modern Power System Protection – Divyesh Oza, TMH Publication

**Other Resources :**

1. NPTEL Course: Power System Protection By Prof. S.A. Soman, Dept. of Electrical Engineering, IIT Bombay:- Web link-
   https://nptel.ac.in/courses/108/101/108101039/
2. NPTEL Course: Power System Protection By Prof. Ashok Kumar Pradhan, Department of Electrical Engineering IIT Roorke,
   Web link- https://onlinecourses.nptel.ac.in/noc20_ee80/preview

**IN-SEMESTER ASSESSMENT (50 MARKS)**

*Suggested breakup of distribution*

1. Continuous Assessment (20 Marks)
   - Quiz based on gate questions: 05 Marks
   - 1 Class test: 05 marks
   - Flip Classroom: 05 marks
   - Regularity and Active Participation: 05 marks
2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PE | EEPEC5011 | ADVANCED POWER ELECTRONICS | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite :**

1. EEPCC407 - Power Electronics
2. EELBC403 - Power Electronics Lab

**Program Outcomes addressed :**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design / Development of Solutions
4. PO5: Engineering tool usage
5. PO8: Individual and Collaborative team work
6. PO9: Communication

**Course Objectives:**

1. To learn different dc to dc converters and multi-level inverters.
2. To learn the principles of design of magnetics for high frequency transformers and inductors.
3. To model the converter, derive the transfer function of the dc-dc converters and analyse its performance in closed loop.

| Module | Details | Hrs | CO |
|---|---|---|---|
| | **Course Introduction**<br>How advancement of power electronics is a revolutionary field in electrical engineering, how energy efficiency and power density can be improved using power electronic technologies and impact of energy efficiency in various applications of our day to day life. | 01 | -- |
| 01. | **Non-Isolated DC-DC Converters** | 09-11 | CO-1 |
| | ***Learning Objective/s:***<br>*Learner will acquire knowledge of various conduction modes of basic dc-dc converters and analyze the operation in various modes.* | | |
| | **Contents**<br>Comparison of Linear voltage regulators and Switching voltage regulators, Concept of Continuous Conduction Mode (CCM), Boundary & Discontinuous conduction mode (DCM); Parameters affecting conduction mode; Buck, Boost and Buck-Boost converter in Boundary and DCM, identification of conduction mode, derivation of output to input voltage ratio, ripple in inductor current and ripple in capacitor voltage, Numerical Problems, comparison of DCM & CCM operation, introduction to fourth order Cuk converter in CCM and its features. | | |
| | ***Self-Learning Topics: Other fourth order converters and its features*** | | |

| | | | |
|---|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Apply fundamental engineering concepts to identify the conduction modes and understand the factors affecting the conduction modes. (PI-1.3.1).*<br>*LO1.2 Apply electrical engineering concepts to understand the operation, derive voltage ratio, ripple in inductor current and capacitor voltage of non-isolated converters (PI-1.4.1).*<br>*LO1.3 Identify parameters to select values of energy storage elements of non-isolated dc-dc converters for the given specifications (PI-2.1.2).*<br>*LO1.4 Analyze different conduction modes of non-isolated dc-dc converters to select a suitable mode of operation for an application (PI-2.2.4).* | | |
| **02.** | **Isolated DC-DC converters** | **8-10** | CO1 |
| | *Learning Objective/s:*<br>*Learner will be able to analyse various isolated dc-dc converters and their features.* | | |
| | Transformer size & frequency, unidirectional and bidirectional core excitation, Flyback converter, Forward converter, Full bridge converter, working, waveforms, derivation of output to input voltage ratio, ripple in inductor current and capacitor voltage, voltage across the switch, numerical problems, comparison and selection of converters for various applications. | | |
| | ***Self-Learning Topics: Nil*** | | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Apply fundamental engineering concepts to differentiate various isolated dc-dc converters. (PI-1.3.1).*<br>*LO2.2 Apply electrical engineering concepts to understand the operation, derive voltage ratio, ripple in inductor current and capacitor voltage of isolated converters (PI-1.4.1).*<br>*LO2.3 Identify parameters to select values of energy storage elements of isolated dc-dc converters for the given specifications (PI-2.1.2).*<br>*LO2.1 Analyze different isolated dc-dc converters, compare their features, to select a suitable converter for an application (PI-2.2.4).* | | |
| **03.** | **Design of Magnetics** | **05-07** | CO2 |
| | *Learning Objective:*<br>*Learner will be able to apply the magnetics concepts to design high frequency inductors and high frequency transformers.* | | |
| | **Contents:**<br>Review of magnetic concepts, ferrite core, area product approach, design steps of high frequency inductor, design of inductor for non-isolated Buck and Boost dc-dc converter and Bidirectional dc-dc converters. Design steps of high frequency transformer, design of high frequency transformer for Flyback dc-dc converter. | | |
| | *Self-Learning Topics: Inductor design of Buck-Boost dc-dc converter* | | |
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO3.1 Apply fundamental engineering concepts to derive equations for the design of high frequency magnetics (PI-1.3.1).* | | |

| | | | |
|---|---|---|---|
| | *LO3.2 Apply electrical engineering concepts to select parameters of high frequency transformer and inductor (PI-1.4.1).*<br>*LO3.3 Determine objectives, functional requirements to design a high frequency inductor. (PI- 3.1.6).*<br>*LO3.4 Refine a conceptual design into an appropriate design taking care of the existing practical constraints. (PI-3.4.1).* | | |
| **04.** | **Modeling of DC-DC Converters** | **06-08** | CO3 |
| | ***Learning Objective:***<br>*Learner will be able to model DC to DC converters using state space averaging and derive the transfer function using small signal analysis..* | | |
| | **Contents:**<br>State space model of Buck, Boost and Flyback dc-dc converter in CCM, DCM, effect of inductor resistance on the state space models in Buck & Boost converter in CCM, state space averaging technique, small signal analysis, derivation of control to output transfer function for ideal converters and non-ideal converters considering inductor resistance for output voltage regulation, current control etc. | | |
| | ***Self-Learning Topics:***<br>*State space model of Buck-Boost dc-dc converter.* | | |
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO4.1 Apply fundamental engineering concepts to write the state space equations and state space averaged model of DC-DC converters (PI-1.3.1).*<br>*LO4.2 Apply electrical engineering concepts to understand and use small signal analysis in dc-dc converters (PI-1.4.1).*<br>*LO4.3 Extend small signal analysis to derive transfer function of ideal dc-dc converters and inverters (PI-5.1.2).*<br>*LO4.4 Demonstrate the use of modeling techniques for the derivation of the transfer function of converters with non-idealities (PI 5.2.2)* | | |
| **05.** | **DC-DC Converter Control & Compensator** | **06-08** | CO4 |
| | ***Learning Objective:***<br>*Learner will be able to select compensator and parameters of feedback control loop of DC to DC converter and analyze the performance.* | | |
| | **Contents:**<br>Objectives of dc-dc converter control, feedback control block diagram, linearized representation of feedback control system, steps to select a compensator based on the transfer function of converter, selection of compensator for Buck, Boost & Flyback dc-dc converters, selection of compensator parameters, analysis of closed loop performance of converter analytically or by Bode plots or any other suitable method. | | |
| | ***Self-Learning Topics: Selection of compensator for Buck-Boost converter*** | | |
| | *A learner will be able to*<br>*LO5.1 Apply fundamental engineering concepts to understand the control objectives of and feedback control of dc-dc converter (PI-1.3.1)* | | |

| | | | |
|---|---|---|---|
| | *LO5.2 Apply electrical engineering concepts to understand the linearized feedback control of the converter (PI-1.4.1).*<br>*LO5.3 Determine objectives, functional requirements to select and design a compensator (PI- 3.1.6).*<br>*LO5.4 Refine the compensator design taking care of feedback control objectives. (PI-3.4.1).*<br>*LO5.5 Collaborate to analyse the given requirements of the dc-dc converter, select compensator parameters for a given application and demonstrate effective communication (8.2.1,9.3.1).*<br>*LO5.6 Present the findings of the analysis of converter closed loop performance individually or as a team. (8.3.1,9.3.2).* | | |
| **06.** | **Inverter Modeling and Multi-Level Inverters** | **04-06** | CO5 |
| | ***Learning Objective/s:***<br>*To demonstrate the knowledge to model an inverter and analyse the features of multilevel inverter and its modulation schemes.* | | |
| | **Contents:**<br>Introduction to inverter modeling: AC-side control model of half bridge inverter, full bridge inverter, Control block diagram of the closed-loop of half-bridge & full bridge inverter system.<br>Draw backs of conventional inverters for medium voltage applications, multi-level concept, types of multilevel inverters: Diode clamped, flying capacitor and cascaded MLI, operation and switching sequence; Phase shifted and level shifted PWM techniques for MLI, Applications and selection of MLI for an application. | | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1 Apply fundamental engineering concepts to analyze and solve the issues of conventional inverter when used for medium voltage application (PI-1.3.1).*<br>*LO6.2 Apply electrical engineering concepts to model conventional inverter and analyze the closed loop operation (PI-1.4.1, PI 5.2.2).*<br>*LO6.3 Analyze the operation of various Multi-level inverters (PI-2.1.2).*<br>*LO6.4 Analyze the modulation schemes and compare them to select a suitable method for the MLI (PI-2.2.4).* | | |
| | **Course Conclusion**<br>Course will conclude by addressing the need for several advanced power electronic converters, modeling of converters and magnetics design. Emphasizing that how advanced power electronics play a crucial role in the development of energy efficient technologies and systems with lesser foot print. | **01** | - |
| | **Total** | **45** | |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |

| | |
|---|---|
| 2.2.4 | Compare alternative solution processes to select the best process |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models |
| 2.4.2 | Produce and validate results through skilful use of contemporary engineering tools and models |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications. |
| 3.4.1 | Refine a conceptual design into a detailed design within the existing constraints (of the resources) |
| 5.1.2 | Extend tools and techniques to solve engineering problems. |
| 5.2.2 | Demonstrate proficiency in using discipline-specific tools |
| 8.2.1 | Demonstrate effective communication, problem solving, conflict resolution and leadership skills |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts |
| 9.1.2 | Produce clear, well-constructed, and well-supported written engineering documents |
| 9.3.1 | Create engineering-standard figures, reports and drawings to complement writing and presentations |

**Course Outcomes:**

Learner will be able to

1. Apply fundamental knowledge to identify the conduction mode and analyse the operation of dc-dc converters. (LO1.1, LO1.2, LO1.3, LO1.4, LO2.1, LO2.2, LO2.3, LO2.4)
2. Identify parameters to select the value of energy storage elements and design high frequency inductors and transformers for dc to dc converters. (LO3.1, LO3.2, LO3.3, LO3.4)
3. Model power electronic converter by applying modern tools or techniques to derive the transfer function of the converter. (LO4.1, LO4.2, LO4.3, LO4.4,LO6.2)
4. Select and design a compensator for the converter to meet the control objectives, analyse the closed loop performance and present the findings. (LO4.1, LO4.2, LO4.3, LO4.4, LO5.1, LO5.2, LO5.3, LO5.4, LO5.5, LO5.6)
5. Analyse multi-level inverters and modulation schemes of Multilevel inverter suitable for power conversion applications. (LO6.1, LO6.2, LO6.3, LO6.4)

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPEC5011.1 | 3 | 3 | | | | | | | | | |
| EEPEC5011.2 | 3 | | 3 | | | | | | | | |
| EEPEC5011.3 | 3 | | | | 3 | | | | | | |
| EEPEC5011.4 | 3 | | 3 | | | | | 3 | 3 | | |
| EEPEC5011.5 | 3 | 3 | | | | | | | | | |
| **Average** | 3 | 3 | 3 | | 3 | | | 3 | 3 | | |

**Text Books:**

| | |
|---|---|
| 1. | N. Mohan, T. M. Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design", John Wiley & Sons. |
| 2. | L. Umanand, S.R. Bhat, "Design of Magnetic Components for switched Mode Power Converters", New Age International Publishers. |
| 3. | Joseph Vithayathil, "Power Electronics: Principles & Applications", McGraw Hill. |
| 4. | A.Yazdani R. and Iravani, VOLTAGE-SOURCED CONVERTERS IN POWER SYSTEM, Modeling, Control and Applications, Wiley, IEEE Press. |
| 5. | M. H. Rashid, "Power Electronic: Circuits, Devices & Applications", Pearson education. |
| 6. | Daniel W. Hart, "Power Electronics", Mc Graw Hill. |
| **Reference Books :** | |
| 1. | Simon Ang, A. Oliva, "Power Switching Converters, CRC Press, Taylor & Francis group. |
| 2. | M. H. Rashid, "Hand book of Power Electronics", PHI. |
| 3. | L. Umanand, "Power Electronics: Essentials & Applications", Wiley. |
| 4. | Bin WU, "High–Power Converters and AC Drives", IEEE Press, Wiley Inter-Science. |
| 5. | V. Ramanarayanan , "Course Material on Switched Mode Power Conversion" , IISc Bangalore. |
| **Other Resources :** | |
| 1. | NPTEL Course: Advance power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee28/ |

**IN-SEMESTER ASSESSMENT (50 MARKS)**

*Suggested breakup of distribution*

1. Continuous Assessment (20 Marks)
    - Development of Working model for demonstration of concept (10marks)
    - Report writing/Public speaking: 05 marks
    - Regularity and Active Participation: 05 marks
2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80 weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PE | EEPEC5012 | ENGINEERING ELECTROMAGNETICS | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite :**

1. BSC101- Engineering Mathematics-I
2. ESC102 -Basic Electrical Engineering
3. BSC205 - Engineering Physics-II

**Program Outcomes addressed :**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Modern tool usage
4. PO8: Individual and team work
5. PO11: Life-long learning

**Course Objectives :**

1. Comprehend the basic principles and concepts of electromagnetic vector fields.
2. Recognize and describe various elements of electrostatics and magneto statics.
3. Comprehend problems relating to electromagnetic fields.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>This course provides a comprehensive understanding of the principles, applications, and operation of Electromagnetic fields and waves, which form the backbone of modern technology from communications to energy transmission. Understanding the principles of Maxwell's equations, the nature of EM waves, and their wide-ranging applications helps us harness their power for diverse purposes, from medical imaging to wireless data transfer. The operation of EM waves is fundamental in both practical engineering and theoretical physics, influencing everything from basic electronics to advanced space technologies. | **01** |
| **01.** | **Introduction to Vector Basics** | **05-07** |
| | ***Learning Objective/s:***<br>*To furnish and comprehend the basic mathematical concepts related to electromagnetic vector fields.* | |
| | **Contents**<br>Introduction to Vectors Calculus, Rectangular, Cylindrical and Spherical Co-ordinate System, Co-ordinate and vector transformation. Numerical on line, Surface and Volume Integrals. | |
| | ***Self-Learning Topics:*** *Enlist applications* | |
| | ***Learning Outcomes:*** | |

| | | |
|---|---|---|
| | *A learner will be able to*<br>*LO1.1: Apply vectors calculus to solve problems. (1.1.1)*<br>*LO1.2: Identify the location of point in rectangular, cylindrical, and spherical co-ordinate system (2.1.3)*<br>*LO1.3: Apply co-ordinate system and vector transformation for a given situation. (1.3.1)*<br>*LO1.4: Interpret and solve numerical on line, Surface and Volume Integrals (2.4.1)* | |
| **02.** | **Electrostatics** | **9-11** |
| | ***Learning Objectives:***<br>1. *To comprehend problems relating to electric field and electric potential by applying the principles of electrostatics.*<br>2. *To teach an application using suitable simulation tool.* | |
| | **Contents:**<br>Coulomb's Law in Vector Form, Electric Field Intensity, Definition, Principle of Superposition, Electric Field due to point charges, Electric Field due to line charge , Electric Field due to an infinite uniformly charged sheet, Definition and physical interpretation of gradient, Electric scalar potential | |
| | ***Self-Learning Topics: Relationship between potential and electric field and its application on Surface voltage gradient on conductor.*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Apply fundamental concepts of electrostatics in vector form (1.3.1)*<br>*LO2.3Apply electric field due to point charges and derive electric field for the specified charge configuration and analyze the electric field. (1.4.1)*<br>*LO2.4 Analyze electric field due to point charges and derive electric field for the specified charge configuration and analyze the electric field. (2.1.3)*<br>*LO2.5 Identify physical interpretation of gradient and derive Electric scalar potential, Relationship between potential and electric field and analyze the electric field. (2.2.1)*<br>*LO2.6 Demonstrate application of simulation software FEMM for electrostatic field in team activity. (5.1.2,5.2.2,8.1.1,8.3.1)* | |
| **03.** | **Magnetostatics** | **07-09** |
| | *Learning Objective:*<br>1. *To comprehend problems relating to magnetic field , magnetic energy density and magnetic potential by applying the principles of magnetostatics.*<br>2. *To teach an application using suitable simulation tool.* | |
| | **Contents:**<br>Biot-Savart's Law in vector form, Magnetic Field intensity due to a finite and infinite wire carrying a current I, Magnetic field intensity on the axis of a circular loop carrying a current I, Ampere's circuital law and its application on A solid cylindrical conductor and Infinitely long coaxial transmission line, Magnetic flux density, Definition and physical interpretation of Curl, Magnetic Vector Potential. Numerical | |
| | ***Self-Learning Topics:***<br>*The Lorentz force equation for a moving charge and its applications on Force on a wire carrying a current I placed in a magnetic field* | |
| | *Learning Outcomes:*<br>*A learner will be able to* | |

| | | |
|---|---|---|
| | *LO3.1 Apply Biot-Savart's Law in vector form for the electromagnetic field .(1.3.1)*<br>*LO3.2 Analyze the magnetic field intensity due to wire carrying a current and relate with magnetic field intensity. (1.4.1)*<br>*LO3.3 Analyze the magnetic field intensity due to a finite and infinite wire carrying a current and derive magnetic field intensity and apply Curl for different magnetic field parameters. (2.1.3)*<br>*LO3.4Analyze Lorentz force equation for a moving charge and its applications on Force on a wire carrying a current placed in a magnetic field (2.2.1)*<br>*LO3.5 Demonstrate application of simulation software like FEMM for magneto static field in team activity. (5.1.2,5.2.2,8.1.1,8.3.1)* | |
| **04.** | **Electric and Magnetic Fields in Materials** | **03-05** |
| | ***Learning Objective:***<br>*To furnish and comprehend electrostatic and magneto static boundary conditions to understand the effect of material medium on electric and magnetic fields* | |
| | **Contents:**<br>Poisson's and Laplace's equation, Electric Polarization, Electric current, Current density, Point form of ohm's law, Continuity equation for current. Numerical. | |
| | ***Self-Learning Topics:***<br>*Electric polarization in dielectric material* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Apply Poisson's and Laplace's equation for the specified field and visualize electric polarization (1.1.1)*<br>*LO4.2Analyze Poisson's and Laplace's equation for the specified field and visualize electric polarization (1.3.1)*<br>*LO4.3 Analyze Continuity equation for current and apply for Kirchhoff's Current Law (2.1.3)*<br>*LO4.4Analyze Continuity equation for current and apply for Kirchhoff's Current Law (2.4.1)* | |
| **05.** | **Electromagnetic Fields** | **07-09** |
| | ***Learning Objective:***<br>*To furnish and teach the concepts related to Faraday's law, induced emf and Maxwell's equations.* | |
| | **Contents:**<br>Faraday's law, Maxwell's Second Equation in integral form from Faraday's Law, Equation expressed in point form, Displacement current, Ampere's circuital law in integral form, Modified form of Ampere's circuital law as Maxwell's first equation in integral form, Equation expressed in point form, Maxwell's four equations in integral form and differential form. Numerical | |
| | ***Self-Learning Topics:***<br>*Boundary condition at interface* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1 Apply time varying Electric and Magnetic Fields under different conditions and demonstrate the ability to apply it.(1.4.1, 11.1.2)* | |

| | | |
|---|---|---|
| | *LO5.2 Identify assumptions in Maxwell's laws and demonstrate for the given dielectric medium and demonstrate the ability to apply. (2.2.3, 11.1.1,11.1.2)* | |
| **06.** | **Electromagnetic Wave Theory** | **06-08** |
| | ***Learning Objective/s:***<br>*To furnish the concepts of Maxwell's equations for the uniform plane waves and develop the ability to analyze the electromagnetic wave.* | |
| | **Contents:**<br>Electromagnetic Wave theory: Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in phasor form, Wave equation in phasor form. (No numerical) | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1 Apply electromagnetic wave theory to derive of electromagnetic wave equation (1.4.1)*<br>*LO6.2 Analyze electromagnetic wave theory to derive of electromagnetic wave equation ( 2.1.3)*<br>*LO6.3 Identify and analyze uniform plane waves for different media and demonstrate the ability to apply it. (2.2.3, 11.1.1,11.1.2)* | |
| | **Course Conclusion**<br>Electromagnetic fields and waves are fundamental to understanding the behavior of electric and magnetic phenomena in various media. Their study bridges the gap between classical physics and modern technological applications for unified nature of fields ,Maxwell's Equations and boundary conditions. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.1.1 | Apply mathematical techniques such as calculus, linear algebra and statistics to solve problems |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| 2.2.1 | Reframe complex problems into interconnected sub-problems. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models |
| 5.1.2 | Create/adapt/modify/extend tools and techniques to solve engineering problems |
| 5.2.2 | Demonstrate proficiency in using discipline-specific tools |
| 9.1.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team |
| 9.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts |
| 11.1.1 | Describe the rationale for the requirement for continuing professional development |
| 11.1.2 | Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap. |

**Course Outcomes:**
Learner will be able to

1. Apply the basic mathematical concepts to analyse the electromagnetic vector fields.*( LO1.1, LO1.2, LO1.3, LO1.4)*
2. Analyse problems relating to electric field by applying the principles of electrostatics. *(LO2.1, LO2.2, LO2.3, LO2.4, LO2.5)*
3. Apply the principles of magneto statics to analyse problems relating to magnetic fields. *(LO3.1, LO3.2, LO3.3, LO3.4)*
4. Use appropriate tool like FEMM to simulate and analyse results in a team based activity.*( LO2.5,LO3.5)*
5. Apply the concepts related to Maxwell's equations to time varying electromagnetic fields.*(LO5.1,LO5.2)*
6. Apply the knowledge of Maxwell's equations to get electromagnetic waves in real life situation. *(LO6.1, LO6.2)*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPE5012.1 | 3 | 3 | | | | | | | | | |
| EEPE5012.2 | 3 | 3 | | | 3 | | | 3 | | | |
| EEPE5012.3 | 3 | 3 | | | 3 | | | 3 | | | |
| EEPE5012.4 | 3 | 3 | | | | | | | | | |
| EEPE5012.5 | | | | | | | | | | | 3 |
| EEPE5012.6 | | | | | | | | | | | 3 |
| **Average** | 3 | 3 | | | 3 | | | 3 | | | 3 |

**Text Books :**

1. W. Hayt, "Engineering electromagnetic", McGraw Hill, 4th edition, 1987.
2. Edminister, "Schaum‟s series in electromagnetic" McGraw Hill publications, 3rd edition, 1986.
3. M.N.O.Sadiku, "Elements of Engineering Electromagnetics" Oxford University Press, 3rd Ed.

**Reference Books :**

1. N. Narayan Rao, "Elements of Electromagnetic", PHI publication, 4th edition, 2001.
2. David K.Cherp, "Field and Wave Electromagnetics - Second Edition-Pearson Edition

**Other Resources :**

1. NPTEL Course: Electromagnetic Fields By Prof. Harishankar Ramachandran, Department of Electrical Engineering IIT Madras :-Web link- https://nptel.ac.in/courses/108/106/108106098/

**IN-SEMESTER ASSESSMENT (50 MARKS)**

*Suggested breakup of distribution*

1. Continuous Assessment (20 Marks)

- Quiz based on gate questions: 05 Marks
- 1 Class test: 05 marks
- Flip Classroom: 05 marks
- Regularity and Active Participation: 05 marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credit |
|---|---|---|---|
| PE | EEPEC5013 | ELECTRIC VEHICLE TECHNOLOGY | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. ESC102- Basic Electrical Engineering
2. ESC203- Basic Electronics Engineering
3. EEPCC407- Power Electronics

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO6: The engineer and The World

**Course Objectives:**

1. To develop the ability to evaluate and compare the performance metrics and environmental impacts of Internal Combustion Engine (ICE) and Electric Vehicle (EV) drivetrains.
2. To determine the optimal EV motor power requirements, considering performance specifications, vehicle dynamics, and drivetrain configurations.
3. To analyse battery pack requirements and design principles for Electric Vehicles (EV) application.
4. To synthesize the inherent control features in Electronic Control Units (ECUs) utilized in Electric Vehicles (EVs)
5. To identify and implement Functional Safety requirements specific to Automotive Electronics in Electric Vehicles (EVs).

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>In recent years, the automotive industry has experienced a significant paradigm shift towards sustainable transportation solutions, driven by concerns over environmental pollution, energy security, and climate change. The journey towards sustainable mobility began with the introduction of hybrid vehicles, which served as a bridge between conventional gasoline-powered cars and fully electric propulsion systems. In this era of electric mobility, innovation is rapidly transforming electric vehicle technology. With advancements like autonomous driving, vehicle-to-grid integration, and smart charging, electric vehicles are set to revolutionize transportation. Upon completion of the Electric Vehicle Technology course, students will have a thorough understanding of the intricacies of e-mobility. | **1-2** |
| **01.** | **Drivetrain: Internal Combustion Engine and Electric Vehicle** | **6-7** |
| | ***Learning Objective/s:*** | |

| | | |
|---|---|---|
| | *To compare and evaluate the performance of Internal Combustion Engine (ICE), Hybrid Electric Vehicle (HEV), and Electric Vehicle (EV) drivetrains.* | |
| | **Contents:** | |
| | Fundamentals of Internal Combustion Engine (ICE) Drivetrains; Electric Vehicle (EV) Drivetrains, Hybrid EV drivetrains; comparison of performance between ICE and EV drivetrains, factors affecting acceleration, torque, and efficiency in ICEs and EVs, evaluation of energy efficiency, environmental impact analysis, cost comparison, technological advancements and market trends. | |
| | ***Self-Learning Topics:***<br>*Understanding the working principles of internal combustion engines, types and components* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Demonstrate understanding of the fundamental principles and operating mechanisms of ICE, EV, and Hybrid EV drivetrains (P.I.-1.3.1)*<br>*LO1.2 Apply engineering concepts to plot the performance characteristics of ICE, EV, and hybrid drivetrains (P.I.-1.4.1)*<br>*LO1.3 Identify trade-offs between performance, efficiency, cost, and environmental impact while selecting ICE, EV, or hybrid drivetrains, and suggest sustainable solutions for improving vehicle design and usage. (P.I.-6.3.2, PI-11.2.1)* | |
| **02.** | **Electric Motors for EVs** | **6-7** |
| | ***Learning Objective/s:***<br>*To analyze and integrate electric motor with their control algorithms into EV drivetrain for optimized performance and functionality.* | |
| | **Contents:** | |
| | Overview of electric motor types commonly used in EV drive trains: AC induction motors, permanent magnet synchronous motors, Switched Reluctance motors and brushless DC motors, comparison of motor characteristics, performance, and efficiency; Motor control algorithms: field-oriented control (FOC), direct torque control (DTC); Integration of electric motors into vehicle architecture and drive train systems. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1 Apply engineering knowledge to identify and differentiate commonly used electric motor types in EV drivetrains (P.I.-1.4.1)*<br>*LO2.2 Identify and apply design criteria and methodologies to optimize the efficiency, power output, and thermal management of electric motors in EV drivetrain (P.I.-3.1.6)*<br>*LO2.3 Identify integration challenges and give solutions to address the challenges of electric motors in EV drivetrain. (P.I.-3.2.3, PI-11.2.1)*<br>*LO2.4 Identify the role of engineers in optimizing EV drivetrains by considering safety, thermal management, and weight distribution to protect public interest. (P.I.-6.1.1)* | |
| **03.** | **Energy Storage and Battery Technologies:** | **5-6** |
| | ***Learning Objective/s:***<br>*To analyze battery chemistry, pack design, safety considerations, and optimization strategies to enhance electric vehicle performance and reliability.* | |
| | **Contents:** | |
| | Battery chemistry fundamentals: Lithium-ion, Solid-state, Nickel-Metal Hydride and emerging technologies. Battery pack design, Battery Management Systems (BMS), safety considerations, energy efficiency and range optimization. Selection and sizing of fuel cell for FCEV, battery-ultra-capacitor hybrid. | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO3.1 Apply knowledge of engineering and evolving technologies to identify principles, characteristics, and safety considerations of various battery chemistries used in electric vehicles (P.I.-2.1.2, PI-6.1.1, PI-11.2.1)*<br>*LO3.2 Determine design objectives and specify battery pack configurations for electric vehicles, considering cell arrangement, thermal management, and structural integrity. (P.I.-3.1.6, PI-11.2.1)*<br>*LO3.3 Identify and implement safety features and protocols in EV battery systems to address risks and ensure protection of public interest. (P.I.-3.1.5, PI-6.1.1)* | |
| **04.** | **Automotive Subsystem and System Integration** | **5-6** |
| | ***Learning Objective/s:***<br>*To analyze the essential architecture, control features, communication protocols, design considerations specific to Electronic Control Units (ECUs), for Electric Vehicles (EVs).* | |
| | **Contents:** | |
| | Electronic Control Unit (ECU): Control Features, Communications between ECUs. Acceleration and braking control, regenerative braking. EMC design on ECU level, EMC design on system level radiated emissions and conducted emissions, EMI EMC measurements. EV chargers and their types, architecture, design considerations for charger, charging protocols and standards. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1 Identify the role of various sensors, actuators, and control algorithms in ECU operation. (P.I.-2.1.2)*<br>*LO4.2 Synthesize design considerations for Electromagnetic Compatibility (EMC) by reviewing state-of-the-art practices and understanding the engineer's role in ensuring safe interaction between vehicle components. (P.I.-3.1.3, P.I.-6.1.1)*<br>*LO4.3 Determine design specifications for Electric Vehicle (EV) chargers with attention to efficiency, compatibility, and compliance with safety standards and regulations. (P.I.-3.1.6, P.I.-6.2.1)*<br>*LO4.4 Identify existing solution methods and justify the importance of interoperability and standardization to support large-scale EV adoption and infrastructure development. (P.I.-2.2.3)* | |
| **05.** | **Functional Safety of Automotive Electronics:** | **4-5** |
| | ***Learning Objective/s:***<br>*To investigate functional safety standards and assure compliance of safety to mitigate hazards in diverse automotive scenarios.* | |
| | **Contents:** | |
| | Functional Safety requirements of Automotive Electronics; ASIL identification and safety goal finalization, ISO 26262, Energy Storage integrity / protection, Hazard and Risk Analysis (HARA) for different situations, testing of vehicles for compliance of safety norms. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1 Identify functional safety requirements for automotive systems based on state-of-the-art practices and evolving technological trends. (P.I.-3.1.3, PI-11.2.1)*<br>*LO5.2 Apply ISO 26262 principles and extract safety requirements from relevant codes and standards to develop and validate safety-critical automotive systems. (P.I.-6.2.1 & P.I.-3.1.4)* | |
| **06.** | **Electric Vehicle System Design:** | **8-10** |

| | | |
|---|---|---|
| | ***Learning Objective/s:***<br>*Analyse design considerations for 2W and 4W EVs.* | |
| | **Contents:** | |
| | Design considerations for 2W and 4W EVs; Torque, power and Speed requirement, Traction Limit, Maximum Acceleration Limit, Maximum Grade Limit, Vehicle Power Demand during Driving Cycles, EV motor power requirement, Battery pack sizing. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1 Determine design objectives and functional requirements for Electric Vehicles (EVs), considering varying road conditions and driving scenarios, based on state-of-the-art engineering practices. (P.I.- 3.1.6)*<br>*LO6.2 Identify key design factors impacting EV performance, including vehicle dynamics, driving range, battery charging requirements, user experience, and safety, while ensuring compliance with relevant regulations and staying updated with technological advancements. (P.I.-3.1.6, P.I. 6.2.1, PI-11.2.1)* | |
| | **Course Conclusion** | **1-2** |
| | By the end of the program, students will have acquired the skills and comprehensive understanding of the fundamental principles of complete lifecycle of electric vehicles, including their inception, design, development, and advanced systems which is necessary to tackle the complexities of this emerging industry. | |
| **Total** | | **45** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems |
| 1.4.1 | Apply engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 3.1.3 | Synthesize engineering requirements from a review of the state-of-the-art |
| 3.1.4 | Extract engineering requirements from relevant engineering Codes and Standards |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications |
| 3.2.3 | Identify suitable criteria for the evaluation of alternate design solutions |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level |
| 6.2.1 | Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public |
| 6.3.2 | Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability |
| 11.2.1 | Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current |

**Course Outcomes:**

1. Apply appropriate performance metrics and assess environmental implications to differentiate between Internal Combustion Engine (ICE) and Electric Vehicle (EV) drivetrains.*(LO1.1, LO1.2, LO2.1)*

2. Integrate design considerations to determine EV motor power and battery capacity requirements based on performance specifications, vehicle dynamics, and drivetrain configuration. *(LO2.3, LO3.1, LO5.1, LO5.2)*
3. Analyse battery pack and motor design principles to enhance efficiency, thermal management, and structural integrity in Electric Vehicles (EVs). *(LO2.2, LO2.3, LO3.2, LO3.3, LO6.1)*
4. Identify Electronic Control Unit (ECU) functionalities to optimize control and performance in Electric Vehicle (EV) systems. *(LO4.1, LO4.4)*
5. Ensure ISO 26262 compliance in Automotive Electronics by implementing functional safety principles, risk mitigation strategies and sustainable design practices. *(LO1.3, LO2.4, LO3.3, LO4.2, LO4.3, LO5.2, LO6.2)*

| CO-ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EEPE5013.1** | 3 | | | | | | | | | | |
| **EEPE5013.2** | | 3 | 3 | | | 3 | | | | | 3 |
| **EEPE5013.3** | | | 3 | | | | | | | | 3 |
| **EEPE5013.4** | | 3 | | | | | | | | | |
| **EEPE5013.5** | | | 3 | | | 3 | | | | | 3 |
| **Average** | **3** | **3** | **3** | | | **3** | | | | | **3** |

**Textbooks:**

1. Electric Vehicle Technology Explained by James Larminie and John Lowry, 1st Edition, 2012, Wiley
2. Electric and Hybrid Vehicles: Design Fundamentals by Iqbal Husain, 1st Edition, 2023, CRC Press
3. Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design
by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi., 1st Edition, 2004, CRC Press

**Reference Books:**

1. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
2. Electric Vehicle Machines and Drives Design, Analysis and Application by K. T. Chau, 2015, IEEE Press and Wiley
3. Energy Management Strategies for Electric and Plug-in Hybrid Vehicles by Sheldon Williamsom, 2013, Springer
4. EMC and Functional Safety of Automotive Electronics by Kai Borgeest, 2018, IET

**Other Resources:**

1. NPTEL Web Course: Electric Vehicles - Part 1 by Prof. Amit Kumar Jain D IIT Delhi.
2. NPTEL Web Course: Fundamentals of Electric vehicles: Technology & Economics, by Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras.
3. NPTEL Web Course: Introduction to Hybrid and Electric Vehicles by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati

**In-semester assessment (50 marks)**

1. Continuous Assessment (20 Marks)
*Suggested breakup of distribution*

Assignment on live problems/ case studies, wherein problems are given prior.
Students are expected to research and collect required resources.
They can use the resources and solve the problem on assigned date and time in Institute premises in presence of faculty member. :10 marks
Think-pair-share worksheets/ Mind mapping/Flip classroom: 05 marks
Regularity & Active Participation: 05 marks

2. Mid Semester Exam (30 Marks)
Mid semester examination will be based on 30% - 40% syllabus.

**End semester examination (50 marks)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20-30% weightage, and the syllabus covered from MSE to ESE carrying 70-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LC | EELBC506 | SWITCHGEAR AND SAFETY LAB | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **Practical /Oral** | **Total** |
| 25 | 25 | 50 |

**Pre-requisite:**

1. EEPCC303 - Elements of Power System
2. EEPCC408 - Power System Engineering
3. EEPCC510 - Protection and Switchgear

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Modern Tool Usage
4. PO6: The Engineer and The World:
5. PO8: Individual and team work
6. PO11: Life long learning

**Course Objectives:**

1. To impart the knowledge on concepts of different protection schemes and their application in power system
2. To impart the knowledge on operation of different Fuses, Contactor and circuit breaker
3. To impart the knowledge on the concept of earthing and its applications in power system

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Switchgears are the most important components of electrical power system. They provide protection as well as safety to the system. Hence, it is very essential to understand the switchgear equipment and their operation. | |
| **01.** | **Protective Devices in Power System** | **06** |
| | ***Learning Objective:***<br>*To impart knowledge on various components and operation of Fuses and Contactor, MCB, MCCB and Air circuit breaker as a team.* | |
| | **Theme for conducting experiment:**<br>**1.** To identify various components and analyse operation of different Fuses, Contactor, MCB, MCCB and Circuit breakers for power system protection<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Identify, assemble various components to analyse the operation of Fuses, Contactor, MCB, MCCB and Circuit breakers for the power system protection, recognize the need for protective devices using technical literature, engineering roles for protection of the public and safety while demonstrating effective communication as individual and present results as a team (PI-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)* | |
| **02.** | **Characteristics of Relays** | **08** |
| | ***Learning Objective:***<br>*To develop skill for performing experiment on overcurrent, over voltage by using Induction Disc relay, Numerical relay and static relay as a team* | |

| | | |
|---|---|---|
| | **Theme for conducting experiment:**<br>**2.** To identify and analyse characteristics of Induction Disc relay, Static relay and Numerical relay for overcurrent protection and overvoltage protection with different TSM and PSM setting<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Identify, and evaluate information for demonstrating over current and over voltage relay operation, conduct experiments using appropriate procedures, tools and technique, recognise new developments in field with effective communication as individual and present results as a team (P.I.-2.2.2, 2.2.3, 4.1.1, 4.3.1, 8.2.1,8.3.1, 11.2.2, 11.3.1)* | |
| **03.** | **Protection Schemes** | **06** |
| | ***Learning Objective:***<br>***To study different protection schemes for transformer, Induction motor, transmission line and busbar.*** | |
| | **Theme for conducting experiment:**<br>**3.** To identify and analyse different protection schemes like protection against overload, locked rotor, single phasing of three-phase Induction motor.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.1: Identify and analyze protection schemes of three-phase Induction motor for protection of the public and safety with new developments in field demonstrating effective communication as individual and present results as a team. (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)* | |
| | **Theme for conducting experiment:**<br>**4.** To perform differential protection for a three phase transformer.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.2: Identify and analyze protection schemes of transformer for protection of the public and safety with new developments in field demonstrating effective communication as individual and present results as a team. (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)* | |
| | **Theme for conducting experiment:**<br>**5.** To perform distance protection in transmission line.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.3: Identify and analyze protection schemes of transmission line for protection of the public and safety with new developments in field demonstrating effective communication as individual and present results as a team. (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)* | |
| | **Theme for conducting experiment:**<br>**6. To perform simulation for protection of transformer, Induction motor, transmission line and busbar.**<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 3.4: Identify modern engineering tools, modeling and analysis for protection of electrical equipment demonstrating effective communication as individual and present results as a team. (P.I.-5.1.1 5.1.2, 8.2.1,.8.3.1, 11.2.2, 11.3.1)* | |

| | | |
|---|---|---|
| **04.** | **Safety of Electrical Systems**<br>**Contents:**<br>Study the various types of earthing for electrical systems, Code of practice for earthing.<br>***Learning Objective:***<br>*To teach type of earthing system and analyze earth resistance for a given system using code and standards.* | **04** |
| | **Theme for conducting experiment:**<br>**7.** To identify earthing system and measure earth resistance using Digital Earth Resistance Tester<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Identify type of existing earthing system, measure earth resistance, recognize the need for earthing system for protection of the public and safety using technical literature and demonstrate effective communication as individual and present results as a team (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)* | |
| | **Theme for conducting experiment:**<br>**8.** To demonstrate operation of ELCB for protection of the public and safety by suitable earthing system.<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.2:Demonstate the operation of ELCB, recognize the need for earthing system for protection of the public and safety using technical literature and demonstrate effective communication as individual and present results as a team (P.I.-2.2.2, 2.2.3, 6.1.1, 6.2.1, 8.2.1,.8.3.1, 11.2.2, 11.3.1)* | |
| | **Theme for conducting experiment:**<br>**9.** Industrial visit to switchgear manufacturing company, substation visit or load dispatch centre etc (report based on actual field Visit)<br>***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.3: Demonstrate effective communication as individual and present reports as a team for an Industrial visit (PI. 8.2.1,.8.3.1)* | |
| | ***Minimum 2 experiments from each module and Industrial visit*** | |

**Performance Indicators:**

| <u>**P.I. No.**</u> | <u>**P.I. Statement**</u> |
|---|---|
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 4.1.1 | Define a problem, its scope and importance for purposes of investigation |
| 4.3.1 | Use appropriate procedures, tools and techniques to conduct experiments and collect data |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities |
| 5.1.2 | Create/adapt/modify/extend tools and techniques to solve engineering problems |
| 6.1.1 | Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level |

6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public

8.2.1 Demonstrate effective communication, problem solving, conflict resolution and leadership skills

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

11.3.1 Source and comprehend technical literature and other credible sources of information

**Course Outcomes:**

Learner will be able to

1. Identify and analyse the functioning of various components and assemble Fuses, MCB, MCCB and Circuit breakers for power system protection using technical literature *(LO1.1).*
2. Identify and analyse methods to conduct experiments on over current and over voltage relay operation *(LO2.1).*
3. Identify and analyse protection schemes for transformer, Induction motor, transmission line and busbar using modern engineering tools *(LO 3.1, LO 3.2)*.
4. Identify existing earthing system and solutions for protection of given power system and report on the technical data *(LO4.1, LO4.2).*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELC506.1 | | 3 | | | | 3 | | 3 | | | 3 |
| EELC506.2 | | 3 | | 3 | | | | 3 | | | 3 |
| EELC506.3 | | 3 | | | 3 | 3 | | 3 | | | 3 |
| EELC506.4 | | 3 | | | | 3 | | 3 | | | 3 |
| **Average** | | 3 | | 3 | 3 | 3 | | 3 | | | 3 |

**Text Books:**

1. Switchgear & Protection by Sunil.S.Rao, Khanna Publications
2. Switchgear by Badriram Vishwakarma, TMH
3. Power system Protection & Power System Protection And Switchgear by Bhuvanesh A O, Nirmal CN, Rashesh PM, Vijay HM, Mc Graw Hill

**Reference Books:**

1. Fundamentals of protection by Paithanker & Bhide.S.R, P.H.I
2. Static Relays by Madhava Rao, TMH.

**Other Resources:**

1. NPTEL Course: Power System Protection By Prof. S.A. Soman, Dept. of Electrical Engineering, IIT Bombay:- Web link- https://nptel.ac.in/courses/108/101/108101039/
2. NPTEL Course: Power System Protection and Switchgear By Prof. Bhaveshkumar Bhalja, Dept. of Electrical Engg, IIT Roorkee:- Web link- https://nptel.ac.in/courses/108/107/108107167/

**CONTINUOUS ASSESSMENT (25 Marks)**

*Suggested breakup of distribution*

- Practical Exercises- 10 Marks
- Oral Test– 05 Marks
- Regularity and active participation - 05 Marks
- Industrial Visit: Students' visit to be arranged to the nearby industry involved in design/ manufacturing/ processing in the following electrical engineering domains: Electrical Switchgears / Electrical Substation. All students shall submit visit report in appropriate format as a part of the submission (05 marks).

**END SEMESTER ASSESSMENT (Practical and Oral Examination) (25 Marks)**

- Two examiners, one Internal and one External will do the evaluation.
- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formula. It will be checked by the examiners and evaluated out of 05 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections/simulation and take readings. The examiners verify the connections and output. The weightage is 05 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LBC | EELBC507 | ELECTRICAL MACHINES LAB | 01 |

| Examination Scheme | | |
|---|---|---|
| Continuous Assessment | Practical /Oral | Total |
| 25 | 25 | 50 |

**Pre-requisite:**

1. ESC102-Basic Electrical Engineering
2. EELBC302-Electrical System Lab
3. EEPCC509-Electrical Machines

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Engineering Tool usage
4. PO8: Individual and team work
5. PO11:Lifelong learning

**Course Objectives:**

1. Comprehend effect of change of load on the performance of Synchronous and Asynchronous motor.
2. Study analysis of different types of connections of three phase transformer.
3. Comprehend voltage regulation of synchronous generator by performing suitable tests.
4. Impart knowledge on analysis of synchronous motor performance under various operating conditions.

| Module | Detailed Contents | Hrs |
|---|---|---|
| | **Course Introduction** | |
| **01.** | **Three Phase Transformer:**<br>***Learning Objective:***<br>*To study the performance of performance of Three phase transformer under different operating conditions and for different types of connections.* | **08** |
| | **Theme for conducting Experiment:**<br>1. Determine equivalent circuit parameters of three phase transformer.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 1.1: Identify appropriate meters to perform O.C. and S.C. test on 3 phase transformer and determine different parameters by performing experiment as a team. (P.I. 2.1.2) (P.I. 4.1.3) (P.I.8.1.1) (P.I.11.2.2)* | |

| | | |
|---|---|---|
| | **Theme for conducting Experiment:**<br>2. Analyze Scott and Open delta connection of three phase transformer.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 1.2: Demonstrate objective and limitation of the Scott Connection and Open delta connection of three phase transformer as a team. (P.I. 2.4.4) (P.I.8.2.2) (P.I.11.3.2)* | |
| | **Theme for conducting Experiment:**<br>3. Analyze phasor relationship when three similar transformers are connected to form three phase transformers of different phasor groups.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 1.3: Connect the given three similar transformers to form three phase transformers of different phasor groups and establish a relationship between measured data and underlying physical principles of Three phase transformer. (P.I. 2.4.4) (P.I.4.3.3) (P.I.11.2.2)* | |
| **02.** | **3-Phase Induction Motors:**<br>***Learning Objective:***<br>*To comprehend the performance characteristics of 3 phase induction motors by performing different tests.* | **10** |
| | **Theme for conducting Experiment:**<br>4. Analyze effect of load on the performance of three phase squirrel cage/slip ring induction motor.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 2.1: Identify effect of change in the load on different parameters of 3 phase Induction motors and represent results/ readings using norms of practice of* | |
| | **Theme for conducting Experiment:**<br>5. Determine the equivalent circuit parameters of three phase induction motor by conducting appropriate tests.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 2.2: Determine losses using readings of O.C.- S.C. test data of three phase induction motor and separate them. Also determine equivalent circuit parameters and draw circle diagram to analyse its performance implementing norms of practice. (PI 2.1.2) (P.I. 2.2.2) (P.I. 8.1.2) (P.I.4.3.3) (P.I.11.3.1)* | |
| | **Theme for conducting Experiment:**<br>6. Demonstrate different types of starting and braking methods of IM.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 2.3: Demonstrate as a team use of different starters and braking methods of three phase induction motor. (P.I. 2.1.1) (P.I.2.4.4) (P.I.8.3.1) (P.I.11.3.1)* | |

| | | |
|---|---|---|
| | **Theme for conducting Experiment:**<br>7. Analyze speed control techniques of three phase induction motor.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 2.4: Analyse performance of 3 phase induction motor for different speed control techniques. (P.I. 2.2.4) (P.I. 4.3.1)* | |
| | **Theme for conducting Experiment:**<br>8. Validate Open circuit and short circuit test results of 3 phase induction motor using modern engineering tool.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 2.5: Demonstrate proficiency in identified modern engineering tool to validate O.C. and S.C. test results of 3 Phase I.M. (PI 5.1.1) (PI 5.2.2) (P.I.11.2.2)* | |
| **03** | **1-Phase Induction Motors:**<br>***Learning Objective:***<br>*To comprehend the performance characteristics of 1 phase induction motors by performing different tests.* | **04** |
| | **Theme for conducting Experiment:**<br>9. Analyze the effect of load on the performance of a single-phase induction motor.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 3.1: Analyze effect of change in the load on different parameters of 1 phase AC Induction motors and represent results/ readings using norms of practice of effective team work. (P.I. 2.1.2) (P.I.4.3.1) (P.I.8.1.2) (P.I.11.3.1)* | |
| | **Theme for conducting Experiment:**<br>10. Determine the equivalent circuit parameters of single phase induction motor by conducting appropriate tests.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 3.2: Use readings of O.C. and S.C. test of single phase induction motor to determine equivalent circuit parameters. (P.I. 2.1.2) (P.I.4.3.1)(P.I.8.1.2) (P.I.11.2.2)* | |
| **04.** | **Synchronous Machines:**<br>***Learning Objectives:***<br>*Study performance of Synchronous machines under different operating conditions and compare voltage regulation estimation using various methods.* | **08** |

| | | |
|---|---|---|
| | **Theme for conducting Experiment:**<br>11. Analyze performance of Synchronous generator by performing direct load test.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 4.1: Identify the effect of change of load and excitation on the performance of synchronous machine and present results as a team. (P.I.2.1.2) (P.I. 4.3.1) (P.I. 8.3.1) (P.I.11.2.2)* | |
| | **Theme for conducting Experiment:**<br>12. Determine and compare voltage regulation of alternator obtained by indirect methods.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 4.2: Perform O.C. and S.C. test on synchronous generator and determine voltage regulation by different methods. Analyze results and find best method of voltage regulation underlying the limitations of each one. (P.I. 2.2.4) (P.I. 4.3.2) (P.I.11.3.1)* | |
| | **Theme for conducting Experiment:**<br>13. Demonstrate and verify different conditions of synchronization/ parallel operation of alternator.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 4.3: Extract desired understanding and conclusions consistent with objectives and limitations of the parallel operation of alternator. (P.I. 2.2.2) (P.I.11.2.2)* | |
| | **Theme for conducting Experiment:**<br>14. Analyze the effect of variation of load as well as an excitation on three phase synchronous motor.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 4.4: Identify variables and plot 'V' curve and inverted 'V' curve using standard norms of practice. (P.I.2.1.2) (P.I.8.1.2) (P.I.11.3.1)* | |
| | **Theme for conducting Experiment:**<br>15. Determine the direct axis and quadrature axis reactance of salient pole synchronous machine.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 4.5: Determine value of $X_d$ and $X_q$ in synchronous machines using slip test. (P.I.2.1.2) (P.I.11.2.2)* | |
| | **Minimum 03 experiments from each module, and total at least 10 experiments** | |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 2.1.1 | Articulate problem statements and identify objectives |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 2.4.4 | Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |
| 4.1.3 | Apply appropriate instrumentation and/or software tools to make measurements of physical quantities. |
| 4.3.1 | Use appropriate procedures, tools and techniques to conduct experiments and collect data. |
| 4.3.2 | Analyze data for trends and correlations, stating possible error and limitations |
| 4.3.3 | Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions. |
| 5.1.1 | Identify modern engineering tools such as computer-aided drafting, modelling and analysis; techniques and resources for engineering activities. |
| 5.2.2 | Demonstrate proficiency in using discipline-specific tools. |
| 8.1.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team |
| 8.1.2 | Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal. |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |
| 11.2.2 | Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field. |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information. |

**Course Outcomes:** Learner will be able to

1. Analyze the performance of 3φ transformer under various operating conditions..(LO 1.1) (LO 1.2) (LO 1.3)
2. Analyze performance characteristics of 3 phase induction motor using different tests. (LO 2.1) (LO 2.2) (LO 2.3) (LO 2.4) (LO 2.5)
3. Analyze effect of load on the performance characteristics of 1 phase induction motor and determine equivalent circuit parameters. (LO 3.1) (LO 3.2)
4. Validate voltage regulation and analyze other performance parameters of synchronous machines by conducting suitable tests. (LO 4.1) (LO 4.2) (LO 4.3) (LO 4.4) (LO 4.5)

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELC508.1 | | 3 | | 3 | | | | 3 | | | 3 |
| EELC508.2 | | 3 | | 3 | 3 | | | 3 | | | 3 |
| EELC508.3 | | 3 | | 3 | | | | 3 | | | 3 |
| EELC508.4 | | 3 | | 3 | | | | 3 | | | 3 |
| **Average** | | 3 | | 3 | 3 | | | 3 | | | 3 |

**Text Books :**

1. Bimbhra P.S., Electric Machinery , Khanna Publisher
2. Bimbhra P.S., Generalized Machine Theory, Khanna Publisher
3. D.P.Kothari, I.J. Nagrath, Electrical Machines, Tata McGraw Hill Education Private Limited

**Reference Books :**

1. M.G. Say, Performance and Design of Alternating Current Machines, CBS Pub.
2. Ashfaq Husain, Electric Machines, Dhanpat Rai and Co.
3. A.E. Fitzgerald, Kingsly, Stephen., Electric Machinery, Tata McGraw Hill

**Other Resources :**

1. NPTEL Course: Electrical Machines-II By Prof. Krishna Vasudevan, Prof. G. Sridhara Rao, Prof. P. Sasidhara Rao, IIT-Madras Weblink: https://nptel.ac.in/courses/108/106/108106072/
2. NPTEL Course: Electrical Machines By Prof. G. Bhuvaneshwari, Dept. of Electrical Engineering ,IIT-Delhi. Weblink:- https://nptel.ac.in/courses/108/102/10810214
3. NPTEL Course: Electrical Machines-II By Prof. Tapas Kumar Bhattacharya, Dept. of Electrical Engg. ,IITKharagpur. Weblink:- https://nptel.ac.in/courses/108/105/108105131/

**CONTINUOUS ASSESSMENT (25 Marks)**

*Suggested breakup of distribution*

- Lab experiments: 10 Marks
- Internal Assessment:10 Marks
  Evaluating proficiency in the field by assessing the candidate's capability to execute connection or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through analysis of the data during laboratory session.
- Regularity and active participation - 5 Marks

**END SEMESTER ASSESSMENT (Practical/Oral Examination) (25 Marks)**

Students will be assessed based on three parameters:

- Drawing circuit diagram, Observation Table, Relevant formula (5Marks)
- Experiment conduction (5Marks)
- Sample calculations and conclusion(5Marks)
- Oral: 10 Marks.

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table and write relevant formula. It will be checked by the examiners (Internal and External) and evaluated out of 05 Marks.

  Then the student will be allowed to start with the performance of the experiment.

- Students will be allocated one hour to complete the circuit connections and take readings. The connections and output are then checked by both the examiners for its correctness. The weightage is 05 Marks
- Students will do sample calculations, draw graph if required and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.
- Two examiners, one Internal and one External will do the evaluation

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **AEC** | AEC 502 | PROFESSIONAL COMMUNICATION & ETHICS-2 | 02 |

| **Examination Scheme** | | | | | |
|---|---|---|---|---|---|
| **Distribution of Marks** | | | **Exam Duration (Hrs.)** | | **Total Marks** |
| **In-semester Assessment** | | **End Semester Examination (ESE)** | | | |
| **Continuous Assessment** | **Mid-Semester Exam (MSE)** | | **MSE** | **ESE** | |
| 50 | -- | -- | -- | -- | 50 |

**Program Outcomes addressed:**

1. PO7 : Ethics
2. PO8 : Individual and Teamwork
3. PO9 : Communication
4. PO11: Life-long learning

**Course Objectives:**

1. To inculcate in students, professional and ethical attitude, effective communication skills, team work and a multidisciplinary approach.
2. To provide students with an academic environment where they will be aware of the need for excellence, leadership and lifelong learning to build a successful academic & professional career.
3. To create awareness about professional ethics and codes of professional practices.
4. To prepare students for a successful academic and/or professional career that meets the global academic and/or corporate requirement by providing students to work on multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork, and other interpersonal skills.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>The curriculum of Professional Communication and Ethics-2 is designed to provide students with an academic environment that promotes a professional and ethical attitude as they participate in individual and team activities. The practical sessions will supplement the learner's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global industrial and corporate requirements. The curriculum will create an awareness of professional ethics and the standard code of conduct. It will further inculcate within the budding engineer the social commitment as responsible technical citizens. It will enhance the learner's team building capacities, interpersonal skills and leadership skills so as to become a well-rounded professional in their field of expertise. | **01** |

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**Employability Skills**

***Learning Objectives:***
*1. Customised writing skills and Content Development: To develop effective writing skills to craft a clear, concise, and compelling Statement of purpose, formal letters and resumes for a specific purpose.*
*2. To instil productive and efficient skills to participate confidently and constructively in group discussions and interviews for employability*
*3. To inculcate Ethical Communication & Empathetic Listening*

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**Contents:**

**1.1 Business Correspondence**

- Letter Writing (Principles, Format, Structure, Content, Types)
- Job Application Letter
- Joining Letter
- Resignation Letter
- Resume Writing

**1.2 Statement of Purpose/ Letter of Intent or Interest**

- Purpose
- Elements of SOP/LOI
- Structure
- Tips for writing effective and ethical SOP/LOI

**1.3 Verbal Aptitude Tests** modeled on CAT,GRE,GMAT,IELTS

**1.4 Group Discussions**: Purpose, parameters of evaluating, Types of GDs (Traditional, Case-based & Role Plays), GD Etiquettes, and Importance of inclusivity, respectful listening and expression of diverse ideas for a common goal.

**1.5 Personal Interviews:** Preparation, Types of questions, Types of interviews and modes of interviews. Types: Structured, Stress, Behavioural, Problem Solving & Case-based, Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual

**1.6 Significance of Ethical approach during Group Discussions and Interviews**

- Respectful listening
- Speaking Assertively
- Inclusivity of diverse individuals
- Mindfulness and openness to different ideas
- Common Goal of Consensus

</td><td>03</td></tr>
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***Self-Learning Topics:***

***Watch recordings of professional interviews from online resources.(ex: Civil Service interviews), IIM and UPSC GDs***

***Activities:***

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| | | |
|---|---|---|
| | *1. Prepare an SOP for admission procedure in a reputed university.*<br>*2. Participate in GDs on a given topic followed by Mock Interview.*<br>*3. Attempt Verbal Aptitude and Comprehension Tests.*<br>*4. Write a Job Application/Resignation/Request/Enquiry letter in the learned format*<br>*5. Write a Resume as a fresh graduate trainee for a specific post.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Write clear, concise and professional letters of various types that effectively convey information, build relationships and achieve professional objectives.(9.1.3, 9.2.3, 9.3.2, 11.1.1)*<br>*LO 1.2: Rationally apply gained knowledge of group discussions and aptitude tests for continuous improvement and professional growth in academia and industry. (8.1.2, 8.2.1, 11.1.1.)*<br>*LO 1.3: Exhibit the ethical code of conduct by treating all team mates with respect and dignity, by listening attentively to each member, and encouraging diversity of ideas during a GD. (7.3.1, 8.1.1, 8.2.2,8.2.3, 8.2.4, 9.2.3)*<br>*LO 1.4: Demonstrate through group discussions and mock interviews, the ability to effectively identify unethical conduct and arrive at ethical decisions through strong leadership skills and respectfully lead a team or oneself to the desired goal. (7.1.1,8.1.2,8.2.1,8.2.3, 8.2.4, 8.3.1,9.2.2, 9.2.3)*<br>*LO 1.5: Exhibit a calm demeanor by effectively preparing for competitive exams through mock tests which contain comprehending logical instructions, analysis, problem solving and verbal aptitude assessment (8.2.4, 9.1.1,11.1.1)* | |
| **02.** | **Interpersonal Skills & Ethics**<br>***Learning Objectives:***<br>*1. Develop Problem Solving & Critical Thinking: To help budding engineers understand the importance of interpersonal skills and demonstrate creativity, resourcefulness, along with enhanced communication in personal and professional settings.*<br>*2. Self-Management & Ethical Awareness: To create awareness of Ethical and Social Responsibility towards individual and society by fostering self and team management leading to increased productivity and job readiness.* | **03** |
| | **Contents:**<br>**2.1 Interpersonal Skills (implementation in all AE activities)**<br>o Emotional intelligence<br>o Effective Leadership<br>o Team Building<br>o Conflict Management<br>o Negotiation & Ethical Conflict Resolution<br>o Time management,<br>o Assertiveness<br>**2.2 Importance of Ethics in Interpersonal Relations**<br>o Ethical and Inclusive Decision making.<br>o Ethics in relation to Emotional Quotient | |

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| | ***Self-Learning Topics: Follow industry leaders and experts on social media or read articles on topics related to corporate ethics and social responsibility.***<br><br>***Activity:***<br>*1. Listen to podcasts that discuss ethics, communication and interpersonal skills, such as "The TED Radio Hour" or "How I Built This" and conduct a GD on its learnings.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Apply the learned interpersonal skills in various A.E. activities such as Report presentations, drafting business plans and SOP in an accepting, respectful and inclusive manner. (7.3.1,8.1.1, 8.1.2, 8.2.1, 8.2.2, 9.2.1, 9.2.3)*<br>*LO 2.2: Apply the awareness of ethics while participating in a well-organized, time bound and constructive GD on topics raising ethical and moral concerns. (7.2.2, 7.3.1,8.2.1, 8.3.1, 9.2.3)*<br>*LO 2.3: Apply empathetic and effective speaking skills utilizing ethical values and principles to resolve any social problem while working in a diverse team for group activities. (7.2.2, 7.3.18.1.1, 8.2.1, 8.2.2, 8.2.3, 9.2.1, 9.2.2.)*<br>. | |
| **03.** | **Advanced Technical Writing: project/problem based learning**<br><br>***Learning Objective:***<br>*1. Structure & Organisation: To enable the learner to craft a well-structured technical report, utilizing a logical flow with clear introduction, body and flow, ensuring clarity and coherence in their writing.*<br>*2. Effective Communication: To enhance the ability to communicate complex information clearly and concisely, using relevant visual aids and making the information accessible to technical and non-technical audience.* | **03** |
| | **Contents:**<br>**3.1 Technical/Academic Report**<br>o **Classification of reports on the basis of**: Subject Matter, Time Interval, Function, Physical Factors.<br>o **Parts of a long formal report**: Front Matter, Main Body and Back Matter.<br>o **Language and style of Reports:** Grammar, Tone, Style, Vocabulary, Format of the report from title page to appendices.<br>**3.2 Definition, purpose and types of Proposal**<br>o Parts of a Proposal**:** Elements, Scope and Limitations, Conclusion<br>o Technical Proposal/Synopsis<br>**3.3 Technical Paper Formats (APA/IEEE)**<br>**Parts of a Research paper**:<br>o Title Page<br>o Abstract,<br>o Introduction<br>o Problem Statement/Hypothesis<br>o Research methods,<br>o Data Search (Primary/Secondary)<br>o Quantitative/ Qualitative Analysis<br>o Discussion, | |

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| | o Delimitations,<br>o future scope and<br>o References.<br>o Appendix<br>o Acknowledgement<br>**3.4 Significance of Presenting and Publishing a Research Paper**<br>o Reading Secondary Data<br>o Looking for research gaps<br>o Understanding Need to fill research gap<br>o Creating a Problem Statement<br>o Writing a Synopsis<br>o Writing an academic paper in the APA/IEEE format | |
| | ***Self-Learning Topics:***<br>***Read academic research papers and look for gaps in the research area.***<br>***Activity*:**<br>*1. Prepare an Academic Research Paper on any technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]* | |
| | ***Learning Outcomes:***<br>*The learner will be able to*<br>*LO3.1: Write, individually or as a team, a research paper, with logical & rational progression of ideas, effectively, in a time bound manner to everyone's understanding (8.3.1, 9.1.3, 9.2.3)*<br>*LO3.2: Read, comprehend, and interpret previous research/ secondary source data and clearly state the purpose of research using the IEEE format. (9.1.1,9.1.3,11.3.1)*<br>*LO3.3: Demonstrate the ability to use critical thinking to find gaps in research, interpret the technical and non-technical data and present it with clarity. (9.1.1, 9.1.3, 11.1.2, 11.3.1)*<br>*LO3.4: Apply gained knowledge of technical writing for continuous improvement in academia and professional growth. (11.1.1)* | |
| **04.** | **Technical/Business Presentations**<br>***Learning Objectives:***<br>*1. The development of effective presentation structure and content for academic and technical presentation with the help of ICT*<br>*2.Capacity building for delivering confident and persuasive presentation to both technical and non-technical audience individually or in a team.* | **02** |
| | **Contents:**<br>**4.1 Effective Presentation Strategies:**<br>o Purpose of a presentation,<br>o Understanding the audience, location and the event,<br>o Arranging the material, structuring the presentation,<br>o Making effective slides and platform skills.<br>**4.2 Group Presentations:**<br>o Working with a mixed team (Diversity)<br>o Sharing responsibility in a team (Delegation)<br>o Creating the content together (Uniformity) | |

| | | |
|---|---|---|
| | - Transition phases and Coordination. (Teamwork)<br>- Time Management (Individual and Team)<br>**4.3 Individual Presentations:**<br>- Introduction of Self and Topic<br>- Understanding the audience, building rapport<br>- Time Management<br>- End with Q n A, Feedback | |
| | ***Self-Learning Topics:***<br>*Watch YouTube videos of presentations like TED TALKS on motivational topics*<br>***Activity*:**<br>*1. Prepare an academic research paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1: Demonstrate efficacious and seamless presentation skills to all audiences as an individual and a team with impeccable leadership qualities through proper delegation, problem solving and management (8.1.2, 8.2.1,8.3.1, 9.1.3, 9.2.2, 9.3.2)*<br>*LO4.2: Engage with a diverse team and a mixed audience, during presentations, keeping in mind their uniqueness and differences. (7.3.1.,8.1.1,8.1.2,8.3.1,9.2.2, 9.2.3)* | |
| **05.** | **Corporate Ethics**<br>***Learning Objective/s:***<br>*1. Ethical Principles & Frameworks: To aid the learner to differentiate between various codes of conduct and ethics in the social and professional world.*<br>*2. Analyse & Resolve Ethical Dilemmas: To enforce the significance of ethical citizenry & generate awareness on the importance of IPR and its consequences* | **02** |
| | **Contents:**<br>**5.1. Intellectual Property Rights : Significance, Duration, Laws**<br>- Copyrights<br>- Trademarks<br>- Patents<br>- Geographical Indication<br>- Industrial Designs<br>- Trade Secrets<br><br>**5.2. Start- Up Skills:**<br>- Financial Literacy<br>- Risk Assessment<br>- Data Analysis.<br><br>**5.3. Gender Equity & Inclusivity at the Work Place**<br>- Study on Cases related to Gender Equity in India & Global<br>- Corporate Social Responsibility<br>- Inclusivity at the work place<br>- Corporate Code of Conduct | |

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|---|---|---|
| | ***Self-Learning Topics: Read a biography on a Business Leader/Philanthropist, Collect information on some failed startups. Assess and analyse the reasons for their failure.***<br><br>***Activity:***<br>1. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)*<br>2. *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)* | |
| | ***Learning Outcomes :***<br>*A learner will be able to*<br>*LO 5.1: Utilise professional, moral and ethical principles to identify wrong conduct and suggest ethical solutions through IPR, Gender Equity and Corporate ethics (7.1.1, 7.2.2, 7.3.1)*<br>*LO 5.2: Critically evaluate various socioeconomic, gender issues of discriminatory nature, while emulating equality and open mindedness in all teams, sectors and activities. (7.1.1, 7.2.2,7.3.1, 8.1.1, 8.1.2, 9.2.3)*<br>*LO 5.3: Employ the awareness of IPR to avoid or solve unethical practices in professional life by following standard rules and practices and emerge as a productive team member and a progressive leader. (7.1.1,7.2.2, 8.2.1, 8.2.2, 11.1.1)*<br>*LO 5.4: Assess a failed business plan, analyse reasons for failure and suggest viable solutions as a team keeping in consideration both the individual and team effort. (8.2.1, 8.3.1,9.1.3, 11.1.2)* | |
| | **Activities for Ability Enhancement (Practical Sessions):** | **30** |
| | **Contents:**<br>1. *Write a job application letter, a joining letter, a letter of apology, a request letter. Attach a Resume to the Job Application letter. Follow Standard formats and protocols for each document. (5M)*<br>2. *Prepare an Academic Research Paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper (5M) + Presentation & Group Dynamics (5M)]*<br>3. *Prepare an SOP for admission procedure in a reputed university. (5M)*<br>4. *Participate in GDs on given topic followed by Mock Interview ((10 M)*<br>5. *Attempt Verbal Aptitude and Comprehension Tests(5M)*<br>6. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* ***OR*** *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)*<br>7. *Active Participation & Regularity (5M)* | |
| | *Activities will start in the inverted pyramid, viz., with group activities first so as to build confidence and ending with solo presentations in the form of research paper presentation or Gender Equity presentation.*<br>*Group Discussion, Interview Skills, Presentation skills will have at least three mock drills before the final assessment of the same.*<br>*Rigorous development of the English language, social and professional etiquette will be the praxis* | |
| | **Course Conclusion** | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 7.1.1 | Identify situations of unethical professional conduct and propose ethical alternatives |
| 7.2.2 | Examine and apply moral & ethical principles to known case studies |
| 7.3.1 | Apply and exhibit universal human values and a diverse and inclusive mind-set, free of discrimination |
| 8.1.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team |
| 8.1.2 | Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal. |
| 8.2.1 | Demonstrate effective communication, problem-solving, conflict resolution and leadership skills |
| 8.2.2 | Treat other team members respectfully |
| 8.2.3 | Listen to other members |
| 8.2.4 | Maintain composure in difficult situations |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts |
| 9.1.1 | Read, understand and interpret technical and non-technical information |
| 9.1.3 | Create flow in a document or presentation - a logical progression of ideas so that the main point is clear |
| 9.2.1 | Listen to and comprehend information, instructions, and viewpoints of others |
| 9.2.2 | Deliver effective oral presentations to technical and non-technical audiences |
| 9.2.3 | Apply efficient and effective communication, keeping in mind the diversity and uniqueness in the team. |
| 9.3.2 | Use a variety of media effectively to convey a message in a document or a presentation |
| 11.1.1 | State the rationale for the requirement for continuing professional development |
| 11.1.2 | Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |

**Course Outcomes:** A learner will be able to -

1. Communicate and present effectively and ethically with mixed media in both oral and written forms business reports and documents which will in turn provide a solid foundation for their future managerial roles. (*LOs 1.1, 1.2, 1.4, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.1)*
2. Exhibit the skill set required for successful employability while expressing ethical, assertive and inclusive leadership skills. (*LOs 2.1, 2.2, 2.3, 3.2, 4.2, 4.3, 5.2)*
3. Develop a critical thinking acumen to prepare for and give various competitive exams, emerge successful in group discussions and conduct healthy debates. (*LOs 1.3*, *2.1, 2.2, 2.3, 3.1, 4.2)*
4. Develop creative and mindful thinking while demonstrating the knowledge of professional and personal etiquettes & ethics, such as diversity and inclusivity, in the global environment. (*LOs 1.2, 2.2, 2.4,1.3, 3.2, 4.3, 5.1, 5.2, 5.3, 5.4)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AEC502.1 | | | | | | | 3 | 3 | 3 | | 3 |
| AEC502.2 | | | | | | | 3 | 3 | 3 | | 3 |
| AEC502.3 | | | | | | | 2 | 3 | 3 | | 3 |
| AEC502.4 | | | | | | | 3 | 3 | 3 | | 3 |
| **Average** | | | | | | | 3 | 3 | 3 | | 3 |

**Reference Books:**


1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin:*
2. *Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill. 2. Bovée, C. L., &Thill, J. V. (2021).
3. *Business communication today*. Upper Saddle River, NJ: Pearson.
4. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
5. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South Western Cengage Learning.
6. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
7. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
8. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
9. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.


**Other Resources :**

1. NPTEL Course: https://archive.nptel.ac.in/courses/109/104/109104030
   Dept. of Humanities and Social Sciences, IIT Kanpur, A Course on Communication Skills

## CONTINUOUS INTERNAL ASSESSMENT (50 Marks)

1. Assignments on Resume Writing and Business Correspondence (5M)
2. Prepare an Academic Research Paper (3500-4000 words) on any one socio-technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper/ IEEE (5 M) + Presentation & Group Dynamics. (5M)]

3. Prepare an SOP for admission procedure in a reputed university. (5M)
4. Participation in Final GD on concrete/abstract topic followed by Mock Interview. (10M)
5. Verbal Aptitude Tests (5M)
6. Analyse a Case Study on the topic of Gender Equity & Inclusivity and present (APA) OR Analyse a failed start up present your case to a mixed audience (APA) (10M)
7. Regularity and Active participation (5M)

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| MNP | EEMNP503 | MINI PROJECT- 2A | 01 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering Tool Usage
6. PO6: The Engineer & the world
7. PO7: Ethics
8. PO8: Individual & team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

**Course Objectives:**

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

**Course Outcomes:**

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

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
   - Research/white paper/article/blog writing/publication, etc.
   - Business plan for entrepreneurship product creation
   - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

**Guidelines for the Mini Project**

Mini project may be carried out in one or more form of following:

Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.

- Students must form groups of 3 to 4 members either from the same or from different departments.

- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

**In-Semester Continuous Assessment and End-Semester Examination Guidelines**

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester V (50 marks):
    - 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
    - 15 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
    - 25 marks for the Final Report & Presentation
    - 05 marks for Regularity and Active participation
- Continuous Assessment marks distribution in semester VI (50 marks):
    - 15 marks for the In-Semester Two Presentations
    - 05 marks for Participation in Project Competitions, TPP, etc.
    - 25 marks for the Final Report & Presentation
    - 05 marks for Regularity and Active participation

The review/progress monitoring committee will assess projects based on the following criteria.

**Semester V:**

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
    - The first review will focus on finalizing the problem statement (topic approval).
    - The second review will centre on finalizing the proposed solution.

**Semester VI:**

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
  - The first review will assess the readiness to build a working prototype.
  - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

**End-Semester Examination in Semester VI (50 marks):**

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| HSS | HSS502 | ENTREPRENEURSHIP | 02 |

<table>
<tr><th colspan="6">Examination Scheme</th></tr>
<tr><th colspan="3">Distribution of Marks</th><th colspan="2" rowspan="2">Exam Duration (Hrs.)</th><th rowspan="3">Total Marks</th></tr>
<tr><th colspan="2">In-semester Assessment</th><th rowspan="2">End Semester Exam (ESE)</th></tr>
<tr><th>Continuous Assessment</th><th>Mid-Semester Exam (MSE)</th><th>MSE</th><th>ESE</th></tr>
<tr><td>50</td><td>--</td><td>--</td><td>--</td><td>--</td><td>50</td></tr>
</table>

**Pre-requisite: NIL**

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solutions
4. PO6: The Engineer & The World.
5. PO7: Ethics
6. PO10: Project Management & Finance
7. PO11: Life-long learning

**Course Objectives:**

1. To develop Entrepreneurial mindset amongst the learners.
2. To promote Entrepreneurship as life-skills to improve quality of life, skills of creation and management of entrepreneurial pursuits.
3. To explore paths of the innovation through the creative problem-solving skills
4. To familiarize with the steps involved in ‘idea to product’ development.
5. To get acquainted with the preparation of pitch at ideation, business idea presentation and funding stages

| Module | Details | Hrs |
|---|---|---|
| **00** | **Course Introduction:**<br>This course aims to equip individuals with the knowledge, skills, and mindset needed to identify and pursue new business opportunities. It aims to foster an entrepreneurial culture and mindset to help develop the next generation of entrepreneurs who can create jobs, drive economic growth, and contribute to the society. Entrepreneurship is a life skill that will help an individual succeed in a variety of scenarios, both personal and professional. By its very nature, entrepreneurship is an interdisciplinary field that draws from a range of disciplines, including business, economics, engineering, and social sciences.<br>Some of the key topics covered in Entrepreneurship Course include opportunity recognition, market research, business planning, financing, marketing, and management while emphasizing the development of critical thinking, creativity, risk-taking, and problem- solving skills. | **1** |

| | | |
|---|---|---|
| 1 | **Fundamentals of Entrepreneurship** | 5-6 |
| | ***Learning Objectives***:<br>• *To gain knowledge about the concepts and principles of entrepreneurship, including opportunity recognition and value creation.*<br>• *To develop an entrepreneurial mindset and skills that will enable them to identify, evaluate, and pursue viable business opportunities with confidence.* | |
| | **Contents:**<br>Introduction to Entrepreneurship, Entrepreneurial Mindset, Opportunity Identification, Market Analysis & Customer Research, Business Models & Go-to-Market, Funding and Financial Management, Marketing Aspects, Scaling the Venture and Growth Strategies:<br>*Note:* A real life case study covering key elements of the module shall be covered. | |
| | ***Learning Outcome:***<br>*The learner would be able to*<br>• *Understand the concept of Entrepreneurship*<br>• *State the myths, advantages and limitations of Entrepreneurship*<br>• *Interpret and analyze market research data and customer analysis to make informed business decisions.*<br>• *Discuss the steps in the process of Entrepreneurship* | |
| 2 | **Technological Innovation and Entrepreneurship** | 4-5 |
| | ***Learning Objectives:***<br>• *To enhance creative problem-solving skills and to examine the importance of innovation in business success.*<br>• *To identify the types of Innovation*<br>• *To gain knowledge for taking an idea to product development stage while protecting the idea with IPR.* | |
| | **Content:**<br>Foundations of Creativity and Innovations, Creative thinking process, Types of Innovation: Incremental, Disruptive, and Radical, Innovation Process: from idea to execution; Protecting ideas - Patents and IPR. Exploring Technological Innovation through Case Studies. | |
| | ***Learning Outcome:***<br>*The learner would be able to*<br>• *Use their understanding of the role Technological innovation plays in driving business success.*<br>• *To formulate steps for taking an idea to product stage with necessary patents* | |
| 3 | **Ideation, Prototyping, Testing, Validation and Commercialisation** | 5-6 |
| | ***Learning Objectives:***<br>• *Experiment to test Minimum Viable Products (MVPs) and validate business ideas.*<br>• *To formulate a Build-Measure-Learn feedback loop for continuous improvement.* | |

| | | |
|---|---|---|
| | **Contents:**<br><br>Identifying customer needs and problems to solve, Ideation, Concept Development, Design Thinking, Prototyping, Minimum Viable Product (MVP), Testing, and Iterations. Understanding the Market, customer feedback and refinement of business idea based on feedback.<br><br>*Note:* A real life case study covering key elements of the module shall be covered. | |
| | ***Learning Outcome:***<br><br>*The learner would be able to*<br><br>• *Select specific measures to design, test, and validate Minimum Viable Products (MVPs) to assess business ideas.*<br>• *Interpret the learnings from the build-measure-learn feedback loop to facilitate continuous improvement and learning.* | |
| **4** | **Financial Resources** | 3-4 |
| | ***Learning Objectives:***<br><br>• *Describe the key concepts, and strategies related to fundraising for entrepreneurial ventures.*<br>• *Compare various funding sources, including angel investors, venture capitalists, grants, and crowdfunding platforms.*<br>• *Devise and create compelling investor pitches, develop financial projections.* | |
| | **Contents:**<br><br>Funding new ventures – bootstrapping, crowd sourcing, Angel investors, VCs, debt financing, and due diligence; Raising fund during life-cycle of a new ventures.<br>*Note:* A real life case study covering key elements of the module shall be covered. | |
| | ***Learning Outcome:***<br><br>*The learner would be able to*<br><br>• *Recognize various fundraising strategies and techniques, enabling s to choose the most appropriate funding sources for their entrepreneurial ventures.*<br>• *Sketch effective pitches and fundraising campaigns tailored to different types of investors and funding sources, ensuring successful capital-raising efforts.* | |
| **5** | **National Entrepreneurial Culture** | 4-5 |
| | ***Learning Objectives:***<br><br>• *To gain knowledge of legal and regulatory requirements for startups, including compliance with relevant regulations.*<br>• *To identify the various government initiatives to develop the start-up ecosystem.* | |
| | **Contents:**<br><br>Entrepreneurial Ecosystem in India, Key regulations and legal aspects, Forms of Business Ownership, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, | |

| | | |
|---|---|---|
| | banks etc. Government incentives for entrepreneurship, Incubation, & Acceleration. | |
| | ***Learning Outcome:***<br>*The learner would be able to*<br>• *Describe the current scenario of Entrepreneurial activity in India.*<br>• *To state legal and regulatory requirements and compliances for start-ups.*<br>• *To state the various government initiatives to support the entrepreneurs.* | |
| **6** | **Start-up Case Studies** | 3-4 |
| | ***Learning Objectives**:*<br>*To relate the real life case studies and analyse them for acquiring the clarity on various aspects of entrepreneurship covered in the first 5 modules* | |
| | **Contents:**<br>Case Studies of various start-ups (with Indian Context): Start-ups from Tech, Edtech, Fintech, and Agriculture domain; Study of successful start-ups and failed start-ups. | |
| | ***Learning Outcome:***<br>• *To evaluate the real-world examples and case studies that will help them understand the practical aspects of idea to product, fundraising and financial management in the context of entrepreneurship.* | |
| | ***Course Conclusion*** | 1 |
| | **Total** | 30 |

**In-semester Assessment - Continuous Assessment: Suggested**

1 Teams of 3-4 students shall present a One-Minute business idea pitch– ideation phase-10 marks
2 Teams of 3-4 students shall present a Three-Minute Business Pitch –Validation phase-10 marks
3 Teams of 3-4 students shall present a Five-Minute Business Pitch for Funding- 15 marks
4 Teams of 3-4 students shall present analysis of one case study of successful or failed start-up- (15 Marks)

**Course Outcome**: Learner will be able to

CO1: State the concept of Entrepreneurship and Indian Start-up ecosystem
CO2: Identify the business ideas and to analyse the environment for potential business opportunity.
CO3: Identify the specific measures to design, test, and validate Minimum Viable Product.
CO4: State the key concepts, and strategies related to fundraising for entrepreneurial ventures.
CO4: Identify the legal and regulatory framework for entrepreneurs in Indian context.
CO5: Analyse and correlate the reasons for the success or the failure of entrepreneurial firms.

**Text Books:**


1. Poornima Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House

5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
6. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
7. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.

**Reference Books:**


1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries
3. India as Global Start-up Hub: Mission with Passion by C B Rao
4. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker
5. Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization - Robert D. Hisrich, Veland Ramadani, Springer (2017)
6. Entrepreneurship- Theory, Process Practice –by Kuratko &Hodgetts, Thompson South-Western Publication


**Relevant Websites:**

1. www.msme.gov.in
2. www.dcmesme.gov.in
3. www.msmetraining.gov.in

**Other Resources**:

1. NPTEL Course: Entrepreneurship By Prof. C Bhaktavatsala Rao, IIT Madrao
   Weblink https://onlinecourses.nptel.ac.in/noc20_mg35/preview
2. NPTEL Course: Entrepreneurship Essentials By Prof. Manoj Kumar Mondal, IIT Kharagpur
   Weblink https://onlinecourses.nptel.ac.in/noc21_ge06/preview

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PCC | EEPCC611 | DRIVES AND CONTROL | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**
1. EEPCC406: Control System
2. EEPCC407: Power Electronics
3. EEPCC509: Electrical Machines

**Program Outcomes addressed:**
1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct investigations of complex problems
4. PO9: Communication
5. PO11: Lifelong learning

**Course Objectives:** To impart knowledge on
1. Fundamental features and dynamics of electrical drives.
2. Selection of motor power rating for applications designed for different duty cycles.
3. DC and AC drives with control schemes.
4. Practical applications of electrical drives.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Electrical drives are extensively utilized in industries and everyday applications for motion control. It is important for electrical engineers to learn drives and control systems, as they are key to operating and managing electrical machines**.** Large scale deployment of electric vehicles has further highlighted the significance of drives and control. To effectively master electrical drives, it is essential to understand their components and dynamics, as this knowledge influences drive selection and performance optimization. | **01** |
| **01.** | **Electrical Drives - Introduction & Dynamics:** | **04-05** |
| | ***Learning Objective/s:***<br>*Acquire the ability to apply the knowledge of motor load system dynamics to analyze the operation of the drive and comprehend the components of electrical drives in real-life examples.* | |
| | **Contents**<br>Introduction, Parts of Electrical Drives with a case study, Choice of Electrical Drives, Fundamental Torque equations, Speed-Torque conventions and Multi-quadrant Operation, Equivalent values of Drive Parameters, Measurement of Moment of Inertia, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability. | |
| | ***Self-Learning Topics:*** *Load equalisation.* | |
| | *Learning Outcomes:*<br>*A learner will be able to* | |

| | | |
|---|---|---|
| | *LO1.1: Apply the fundamental torque equation (based on Newton's law) to find the transient response of electrical drives (PI 1.3.1).*<br>*LO1.2: Apply the relevant equations of electrical machines to solve problems related to electrical drives (PI 1.4.1).*<br>*LO1.3: Interpret the factors affecting the choice of electrical drives for various applications (PI 2.1.3).*<br>*LO1.4: Analyze the steady state stability of a drive in all the four quadrants (PI 2.2.4).* | |
| **02.** | **Selection of Motor Power Rating** | **06-07** |
| | ***Learning Objective:***<br>*To acquire a skill to choose the appropriate motor power rating for applications of different duty cycles.* | |
| | **Contents:**<br>Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating: Continuous duty; Equivalent current, Torque and Power Methods for Fluctuating and Intermittent Loads; Short Time Duty; Intermittent Duty. | |
| | ***Self-Learning Topics:*** *Identify the availability and specifications of different duty cycle motors from the catalogue available in the motor manufacturer's website.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1: Derive the thermal model equations and draw the heating and cooling curves of the motor (PI 2.3.1)*<br>*LO2.2: Derive the equivalent current, Torque and Power equations for Fluctuating and Intermittent Loads (PI 1.4.1)*<br>*LO2.3: Refer the manufacturer's website to identify the different classes of motor duty and explain their relevance with suitable example applications. (PI 1.3.1, 11.3.1).*<br>*LO2.4: Select the motor power rating of a motor for applications intended for various duty cycles considering the overload factor and constraints like maximum allowable current and breakdown torque (PI 2.2.3).* | |
| **03.** | **Basic Control Aspects of Four Quadrant DC Drives** | **05-06** |
| | *Learning Objective:*<br>*To gain knowledge on the fundamental control aspects of electrical drives, particularly focusing on four quadrant DC drives* | |
| | **Contents:**<br>Review of Basic multi-quadrant speed torque characteristics and equations of DC motors, DC separately excited motor: Modes of Operation, Speed Transitions during Acceleration and Deceleration showing the quadrant of operation, Single and Three Phase Fully Controlled Converter based Separately Excited DC Motor Drive. Chopper based multi-quadrant Separately Excited DC Motor Drive, Closed loop control – Torque control, Speed control loop with inner current control loop. (No Numerical on this Module) | |
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO3.1: Identify the different modes of operation of electrical drives and draw the speed torque characteristics of both motor and load. (PI 1.3.1)*<br>*LO3.2: Analyze different closed loop control schemes of drives – Torque control, Speed control loop with inner current control loop (PI 1.4.1)*<br>*LO3.3: Apply the basic multi-quadrant speed torque characteristics and equations of DC motors to analyze the operation of power electronic DC drives. (PI 2.1.3)*<br>*LO3.4: Analyze the multi-quadrant operation of fully controlled converter fed and chopper fed separately excited dc motor. (PI 2.2.3)* | |
| **04.** | **Induction Motor Drives** | **09-10** |
| | ***Learning Objective:***<br>*To gain knowledge on the basic control schemes in induction motor drives* | |

| | | |
|---|---|---|
| | **Contents:**<br>Basic Multi-Quadrant Speed-Torque Characteristics and Equations of Induction Motor (IM), Regenerative Braking, Plugging, Speed Transitions during Acceleration and Deceleration, Speed Control: Stator Voltage Control, Variable frequency Drive (VFD): V/f Control (Constant torque, constant power and constant slip region). Open loop V/f control, Soft starting with V/f control. Closed loop V/f control with slip regulation, Closed loop V/f control with torque and flux control. | |
| | ***Self-Learning Topics:***<br>Application reports for the implementation of V/f speed control of induction motor, provided by Texas Instruments, Infineon Technologies etc. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO4.1: Apply the basic multi-quadrant speed torque characteristics and equations of induction motors to solve problems on electrical drives. (PI 1.3.1)*<br>*LO4.2: Analyze the transition in different modes of operation of IM with reference to regenerating braking and plugging. (PI 2.2.3)*<br>*LO4.3: Analyze VFD in constant torque and constant power mode. Also show the speed transitions during acceleration and deceleration. (PI 2.2.2)*<br>*LO4.4: Apply electrical engineering concepts and justify why it is suggested to have soft control rather than drastic variations of V and f. (PI 1.4.1)* | |
| **05.** | **Direct Vector Control of Induction Motor** | **08-09** |
| | ***Learning Objective:***<br>*To gain knowledge on direct vector control of IM and practical implementation of IM drives* | |
| | **Contents:**<br>Review of d-q Model of Induction Motor, d-q Model of Induction Motor in synchronously rotating reference frame, Principle of Vector Control (also called as Field Oriented Control (FOC)), DC Motor Analogy, Voltage model of IM for flux estimation. Direct Vector Control Scheme, Comparison of Scalar and Vector control. Factors to be considered for the practical implementation of V/f control/Vector control of Induction Motor. | |
| | ***Self-Learning Topics:***<br>*Indirect Vector Control of IM: Application reports for the implementation of indirect vector control of IM, provided by Texas Instruments, Infineon Technologies etc.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO5.1: Analyze the d-q model of IM in synchronously rotating reference frame and interpret how direct and quadrature axis current can be made analogous to field and armature current of DC motor for direct vector control implementation (PI 2.1.3)*<br>*LO5.2: Compare scalar and vector control of IM and decide the suitability of these control methods in various applications. (PI 2.2.4)*<br>*LO5.3: Examine the relevant methods, tools and techniques for the practical implementation of V/f control/Vector control of Induction Motor (PI 4.1.2).*<br>*LO5.4: Specify appropriate equipment and procedures for the practical implementation of V/f control/Vector control of Induction Motor (PI 4.2.1).* | |
| **06.** | **PMSM Drive for EV Application** | **05-06** |
| | ***Learning Objective/s:***<br>*Comprehend the suitability of PMSM drive for EV application.* | |
| | **Contents:**<br>PM Synchronous Motor Control: permanent-magnet ac synchronous motor-surface-permanent-magnet (SPM) motors and interior-permanent-magnet (IPM) motors, Suitability of PMSM for EV application. Field-Oriented Control of PMSM, Flux-Weakening Control of PMSM. | |

| | | |
|---|---|---|
| | ***Self-Learning Topics:***<br>*Watch videos on PMSM Drive for EV Application and other real-world electrical drives.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1: Identify the control of IM in constant torque region and constant power region and discuss the requirement of it in EV application. (PI-2.2.2)*<br>*LO6.2: Identify the suitability of PMSM drive for EV application compared to that of IM drive referring credible sources of information. (PI-2.2.4, 11.3.1)*<br>*LO6.3: Study anyone real-world electrical drive, find the main parts, understand how they work, and make power point slides to show the findings (PI 1.3.1, 9.1.3).*<br>*LO6.4: Identify feasible improvements to enhance the performance of anyone real-world electrical drive (PI 2.2.4, 11.1.2).*<br>*LO6.5: Deliver a clear and effective presentation on electrical drive systems, showcasing an understanding of essential components and drive performance through real-world examples (PI 1.4.1, 9.2.2).* | |
| | **Course Conclusion**<br>The course on drives and control teaches how to apply the basics of electric motors, power electronics, and control systems in drives applications. Students learn to apply the knowledge of dynamics of motor load system to solve problems on electrical drives. Students learn how to analyse and use these systems in industry. Through hands-on labs and real-world examples, they gain practical skills to improve the performance of electric. | **01** |
| | **Total** | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.3 | Identify the mathematical, engineering, and other relevant knowledge that applies to a given problem |
| 2.2.2 | Identify, assemble, and evaluate information and resources. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 2.3.1 | Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy |
| 4.1.2 | Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation |
| 4.2.1 | Design and develop an experimental approach, specify appropriate equipment and procedures |
| 9.1.3 | Create flow in a document or presentation - a logical progression of ideas so that the main point is clear |
| 9.2.2 | Deliver effective oral presentations to technical and non-technical audiences |
| 11.1.2 | Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |

**Course Outcomes:**
Learner will be able to

1. Apply the basic principles of dynamics of motor load system to analyse the operation of electrical drives *(LO1.1, LO1.2, LO1.3, LO1.4).*
2. Choose the appropriate motor power rating for applications designed to operate under different duty cycles *(LO2.1, LO2.2, LO2.3, LO2.4).*
3. Analyse the primary control schemes of multi-quadrant DC drives *(LO3.1, LO3.2, LO3.3, LO3.4).*
4. Determine the suitability of scalar and vector control methods for induction motors in different applications and interpret the practical implementation aspects of any one method. *( LO4.1, LO4.2, LO4.3, LO4.4, LO5.1, LO5.2, LO5.3, LO5.4).*
5. Analyze real-life examples of electrical drives, outline their key components with functions, and present the findings during the class session *(LO6.1, LO6.2, LO6.3, LO6.4, LO6.5).*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPCC611.1 | 3 | 3 | | | | | | | | | |
| EEPCC611.2 | | 3 | | | | | | | | | 2 |
| EEPCC611.3 | 3 | 3 | | | | | | | | | |
| EEPCC611.4 | 3 | 3 | | 3 | | | | | | | |
| EEPCC611.5 | 3 | 3 | | | | | | | 3 | | 3 |
| **Average** | 3 | 3 | | 3 | | | | | 3 | | 3 |

**Text Books:**

1. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publication
2. A First Course on Electrical Drives by S. K. Pillai, New Age International.
3. Modern Power Electronics and AC Drives by B. K. Bose, Prentice Hall PTR

**Reference Books:**

1. Electric Motor Drives: Modelling, Analysis and Control by Krishnan R, PHI
2. Power electronics by Muhammad H. Rashid, Pearson

**Other Resources:**

1. NPTEL Course: Fundamentals of Electric Drives, IIT Kanpur by Prof. Shyama Prasad Das https://nptel.ac.in/courses/108/104/108104140/
2. NPTEL Course: Industrial Drives - Power Electronics, IISc Bangalore by Prof. K. Gopakumar. https://nptel.ac.in/courses/108/108/108108077/
3. NPTEL Course: Industrial Drives, IIT Delhi by Dr.K .R. Rajagopal https://nptel.ac.in/courses/108/102/108102046/
4. Application reports for the implementation of V/f control and indirect vector control of IM, provided by Texas Instruments, Infineon Technologies etc.

**IN-SEMESTER ASSESSMENT (50 MARKS)**

*Suggested breakup of distribution*

1. Continuous Assessment (20 Marks)
   - Numerical Assignment/s (minimum 20 problems) + Class test based on above numerical assignment: 10 Marks
   - Gather real-life drives information through reading articles, observations, watching videos, and present it in the class: 05 marks

- Regularity and Active Participation: 05 marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PE | EEPEC6021 | LIGHTING SYSTEM DESIGN | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. ESC102 -Basic Electrical Engineering

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO6: The Engineer and The World
5. PO11: Life-long learning

**Course Objectives:**

1. To impart knowledge on various laws of illumination, lighting parameters, light sources, luminaries and their characteristics to be used for lighting design.
2. To impart knowledge on lighting design considerations for interior and exterior applications.
3. To impart knowledge on LED based solid-state lighting with different lighting control technologies and standards.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Lighting System Design course is a specialized course focusing on the design and implementation of lighting systems. Understanding the intricacies of light and how it interacts with spaces is crucial for creating efficient and aesthetically pleasing lighting designs. This course enhances knowledge and helps discover the latest trends and techniques in the field. Hence, the fundamental concepts of this course are essential for designing the lighting systems. | **01** |
| **01.** | **Introduction:** | **04-05** |
| | ***Learning Objective/s:***<br>*To study various lighting parameters and apply the laws of illumination for the Photometric measurements.* | |
| | **Contents**<br>Review of Light, Color and Photometry: Laws of illumination, illumination entities. Radiometric and photometric standards, Photometers, Photometric measurement procedure for assessment of lamp efficacy, Color temperature, CRI, Glare, lighting level, uniformity, contrast, modeling effect, directional lighting, diffused lighting | |
| | ***Self-Learning Topics:*** *Structure of Eye, Adaptation, Accommodation* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 1.1: Apply laws of natural science to perform the photometric measurements (PI-1.2.1)* | |

| | | |
|---|---|---|
| | *LO 1.2: Apply basic principles to solve problems based on laws of illumination (PI-1.4.1)*<br>*LO 1.3: Identify lighting parameters and analyze their characteristics for designing lighting systems(PI-2.1.2)*<br>*LO 1.4:Identify existing processes/solution methods for analyzing the photometric measurements (PI-2.2.3)* | |
| **02.** | **Sources of Light** | **06-07** |
| | ***Learning Objective:***<br>*To teach various lamps, lighting components/ subsystems, thermal management and lifetime studies.* | |
| | **Contents:**<br>Sources of Light, Review of development, construction and characteristics of Lamps: Incandescent lamp, Halogen lamp, Discharge lamps: Fluorescent lamp, High-pressure discharge lamps, Metal Halide lamp, Induction lamp, and LED lamp. OLEDs, light-emitting polymers (LEPs), Thermal Management and Lifetime Studies. | |
| | ***Self-Learning Topics:*** *Low Pressure and High Pressure Sodium Vapour lamp, High pressure Mercury Vapour lamp* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 2.1: Apply laws of natural science to study the characteristics of lamps(PI-1.2.1)*<br>*LO 2.2: Apply fundamental engineering concepts to solve lighting system design problems (PI-1.4.1)*<br>*LO 2.3: Identify lighting components and analyze the characteristics of various lamps (PI-2.1.2)*<br>*LO 2.4: Identify existing processes/solution methods for analyzing the performance of various lamps (PI-2.2.3)* | |
| **03.** | **Luminaries** | **05-06** |
| | *Learning Objective:*<br>*To impart knowledge on various control gear, lighting fixtures and lighting schemes for various lamps.* | |
| | **Contents:**<br>Optical control, Control gear: ballast, standard and electronic, Luminaries photometry, Drivers for LED lamps, standards and regulations, LED luminaries, LED Light Distributions, Lighting fixtures, High bay, Low bay luminaires, Direct/ indirect light luminaires | |
| | *Learning Outcomes:*<br>*A learner will be able to*<br>*LO 3.1: Identify and analyse control gear for various light sources (PI-2.1.2)*<br>*LO 3.2: Identify existing processes/solution methods for control gear (PI-2.2.3)*<br>*LO 3.3: Extract engineering requirements from relevant engineering codes and standards of lighting system design for protection of the public (PI-3.1.4, 6.2.1)*<br>*LO 3.4: Determine objectives, functional requirements and arrive at specifications and apply principles for sustainable development using LED luminaires (PI-3.1.6, 6.3.4)* | |
| **04.** | **Interior Lighting Design and Calculation** | **09-10** |

| | | |
|---|---|---|
| | ***Learning Objective:***<br>*To teach the concepts of design for an Interior Lighting system through standards, design considerations and calculation for different application areas and simulate using modern tools.* | |
| | **Contents:**<br>Objectives, quality and quantity of lighting. Lamp /Luminaire selection and placement, design considerations and calculation. Glare Consideration and control. Indoor lighting design by lumen method, point-by-point method. Applications: residential, educational institute, industries, sports centers, commercial premises: retail stores, offices etc. Applicable standards. | |
| | ***Self-Learning Topics:***<br>*Simulate interior lighting design using software tools and analyse results.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 4.1: Apply fundamental engineering concepts in interior lighting design using lumen method (PI-1.3.1)*<br>*LO 4.2: Apply basic principles to solve interior lighting design problems using lumen method (PI-1.4.1)*<br>*LO 4.3: Extract engineering requirements from relevant engineering Codes and Standards for interior lighting design applications (PI-3.1.4, PI-6.2.1)*<br>*LO 4.4: Determine design objectives, functional requirements and arrive at specifications for interior lighting design applications for sustainable development (PI-3.1.6, 6.3.4)* | |
| **05.** | **Exterior Lighting Design and Calculation** | **07-08** |
| | ***Learning Objective:***<br>*To teach the concepts of design for an Exterior Lighting system through standards, design considerations and calculation for different application areas and simulate using modern tools.* | |
| | **Contents:**<br>Exterior lighting system- Road lighting system, lighting at junctions, Utility area lighting, Sports lighting, Tunnel lighting, Decorative flood lighting, Building Façade lighting. Applicable standards | |
| | ***Self-Learning Topics:***<br>*Simulate Exterior lighting design using software tools and analyse results.* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 5.1: Apply fundamental engineering concepts in exterior lighting design using lumen method (PI-1.3.1)*<br>*LO 5.2: : Apply basic principles to solve exterior lighting design problems using lumen method (PI-1.4.1)*<br>*LO 5.3: Extract engineering requirements from relevant engineering Codes and Standards for exterior lighting design for various applications (PI-3.1.4, PI-6.2.1)*<br>*LO 5.4: Determine design objectives, functional requirements and arrive at specifications for exterior lighting design applications for sustainable development (PI-3.1.6, 6.3.4)* | |
| **06.** | **Lighting Control and Recent trends in Lighting** | **06-07** |
| | ***Learning Objective/s:***<br>*To impart knowledge on lighting control and recent trends in lighting using codes and standards.* | |

| | | |
|---|---|---|
| | **Contents:**<br>Introduction to Lighting Control, Controls, Selection of Lighting Controls, Lighting Control Schemes, Lighting and LEED, Daylighting control, Controlling LED Lighting Systems, Smart Lighting Fixtures, Digital Lighting Networks, DMX control, Smart Street Lighting with Remote Monitoring and Control System, Solar Powered LED Lighting, Lighting for health and safety, Circadian Rhythm and Human Centric Lighting. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO 6.1: Identify existing processes/solution methods of lighting control schemes and digital lighting networks for health and safety (PI-2.2.3)*<br>*LO 6.2: Compare and analyse alternative solution of lighting control schemes using energy using efficient lighting system (PI-2.2.4)*<br>*LO 6.3: Extract engineering requirements from relevant engineering codes and standards, recognize the need and keep current regarding new developments of lighting control schemes and digital lighting networks for health and safety (PI-3.1.4, 6.2.1,11.2.1)*<br>*LO 6.4: Determine design objectives, functional requirements and arrive at specifications and of lighting control schemes using energy using efficient lighting system and digital lighting networks for sustainable development (PI-3.1.6, 6.3.4,11.2.2)* | |
| | **Course Conclusion**<br>Lighting is the deliberate use of light to achieve aesthetic effects. Lighting includes the use of both artificial light sources like lamps and light fixtures, as well as natural daylight. Proper lighting can enhance task performance, improve the appearance of an area and have positive psychological effects on occupants. | **01** |
| **Total** | | **45** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 1.2.1 | Apply laws of natural science to an engineering problem |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 3.1.4 | Extract engineering requirements from relevant engineering Codes and Standards such as ASME, ASTM, BIS, ISO and ASHRAE. |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications |
| 6.2.1 | Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public |
| 6.3.4 | Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline |
| 11.2.1 | Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current |
| 11.2.2 | Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field |

**Course Outcomes:**

Learner will be able to

1. Apply basic principles to solve problems on illumination for designing lighting systems *(LO 1.1, LO 1.2,LO 1.3, LO 1.4).*
2. Identify lighting components, control gear for various lamps, and analyse their characteristics for designing lighting systems *(LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 3.1, LO 3.2, LO3.3, LO3.4).*
3. Apply basic principles to solve problems on interior and exterior lighting design *(LO 4.1, LO 4.2, LO 5.1, LO 5.2).*
4. Determine design objectives, functional requirements for interior and exterior lighting applications through codes and standards and keep current regarding new developments in lighting design (*LO 4.3, LO 4.4, LO 5.3, LO 5.4*).
5. Identify and analyse lighting control schemes through codes and standards for sustainable development using energy using efficient lighting system *(LO6.1, LO6.2, LO6.3,LO 6.4, LO6.5)*

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPEC6021.1 | 3 | 3 | | | | | | | | | |
| EEPEC6021.2 | 3 | 3 | 3 | | | 3 | | | | | |
| EEPEC6021.3 | 3 | | | | | | | | | | |
| EEPEC6021.4 | | | 3 | | | 3 | | | | | |
| EEPEC6021.5 | | 3 | 3 | | | 3 | | | | | 3 |
| **Average** | **3** | **3** | **3** | | | **3** | | | | | **3** |

**Text Books :**

1. Anil Valia, Designing with Light – A Lighting Handbook, International Lighting Academy
2. M. Nisa Khan, Understanding LED Illumination, CRC Press 2013
3. Anil Valia, LED LIGHTING SYSTEMS All you need to know, International Lighting Academy
4. National Lighting Code- 2011
5. Kao Chen, Energy Management in Illumination Systems, CRC Press.
6. John L. Fetters, The Hand Book of Lighting Surveys and Audits, CRC Press.

**Reference Books :**

1. Illuminating Engineering Society―The IES Lighting Handbook, 10th Edition
2. J. L. Lindsey and S. C. Dunning ―Applied Illumination Engineering, Third Edition, Fairmont Press, 2016
3. Lamps and Lighting – Edited by J.R. Coaton and A.M. Marsden, 4th Edition
4. Lighting for health and safety – N.A. Smith, Butterworth-Heimann.
5. Human Factors in Lighting – Peter R. Boyce, Taylor & Francis.

**Other Resources :**

1. NPTEL Course: Illumination Engineering, Prof. N.K. Kishore, IIT Kharagpur https://archive.nptel.ac.in/courses/108/105/108105060/

**IN-SEMESTER ASSESSMENT (50 MARKS)**

*Suggested breakup of distribution*

1. Continuous Assessment (20 Marks)
   - MCQ: 10 Marks
   - Class test: 05 marks
   - Regularity and Active Participation: 05 marks
2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| PEC | EEPEC6022 | HIGH VOLTAGE DC TRANSMISSION | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | | | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | MSE | ESE | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite:**

1. EEPCC301- Engineering Mathematics-III
2. EEPCC302-Circuit and Signal Analysis
3. EEPCC405-Engineering Mathematics-IV
4. EEPCC406-Control System
5. EEPCC408-Powersystem Engineering
6. EEPCC407-Power Electronics

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct investigations of complex problems
4. PO6: The engineer and the World
5. PO11: Lifelong learning

**Course Objectives:**

1. To learn the advantages, disadvantages, applications, classification and components of HVDC system
2. To study the modelling of the complete equivalent circuit of HVDC system and analyse its operation under various conditions.
3. To learn the control of HVDC system under normal and abnormal condition.
4. To learn the faults in HVDC transmission and the protections methods.
5. To acquire the knowledge of the impact of HVDC to the power system and the mitigation methods.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Early discoveries and evolution of HVDC system. Advances in HVDC transmission and its application. | **01** |
| **01.** | ***Learning Objective:***<br>*To learn the fundamentals of electrical engineering to identify suitable transmission systems based on applications, Prioritizing Public Safety Considerations.* | **04-06** |
| | **Contents: Introduction**<br>Comparison of HVAC and HVDC transmission. Classification of HVDC links, Components HVDC Transmission system, Ground Return Advantages and Problems. | |

| | | |
|---|---|---|
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1 Apply electrical engineering concepts to understand the limitation and advantages of AC and DC transmission. (P.I.-1.3.1)*<br>*LO1.2 Use core principles of engineering to understand components and classification of HVDC system and describe the cares taken to prevent touch and step potential (PI-1.4.1, PI-6.1.1)* | |
| **02.** | **Analysis of the Bridge rectifier** | **12-14** |
| | ***Learning Objective:***<br>*To formulate the equivalent circuit model of a complete HVDC system from the model of rectifier side and inverter side and analyze the performance of converters under different operating conditions* | |
| | **Contents:**<br>Analysis of simple rectifier circuits, Features required for an HVDC converter, Analysis of six pulse converter with grid control but no overlap, Analysis of six pulse converter with grid control and overlap less than 60°, Relation between AC and DC quantities, Analysis with overlap greater than 60°, Rectifier operation, output voltage, valve voltage waveforms, Inverter operation, output voltage waveforms, valve voltage waveforms. Equivalent circuit, Multi bridge converter, Numerical from converter circuits and multiple bridge converters. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO2.1: Apply the electrical engineering knowledge to understand the operation of three phase converter/inverter. (P.I.-1.3.1)*<br>*LO2.2: Apply advanced mathematical concepts to develop the equivalent circuit of HVDC system. (P.I.-1.1.1)*<br>*LO2.3: Identify assumptions necessary to allow modeling of an HVDC system and analyse the complete model and develop relation between AC and DC quantities. (P.I.-2.3.2)*<br>*LO2.4: Analyse HVDC mathematical models to find the electrical parameters of converter and inverter side (P.I.-2.4.1)*<br>*LO2.5: Analyze raw data from HVDC systems, synthesize key insights, and draw meaningful conclusions to enhance understanding of system performance and behavior ( P.I-4.3.3, P.I-4.3.4)* | |
| **03.** | **HVDC System Control** | **09-11** |
| | ***Learning Objective:***<br>*To comprehend HVDC operation under normal and abnormal conditions from control characteristics* | |
| | **Contents:**<br>Desired features of control, Basic means of control, Limitation of manual control, Constant current verses constant voltage control, Actual control characteristics, Significance of current margin, Power reversal, Control implementation, Converter Firing Control Schemes (EPC and IPC). Energization and de-energization of HVDC link, Starting and shutting down the HVDC link | |
| | ***Learning Outcomes:***<br>***A learner will be able to*** | |

| | | |
|---|---|---|
| | *LO3.1: Apply the electrical engineering knowledge to understand the requirement for rapid control in HVDC and various firing control scheme (P.I- 1.4.1)*<br><br>*LO3.2: Apply advanced mathematical concepts to develop the control characteristics of HVDC system under normal and abnormal condition. (P.I.-1.1.1)*<br><br>*LO3.3: Analyse the control of HVDC under steady state and transient condition using control characteristics . (P.I.-2.1.3)*<br><br>*LO3.4: Construct control characteristics for power reversal and analyze the shift of operating point under power flow reversal. (P.I.-2.2.3)* | |
| **04.** | **Faults and protection** | **07-09** |
| | ***Learning Objective:*** *To study various faults in HVDC transmission and analyse the causes and effects of faults, also identify suitable protection schemes suitable for each fault* | |
| | **Contents:**<br><br>Converter faults, By pass valve, single commutation failure, double commutation failure, DC reactor and damper circuits, short circuits in converter station, System protection | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO4.1: Apply the electrical engineering knowledge to understand the causes and effect of various faults (P.I- 1.4.1)*<br><br>*LO4.2: Apply fundamental mathematical concepts to differentiate the over current, over voltages and short circuits condition. (P.I.-1.1.1)*<br><br>*LO4.3: Analyse the operation of bypass valve as a protection circuit in converter valve faults(P.I.-2.1.3)*<br><br>*LO4.4: Articulate the causes and analyse the effect of commutation failure with the help of circuit diagram and phase voltage, line voltage, line current waveforms. (P.I.-2.2.3)* | |
| **05.** | **Harmonics & Filters** | **03-05** |
| | ***Learning Objective:***<br><br>***To formulate the state variable models, identify the eigen values and use it to analyze the system behaviour*** | |
| | **Contents:**<br><br>Harmonics, Causes, Consequences, Means of Reducing Harmonics, Filters, AC & DC Filters | |
| | *Self-Learning Topics: Filter design* | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO5.1: Apply the electrical engineering knowledge to understand the causes and effect of harmonics (P.I- 1.4.1)*<br><br>*LO5.2: Apply fundamental mathematical concepts to differentiate the characteristic and non-characteristic harmonics. (P.I.-1.1.1)*<br><br>*LO5.3: Synthesize source current and load current of a converter using Fourier analysis to showcase the order of harmonics in the input and output side of HVDC system(P.I.-2.2.3)* | |

| | | |
|---|---|---|
| | *LO5.4: Identify suitable filter and analyze its impact on system performance. (P.I.-2.1.2)*<br>*LO5.5: Recognize the need and be able to clearly explain why it is vitally important to know the causes, effect of harmonics and the methods to minimize it. (PI 11.2.2)* | |
| **06.** | **Multi terminal HVDC system and its Application** | **03-05** |
| | ***Learning Objective:***<br>*To acquire the electrical engineering concepts to understand Modern trends in HVDC transmission* | |
| | Contents: Multi terminal HVDC system, HVDC light, HVDC system in wind power generation, Modern trends in HVDC transmission. | |
| | ***Self-Learning Topics: Power flaw in AC-DC system*** | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO6.1: Apply the electrical engineering knowledge to understand the operation multi terminal HVDC system (P.I- 1.4.1)*<br>*LO6.2: Apply advanced mathematical concepts to develop the model of HVDC system in wind power application (P.I.-1.1.1)*<br>LO6.3: Submits a report or delivers a presentation analyzing *advancements in HVDC Transmission Systems, and the need of using HVDC in wind power generation (PI-11.2.1, PI-11.3.1)* | |
| | **Course Conclusion**<br>The need and effectiveness of HVDC transmission based on the application, implementation, impact on power system and selection of suitable transmission based on application | **01** |
| **Total** | | **45** |

**Performance Indicators:**

| P.I. No. | P.I. Statement |
|---|---|
| 1.1.1 | Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.1.3 | Identify the mathematical, engineering and other relevant knowledge that applies to a given problem |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.3.2 | Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required. |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models |
| 4.3.3 | Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions. |
| 4.3.4 | Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions |

6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
11.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
11.3.1 Source and comprehend technical literature and other credible sources of information

**Course Outcomes:**

1. Apply the fundamentals of engineering concepts to identify the application of HVDC transmission, components and classification of HVDC system and safe grounding methods to prevent hazards..( LO1.1, LO1.2)
2. Formulate mathematical models for HVDC transmission system and analyse its performance under various operating conditions. (LO2.1, LO2.2, LO2.3, LO2.4, LO2.5)
3. Apply engineering mathematics to develop control characteristics for HVDC converters and analyse its operation under normal and abnormal conditions. (LO3.1, LO3.2, LO3.3, LO3.4)
4. Analyse the causes and effects of faults in HVDC system and operation of protection schemes. (LO4.1, LO4.2, LO4.3, LO4.4)
5. Analyze HVDC advancements and the impact of harmonics, including causes, effects, and mitigation, through reports and presentations. LO5.1, LO5.2, LO5.3, LO5.4, LO5.5, LO6.1, LO6.2, LO6.3)

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPEC6022.1 | 3 | | | | | 2 | | | | | |
| EEPEC6022.2 | 3 | 3 | | 3 | | | | | | | |
| EEPEC6022.3 | 3 | 3 | | | | | | | | | |
| EEPEC6022.4 | 3 | 3 | | | | | | | | | |
| EEPEC6022.5 | 3 | 3 | | | | | | | | | 3 |
| **Average** | 3 | 3 | | 3 | | 2 | | | | | 3 |

**Text Books:**

1. Edward Wilson Kimbark, Direct Current Transmission, Wiley publication Interscience
2. K R Padiyar, HVDC power transmission systems, second edition, New Age International Ltd
3. S. Kamkshaiah and V Kamraju, HVDC transmission, Tata McGraw Hill, New Delhi
4. S.N. Singh, Electric Power Generation, Transmission and Distribution, PHI, New Delhi, 2nd edition, 2008

**Reference Books:**

1. S. Rao, EHVAC and HVDC Transmission Engineering and Practice, Khanna publication, 1990
2. J. Arrillaga, HVDC Transmission, Wiley publication Inter science
3. C.L. Wadhwa, Electrical Power System (2nd Edition)

**Other Resources:**

1. NPTEL Course: High Voltage DC Transmission, by Dr. S.N. Singh, IIT Kanpur http://nptel.iitm.ac HVDC.in youtube.com

youtube.com

**IN-SEMESTER ASSESSMENT (50 MARKS)**

1. Continuous Assessment (20 Marks)

   *Suggested breakup of distribution*

   01 MCQ test + 01 Class test: 10 Marks

   Flip class room: 05 Marks

   Regularity and active participation: 05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| **PE** | EEPEC6023 | ADVANCED CONTROL SYSTEM | 03 |

| Examination Scheme | | | | | |
|---|---|---|---|---|---|
| Distribution of Marks | | | Exam Duration (Hrs.) | | Total Marks |
| In-semester Assessment | | End Semester Exam (ESE) | MSE | ESE | |
| Continuous Assessment | Mid-Semester Exam (MSE) | | | | |
| 20 | 30 | 50 | 1.5 | 2 | 100 |

**Pre-requisite :**

1. EEPCC406 –Control System

**Program Outcomes addressed :**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool usage
5. PO8: Individual and Collaborative Team work
6. PO11: Life-long learning

**Course Objectives :**

1. To impart the knowledge on fundamentals of compensators and its physical realization.
2. To familiarize the design procedure of compensators to meet the desired transient and steady state error performance specifications using bode plot and state space techniques.
3. To impart knowledge on fuzzy logic and genetic algorithm to solve real-world control and optimization problems.
4. To introduce mathematical techniques to formulate and analyze the given system in digital form.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>Introduction to compensators, basic concept of compensator design, its requirement, importance with an electrical closed loop system. | **01** |
| **01.** | **Introduction to the Compensators** | **05** |
| | ***Learning Objective/s:***<br>*To provide the knowledge on the fundamentals of compensators and its physical realization to realize a suitable compensator for real life applications.* | |
| | **Contents**<br>Basic concepts of active and passive compensators, cascade and parallel compensators, proportional, derivative, integral compensators, lag, lead and lag-lead compensators, physical realization of compensators with passive and active components, manual and Ziegler-Nichols tuning methods, application with electrical system. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*LO1.1: Apply fundamental engineering concepts to understand the importance of compensators in control system. (P.I.-1.3.1)*<br>*LO1.2: Identify the active/passive compensator required to improve the desired steady state / transient response. (P.I.-2.1.2)* | |

<table>
<tr><td></td><td>LO1.3: Use electrical engineering concepts to determine the physical realization for various active/passive compensators as per the desired response. (P.I.-1.4.1)<br><br>LO1.4: Compare the performance of PI and Lag compensator / PD and lead compensator/ PID and Lag-Lead compensator to achieve the desired response. (P.I.-2.2.4)</td><td></td></tr>
<tr><td>02.</td><td>Design of Compensators using Frequency Response Technique (Bode Plot)</td><td>09</td></tr>
<tr><td></td><td>Learning Objective:<br>To provide knowledge on designing compensators using open-loop frequency response parameters from the Bode plot to achieve the desired transient and steady-state error specifications.</td><td></td></tr>
<tr><td></td><td>Contents:<br>Relation between closed-loop time response parameters of peak time, settling time, and percent overshoot with the open-loop frequency response parameters, transient response improvement by gain adjustment, design of lag, lead and lag-lead compensators using bode plots, application of bode plot compensator design in electrical systems.</td><td></td></tr>
<tr><td></td><td>Learning Outcomes:<br>A learner will be able to<br>LO2.1: Apply engineering mathematical skill to analyze the transient parameters of the given system using open loop frequency response parameters from the bode plot. (PI-2.4.1)<br><br>LO2.2: Determine suitable gain of the compensator using bode plot to yield a specific transient response for the given system. (PI-2.4.2)<br><br>LO2.3: Determine the desired open-loop frequency response parameters from the closed loop time domain parameters, and then design suitable compensators to meet the requirements for the given system. (PI-3.1.6)<br><br>LO2.4: Develop a suitable algorithm and design a compensator to achieve the desired response using the frequency response based tool, called bode plot (PI-3.2.1)<br><br>LO2.5: Collaboratively design and analyze an electrical system using Bode plot, using a suitable simulation tool, demonstrating effective leadership skill and problem-solving strategies. (PI-5.1.1, PI-8.2.1)<br><br>LO2.6: Adapt the simulation tool to model the given electrical system, analyze its performance, design a suitable compensator to achieve the desired response using bode plot and present the result as a group, combining everyone's work into a clear and well-organized presentation. (PI-5.1.2, PI-8.3.1)</td><td></td></tr>
<tr><td>03.</td><td>Design of Compensators using State variable approach</td><td>10</td></tr>
<tr><td></td><td>Learning Objective:<br><br>To provide knowledge on designing controllers and observers using state-space techniques to achieve the desired transient and steady-state error specifications.</td><td></td></tr>
<tr><td></td><td>Contents:<br><br>State space modelling of electrical systems, different state space representation, design of state feedback controllers, controllability, application of similarity transforms for controller design, observability, state estimators/observers, application of similarity transform for observer design. Integral controller design using state space, application of state space controller design in electrical systems.</td><td></td></tr>
<tr><td></td><td>Learning Outcomes:<br><br>A learner will be able to<br><br>LO 3.1: Apply mathematical skill to determine the transformation matrices to convert the given cascade/ parallel/ representation into a suitable representation for the controller/ observer design. (PI-2.4.1)</td><td></td></tr>
</table>

| | | |
|---|---|---|
| | *LO 3.2: Determine suitable gain of the controller using state space technique to yield a specific transient response for the given system. (PI-2.4.2)*<br><br>*LO 3.3: Develop an algorithm and design a controller/ observer to achieve the desired response if the plant is represented in cascade/ parallel representation of state space. (PI-3.2.1)*<br><br>*LO 3.4: Determine the desired pole locations / requirement of observer / integral controller and then determine the suitable controller/ observer gains to meet the requirements for the given system. (PI-3.1.6)*<br><br>*LO 3.5: Collaboratively design and analyze an electrical system using state space, using a suitable simulation tool, demonstrating effective leadership skill and problem-solving strategies. (PI-5.1.1, PI-8.2.1)*<br><br>*LO 3.6: Adapt the simulation tool to model the given electrical system, analyze its performance, design a suitable compensator to achieve the desired response using state space, and present the result as a group, combining everyone's work into a clear and well-organized presentation. (PI-5.1.2, PI-8.3.1)* | |
| **04.** | **Approaches to intelligent control** | **06** |
| | ***Learning Objective:***<br>*To impart the knowledge on basic concepts and principles of fuzzy logic to design fuzzy logic controllers for the given control applications.* | |
| | **Contents:**<br><br>Introduction to fuzzy logic, fuzzy sets and membership functions, fuzzification, inferencing and defuzzification, fuzzy knowledge and rule based inference systems, fuzzy logic controller design, fuzzy logic application in control system. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO4.1: Apply fundamental engineering concepts to formulate the fuzzy rules, identify a suitable membership function etc. for the given problem. (PI-1.3.1)*<br><br>*LO4.2: Determine design objectives, corresponding fuzzy sets and rules and design a suitable fuzzy logic controller for the given application (PI-3.1.6)*<br><br>*LO4.3: Apply fuzzy logic with variations in fuzzy subsets/ membership functions/ defuzzification process to develop multiple engineering design solutions (PI-3.2.1)*<br><br>*LO4.4: Identify few literatures in the relevant field and interpret it effectively for the given problem. (PI 11.3.1)*<br><br>*LO4.5: Review at least one research paper and applies the knowledge to ensure that it is practical, effective, and sustainable for the given problem. (PI 11.3.2)* | |
| **05.** | **Genetic Algorithm** | **06** |
| | ***Learning Objective:***<br>*To provide knowledge of the fundamental concepts of genetic algorithms and related optimization techniques for solving control and optimization problems.* | |
| | **Contents:**<br><br>Basic concept of genetic algorithm, concept of genes, chromosomes, population, fitness function, crossover and mutation, detailed algorithmic steps, adjustment of free parameters, solution of typical control problems using genetic algorithm, concept on similar search techniques like simulated annealing, particle swarm optimization for solving optimization problems. | |
| | ***Learning Outcomes:*** | |

| | | |
|---|---|---|
| | *A learner will be able to*<br><br>*LO5.1: Apply fundamental engineering concepts to identify the selection of various parameters such as genes, chromosomes, mutation/ crossover probability, termination criteria, fitness function etc. for the given problem. (PI-1.3.1)*<br><br>*LO5.2: Apply genetic algorithm with variations in fitness calculation or crossover/ mutation operations to develop multiple optimum solution. (PI-3.2.1)*<br><br>*LO5.3: Determine design objectives, corresponding parameters such as initial population, fitness function, refining process to generate the new population etc. to converge the iteration process to an optimum solution for the given application (PI-3.1.6)*<br><br>*LO5.4: Identify few literatures in the relevant field and interpret it effectively for the given problem. (PI 11.3.1)*<br><br>*LO5.5: Review at least one research paper and applies the knowledge to ensure that it is practical, effective, and sustainable for the given problem. (PI 11.3.2)* | |
| **06.** | **Digital control System** | **07** |
| | ***Learning Objective/s:***<br>*To provide knowledge on applying mathematical techniques to formulate and analyze systems in digital form.* | |
| | **Contents:**<br><br>Advantage of digital control, components of digital control system, stability of digital system on z-plane, steady state error and error constants, transient response on z-plane, design of digital compensators using bilinear transformation, implementing the digital compensator. | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br><br>*LO 6.1: Apply electrical engineering concepts to model the components in digital control system (PI-1.4.1)*<br><br>*LO6.2:* Apply fundamental engineering concepts to model a sampled data system *(PI-1.3.1)*<br><br>*LO6.3: Apply mathematical and computational skill to analyse the sampled-data transfer functions and determine the range of gain/ sampling rates for stability. (PI-2.4.1)*<br><br>*LO 6.4: Construct and interpret a basic Routh array to analyze the system for its stability. (P.I.-2.4.2)*<br><br>*LO 6.5: Determine the steady-state error constants and error specification for the given digital system and use this information to analyze the steady state behavior of the system. (PI-2.4.1)*<br><br>*LO 6.6: Apply bilinear transformation to formulate a digital compensator and realize it using a suitable flow chart. (PI-2.4.1)* | |
| | **Course Conclusion**<br><br>The course concludes with a comprehensive understanding of compensators and their design using tools such as Bode plots and state-space techniques to enhance system performance. Additionally, the integration of fuzzy logic and genetic algorithms helps learners to tackle complex optimization and control challenges in real-world applications. | **01** |
| | **Total** | **45** |

| **Performance Indicators:** | |
|---|---|
| **P.I. No.** | **P.I. Statement** |
| 1.3.1 | Apply fundamental engineering concepts to solve engineering problems. |
| 1.4.1 | Apply electrical engineering concepts to solve engineering problems. |
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.2.4 | Compare and contrast alternative solution processes to select the best process. |
| 2.4.1 | Apply engineering mathematics and computations to solve mathematical models |
| 2.4.2 | Produce and validate results through skillful use of contemporary engineering tools and models |
| 3.1.6 | Determine design objectives, functional requirements and arrive at specifications |
| 3.2.1 | Apply formal idea generation tools to develop multiple engineering design solutions |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities |
| 5.1.2 | Create/adapt/modify/extend tools and techniques to solve engineering problems |
| 8.2.1 | Demonstrate effective communication, problem solving, conflict resolution and leadership skills |
| 8.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |
| 11.3.2 | Analyze sourced technical and popular information for feasibility, viability, sustainability, etc. |

| **Course Outcomes:** A learner will be able to | |
|---|---|
| 1. | Apply fundamental engineering concepts to identify a suitable controller for the given problem by selecting appropriate parameters and utilizing techniques such as fuzzy logic and genetic algorithm. *(LO1.1, LO1.2, LO1.3, LO1.4, LO4.1, LO5.1)* |
| 2. | Analyze the given system and design a suitable compensator to achieve the desired performance using bode plot and state space technique. *(LO2.1, LO2.2, LO2.3, LO2.4, LO3.1, LO3.2, LO3.3, LO3.4)* |
| 3. | Design suitable controllers for a given system to achieve the desired response, enabling them to address real-world control and optimization challenges effectively. *(LO4.2, LO 4.3, LO4.4, LO4.5, LO5.2, LO 5.3, LO5.4, LO5.5)* |
| 4. | Develop mathematical models for digital control systems and analyze their behavior based on system response. *(LO6.1, LO6.2, LO6.3, LO6.4, LO6.5)* |
| 5. | Use an appropriate simulation tool to design and analyze the performance of the controller or compensator using Bode plot and state-space techniques, and present the results as part of a team activity. *(LO2.5, LO2.6, LO3.5, LO3.6)* |

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPEC6023.1 | 3 | 3 | | | | | | | | | |
| EEPEC6023.2 | | 3 | 3 | | | | | | | | |
| EEPEC6023.3 | | | 3 | | | | | | | | 3 |
| EEPEC6023.4 | 3 | 3 | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EEPEC6023.5 | | | | | 3 | | | 3 | | | |
| **Average** | 3 | 3 | 3 | | 3 | | | 3 | | | 3 |

| **Text Books :** | |
|---|---|
| 1. | Norman S. Nise, Control Systems Engineering, Seventh Edition, 2015, John Wiley & Sons |
| 2. | Wilkie J., Johnson M., Katebi R., Control Engineering: An Introductory Course, Palgrave MacMillan |
| 3. | Richard C Dorf, Robert H Bishop, Modern Control Systems, Twelfth edition, 2021, Pearson. |
| 4. | G.F. Franklin, Feedback control of Dynamic System, Eighth Edition, 2021, Pearson higher education |
| 5. | Enrique Trillas Ruiz and Luka Eciolaza, Fuzzy Logic: An Introductory Course for Engineering Student, Springer. |
| 6. | S. N. Sivanandam , Introduction to Genetic Algorithms, Springer. |

| **Reference Books :** | |
|---|---|
| 1. | S. K. Bhattacharya, Control Systems Engineering, Second Edition, 2015, Pearson. |
| 2. | Curtis Johnson, Control Systems Technology, Heidar Malki, 2002, Pearson |
| 3. | Agoston E. Eiben, J.E. Smith, Introduction to Evolutionary Computing (Natural Computing Series), Springer |
| 4. | Eyal Wirsansky, Hands-On Genetic Algorithms with Python, Packt Publishing. |
| 5. | Benjamin C. Kuo, Digital Control Systems, Oxford series 2nd Edition |

| **Other Resources :** |
|---|
| NPTEL Course: Advanced Linear Continuous Control Systems By Prof. Yogesh Hote, Dept. of Electrical Engineering, IIT Roorkee:- Web link- https://nptel.ac.in/courses/108/107/108107115/ |

**IN-SEMESTER ASSESSMENT (50 MARKS)**

**1. Continuous Assessment - Theory-(20 Marks)**

- Case Study assignment: 10 Marks
- Open book test/Open note test: 05 marks
- Regularity and Active Participation: 05 marks

**2. Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

**END SEMESTER EXAMINATION (50 MARKS)**

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LBC | EELBC608 | DRIVES AND CONTROL LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| **Continuous Assessment** | **Practical /Oral** | **Total** |
| 25 | 25 | 50 |

**Pre-requisite:**

1. EEPCC406: Control System
2. EEPCC407: Power Electronics
3. EEPCC509: Electrical Machines

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Engineering tool usage
4. PO8: Individual and Collaborative Team work
5. PO11: Life-long learning

**Course Objectives:** To impart knowledge on

1. various subsystems of electrical drives.
2. transient and steady state analysis of electrical drives.
3. simulation, analysis and implementation of Electrical drives.

| Module | Details | Hrs |
|---|---|---|
| | **Course Introduction**<br>The drives are essential in industries and electric vehicles, enabling efficient motion control. Hence hands-on experience with electrical drives and control is crucial for electrical engineers. Mastering DC and AC drive modeling, simulation, and implementation is key for understanding advanced motor control. Additionally, programming drives and integrating them with PLCs is vital for industrial automation. | |
| **01.** | ***Learning Objective:***<br>*To acquire skill to use simulation/hardware tools to analyze the performance of DC/AC machines.* | **06** |
| | **Theme for conducting experiments:**<br>1. Analyze the performance of DC/AC machine using its dynamic model (Simulation). | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO1.1: Use simulation tools, such as Simulink, to model DC and three-phase induction motors, analyze their performance, and assess transient operations (PI 2.1.2, 2.2.2, 5.2.1, 5.2.2)* | |
| | **Theme for conducting experiments:**<br>2. Analyze the dynamics of DC/AC motor during starting and braking (experiments). | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO1.2: Collaboratively conduct hardware experiments on DC shunt and induction motors to analyze transient operations during starting and braking phases, apply appropriate testing procedures, ensure safety precautions, collect and represent data in* | |

| | | |
|---|---|---|
| | *tabular/graphical forms, and interpret results for performance analysis (PI 2.2.3, 2.4.4, 4.1.3, 4.3.3, 8.2.1, 8.2.2)* | |
| **02.** | ***Learning Objective:***<br>*To acquire skill on implementation of speed control schemes of DC drives.* | **08** |
| | **Theme for conducting experiments:**<br>3. Analyze the speed control methods of DC motor by simulation. | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO2.1: Use simulation tools, such as Simulink, to model chopper-fed separately excited DC motors, analyze their performance under various conditions by plotting and interpreting waveforms (PI 2.2.2, 2.2.3, 5.2.1, 5.2.2).* | |
| | **Theme for conducting experiments:**<br>4. Implement subsystems of DC drive. | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO2.2: Collaboratively design and implement simple sub-systems (power/control/sensor circuits) of a DC motor drive, demonstrating an understanding of their integration and functionality in speed control applications. (PI 2.2.2, 2.2.3, 8.2.1, 8.2.2)* | |
| | **Theme for conducting experiments:**<br>5. Analyze the speed control methods of DC motor experimentally. | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO2.3: Conduct experimental analysis of DC motor speed control schemes, represent performance data in tabular and graphical forms, and produce a clear, well-supported report with appropriate conclusions based on the analysis of performance characteristics. (PI 2.2.2, 2.2.3, 4.3.3, 4.3.4, 8.2.1, 8.2.2)* | |
| **03.** | ***Learning Objective:***<br>*To acquire skill on implementation of speed control schemes of AC drives.* | **09** |
| | **Theme for conducting experiments:**<br>6. Analyze the speed control methods of AC motor by simulation. | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO3.1: Use simulation tools to model PWM-based inverter-fed induction motors and analyze the performance of stator voltage and/or V/f speed control methods by observing and interpreting relevant waveforms. (PI 2.2.2, 2.2.3, 11.3.1, 11.3.2)* | |
| | **Theme for conducting experiments:**<br>7. Implement subsystems of AC drive. | |
| | ***Self-Learning Topics:***<br>*Application reports for the implementation of V/f speed control and Field oriented control of induction motor, provided by Texas Instruments, Infineon Technologies etc.* | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO3.2: Collaboratively design and implement simple sub-systems (power, control, and sensor circuits) of an AC motor drive, demonstrating an understanding of their integration and role in speed control applications. (PI 2.2.2, 2.2.3, 8.2.1, 8.2.2)* | |
| | **Theme for conducting experiments:**<br>8. Analyze the speed control methods of AC motor experimentally. | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO3.3: Experimentally analyze AC motor speed control schemes by observing relevant waveforms, representing the data in tabular and graphical forms, and producing a clear, well-supported report with appropriate conclusions based on performance characteristics. (PI 2.2.3, 2.4.4, 4.3.3, 4.3.4, 8.2.1, 8.2.2)* | |

| | | |
|---|---|---|
| **04.** | ***Learning Objective:***<br>*To acquire skill on programming of AC drive and interfacing it with PLC.* | **07** |
| | **Theme for conducting experiments:**<br>9. Programming the basic AC industrial drive. | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO4.1: Perform the connections for the control and power circuits of an AC drive and program the drive according to various application requirements by referring to the user manual. (PI 2.2.2, 2.2.3, 11.3.1, 11.3.2)* | |
| | **Theme for conducting experiments:**<br>10. Interfacing AC Drive with PLC for Automation | |
| | ***Learning Outcome:***<br>*A learner will be able to*<br>*LO4.2: Interface the AC drive with a PLC and develop appropriate programs for both systems to achieve the desired automation requirements. (PI 2.1.2, 2.2.3, 11.3.1, 11.3.2)* | |
| | ***Minimum 2 experiments from each module, and total at least 10 experiments*** | **30** |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 2.2.3 | Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions |
| 2.4.4 | Extract desired understanding and conclusions consistent with objectives and limitations of the analysis |
| 4.1.3 | Apply appropriate instrumentation and/or software tools to make measurements of physical quantities |
| 4.3.3 | Represent data in tabular and/or graphical forms so as to facilitate analysis and explanation of the data, and drawing of conclusions |
| 4.3.4 | Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions |
| 5.2.1 | Identify the strengths and limitations of tools for (i) acquiring information, (ii) modelling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs. |
| 5.2.2 | Demonstrate proficiency in using discipline specific tools. |
| 8.2.1 | Demonstrate effective communication, problem solving, conflict resolution and leadership skills. |
| 8.2.2 | Treat other team members respectfully. |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |
| 11.3.2 | Analyze sourced technical and popular information for feasibility, viability, sustainability, etc |

**Course Outcomes:**

Learner will be able to

1. Analyse the transient operation of a drive in different modes of operation (*LO1.1, LO1.2).*
2. Analyse the speed control schemes of DC and AC drives through simulation and experimental investigation (*LO2.1, LO2.3, LO3.1, LO3.3).*
3. Implement simple sub-systems of DC/AC motor drives in a team (*LO2.2, LO3.2).*
4. Program a basic AC industrial drive using the manual and integrate it with a PLC for automated control (*LO4.1, LO4.2).*

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELBC608.1 | | 3 | | 3 | 3 | | | 3 | | | |
| EELBC608.2 | | 3 | | 3 | 3 | | | 3 | | | |
| EELBC608.3 | | 3 | | 3 | | | | | | | 3 |
| EELBC608.4 | | 3 | | | | | | | | | 3 |
| **Average** | | 3 | | 3 | 3 | | | | | | 3 |

**Text Books:**

1. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publication
2. A First Course on Electrical Drives by S. K. Pillai, New Age International.
3. Modern Power Electronics and AC Drives by B. K. Bose, Prentice Hall PTR

**Reference Books:**

1. Electric Motor Drives: Modelling, Analysis and Control by Krishnan R, PHI
2. Power electronics by Muhammad H. Rashid, Pearson

**Other Resources :**

1. NPTEL Course: Fundamentals of Electric Drives, IIT Kanpur by Prof. Shyama Prasad Das https://nptel.ac.in/courses/108/104/108104140/
2. NPTEL Course: Industrial Drives - Power Electronics, IISc Bangalore by Prof. K. Gopakumar. https://nptel.ac.in/courses/108/108/108108077/
3. NPTEL Course: Industrial Drives, IIT Delhi by Dr.K .R. Rajagopal https://nptel.ac.in/courses/108/102/108102046/
4. Application reports for the implementation of V/f control and indirect vector control of IM, provided by Texas Instruments, Infineon Technologies etc.

## CONTINUOUS ASSESSMENT (25 Marks)

*Suggested breakup of distribution*

- Practical Exercises- 10 Marks
- Internal Assessment - 10 Marks
  Evaluating proficiency in the field by assessing the candidate's capability to execute connections or circuits, conduct experiments, accurately record test data, and derive meaningful conclusions through data analysis during regular laboratory sessions.
- Regularity and active participation - 05 Marks

## END SEMESTER ASSESSMENT (Practical and Oral Examination) (25 Marks)

**Two examiners, one Internal and one External will do the evaluation.**

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formulae. It will be checked by the examiners and evaluated out of 05 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections and take readings. The connections and output are verified by the examiners. The weightage is 05 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 05 Marks.
- Students will then be appearing for Oral test in front of both Internal and External examiners. The weightage of Oral test will be of 10 Marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LBC | EELBC609 | ELECTRICAL SOFTWARE LABORATORY | 01 |

| Examination Scheme | | |
|---|---|---|
| Continuous Assessment | Practical /Oral | Total |
| 25 | 25 | 50 |

**Pre-requisite:**

1. EEPCC303: Electrical Power System
2. EESBL301: Python Laboratory
3. EEPCC407: Power Electronics

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Engineering tool usage
4. PO9: Communication
5. PO11: Lifelong learning

**Course Objectives:**

1. To impart knowledge on development of AI-based solutions for electrical engineering challenges using Python and machine learning to enhance performance and decision-making..
2. To gain expertise in power electronics focusing on their application in energy-efficient technologies like electric vehicles.
3. To model electrical systems, including lighting and HVDC, with advanced controls to improve efficiency and reliability.
4. To impart knowledge on electromagnetic analysis of electrical/electronic devices and systems using suitable simulation software.

| Module | Details | Hrs. |
|---|---|---|
| | **Course Introduction**<br>This course provides a comprehensive exploration of AI-based solutions and advanced simulation techniques for solving complex electrical engineering problems. By leveraging Python and cutting-edge AI methodologies, students will develop intelligent models for fault detection, performance optimization, and predictive maintenance in electrical systems. Additionally, the course covers power electronics, control strategies, and electromagnetic field analysis using simulation software. Through hands-on experiments and real-world applications, learners will gain practical expertise in data collection, AI model development, system simulation, and performance evaluation. This course equips students with the skills needed to integrate AI and simulation tools into modern electrical engineering applications. | **01** |
| **01.** | *Learning Objective:* ***To impart knowledge on development of AI-based solutions to address complex problems in electrical engineering, leveraging the power of Python software and AI techniques.*** | **06** |
| | **Contents/Experiments:** Develop AI based solutions using python software for various complex problems in electrical engineering.<br><br>**Theme for experiment:** | |

| | | |
|---|---|---|
| | **1.** Classifying data and predict Electrical devices/system performance using different Python based AIML algorithms.<br><br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO1.1: Collect, preprocess, and interpret data using simulations, experiments or historical records. Also identify and develop AI models, train and fine-tune them using Python to achieve required accuracy, and integrate them with Electrical Engineering systems. Additionally, perform model evaluation, technical documentation, and independent learning through research and experimentation. (PI- 2.1.1, 2.3.1, 2.4.1, 4.1.3, 4.3.1, 5.1.1, 5.3.2, 9.1.1, 9.1.2, 11.3.1, 11.3.2)* | |
| **02.** | *Learning Objective:* ***To acquire knowledge and skills in simulating and analyzing power electronic converters in various domains including electric vehicle technology.***<br><br>**Contents/Experiments:** Use simulation software to analyze the characteristics of power electronic systems and its applications in various domains including electric vehicle technology under various operating conditions, employing appropriate system models with and without control algorithms to optimize performance.<br><br>**Theme for experiment:**<br>1. Simulating power electronic converters and analyzing their performance under different conditions.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 2.1: Implement power electronic system models using simulation software, identify control algorithms, execute experiments, assess performance accuracy, and correlate simulation results with expectations. (P.I.- 2.1.1, 2.4.2, 4.3.1, 4.1.4, 5.1.1, 5.3.2)*<br><br>2. Analyzing impact of controllers on performance of power electronic converters.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 2.2: Interpret technical data, document the findings and engage in independent research to enhance understanding and propose experimental extensions. (P.I.- 9.1.1, 9.1.2, 11.3.1, 11.3.2)* | **8** |
| **03.** | *Learning Objective:* ***To impart knowledge on electrical systems including Power System, lighting technologies., HVDC technologies and to implement advanced control techniques to enhance their efficiency and reliability.***<br><br>**Contents/Experiments:** Use simulation software to develop practical skills in modeling, simulating, and optimizing power systems, lighting solutions, and HVDC transmission networks, while implementing control strategies to improve system performance under varying operational conditions.<br><br>**Theme for experiment:**<br>1. Modelling and analyzing electrical power system using simulation software.<br>***Learning Outcome:***<br>*A learner will be able to*<br>*LO 3.1: Implement power system models using simulation software, select and apply control algorithms, execute experiments, analyze performance, validate simulation accuracy, and correlate results with expectations, (P.I.- 2.1.1, 2.4.2, 4.3.1, 4.1.4, 5.1.1, 5.3.2)* | **6** |

| | | |
|---|---|---|
| | 2. Implementing control strategies to improve system performance under varying operational conditions.<br>***Learning Outcome:***<br>***A learner will be able to***<br>*LO 3.2: Interpret technical data, clearly document findings, and explore additional resources for independent learning by proposing new experiments or extending existing investigations. (P.I.- 9.1.1, 9.1.2, 11.3.1, 11.3.2)* | |
| **04.** | *Learning Objectives:* ***Comprehend electromagnetic effects in electrical/electronic devices and systems using suitable simulation software.*** | **8** |
| | **Contents/Experiments:**<br>**Use FEMM software to perform experiments on few of following topics:**<br>Electric field between capacitor plates, electric potential and field lines around charges or electrodes, electric field distribution in a system with multiple dielectric layers, magnetic field generated by a straight wire or coil, field distribution around permanent magnets of different shapes, Lorentz force on a wire in a magnetic field, induced EMF in a coil due to a time-varying magnetic field.<br>**Theme for experiment:**<br>1. Simulation of Electromagnetic Fields and Their Interactions with Materials.<br>2. Visualizing Electric and Magnetic Fields: Effects of Charges, Conductors, and Dielectrics.<br>*Learning Outcomes:*<br>*A learner will be able to*<br>*LO 4.1: Leverage simulation software to analyze electromagnetic and electrostatic effects on electrical and electronic materials and devices. Identify variables, measure physical quantities, implement experiments, and evaluate results for accuracy. (P.I.- 2.1.1, 2.4.2, 4.1.3, 4.3.1, 5.1.1, 5.3.2)*<br><br>3. Analyzing Electromagnetic Field Distribution and Induced Effects in Various Systems.<br>*Learning Outcomes:*<br>*A learner will be able to*<br>*LO 4.2: Interpret technical data, document findings, and explore resources to extend lab knowledge and develop experiments. (P.I.- 9.1.1, 9.1.2, 11.3.1, 11.3.2)* | |
| | **Course Conclusion**<br>The acquired skills in machine learning, power electronics, control systems, and electromagnetic field analysis will enable students to tackle industry-relevant challenges effectively. As they move forward, students are encouraged to continue exploring AI advancements and emerging simulation tools to further refine their expertise and contribute to the evolving field of electrical engineering. | **01** |
| | **Total** | **30** |

**Performance Indicators:**

2.1.1 Identify engineering systems, variables, and parameters to solve the problems

2.3.1 Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy.

2.4.1 Apply engineering mathematics and computations to solve mathematical models.

2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models
4.1.3 Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
4.1.4 Establish a relationship between measured data and underlying physical principles
4.3.1 Use appropriate procedures, tools and techniques to conduct experiments and collect data
5.1.1 Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.3.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
9.1.1 Read, understand and interpret technical and non-technical information.
9.1.2 Produce clear, well-constructed, and well-supported written engineering documents.
11.3.1 Source and comprehend technical literature and other credible sources of information.
11.3.2 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

**Course Outcomes:**

Learner will be able to

1. Apply AI techniques and Python programming to solve complex electrical engineering problems using suitable software tool. *(LO 1.1)*
2. Analyze applications of power electronic converters in modern technologies such as electric vehicles for improved efficiency and functionality. *(LO 2.1, LO 2.2)*
3. Implement and analyze electrical power system, energy-efficient lighting system and HVDC technologies using simulation software. *(LO 3.1, LO 3.2)*
4. Analyze electromagnetic behaviours and their effect on performance of Electrical/Electronic devices and systems using suitable simulation software. *(LO 4.1, LO 4.2)*

**CO-PO Mapping Table with Correlation Level**

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EELBC609.1 | | 3 | | 3 | 3 | | | | 3 | | 3 |
| EELBC609.2 | | 3 | | 3 | 3 | | | | 3 | | 3 |
| EELBC609.3 | | 3 | | 3 | 3 | | | | 3 | | 3 |
| EELBC609.4 | | 3 | | 3 | 3 | | | | 3 | | 3 |
| **Average** | | 3 | | 3 | 3 | | | | 3 | | 3 |

**Reference Books:**


1. *Power Electronics: Converters, Applications, and Design* by Ned Mohan, Tore M. Undeland, William P. Robbins.
2. *Electric Vehicle Technology Explained* by James Larminie and John Lowry.
3. *Power System Analysis* by John J. Grainger and William D. Stevenson.
4. *High Voltage Direct Current Transmission* by Adamson and Hingorani.
5. *Electromagnetic Field Theory* by William Hayt and John Buck.
6. *Artificial Intelligence Techniques in Power Systems* by Kevin Warwick.

**Text Books:**

1. *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles* by Mehrdad Ehsani et al.
2. *Lighting Handbook* by Illuminating Engineering Society (IES).
3. *Finite Element Method Electromagnetics* by Jian-Ming Jin.
4. *Control Systems Engineering* by Norman S. Nise.
5. *Python Machine Learning* by Sebastian Raschka and Vahid Mirjalili.

**Other Resources:**

1. NPTEL/SWAYAM Course: https://archive.nptel.ac.in/courses/108/101/108101167/

**CONTINUOUS ASSESSMENT (25 Marks)**

***Suggested breakup of distribution***

Lab Experiments: 10 Marks

Internal Assessment (Mock practical -5 Marks, Oral 5 Marks): 10 marks

Attendance: 5 marks

**END SEMESTER ASSESSMENT (Pract. /Oral Exam) (25 Marks)**

Drawing circuit/block diagram, Observation Table, Relevant formulae as per aim (5Marks)

Experiment conduction (5Marks)

Sample calculations and Conclusion(5Marks)

Oral: 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| SBL | EESBL603 | INDUSTRIAL AUTOMATION LAB | 02 |

| Examination Scheme | | |
|---|---|---|
| Continuous Assessment | Practical /Oral | Total |
| 50 | 50 | 100 |

**Pre-requisite:**

1. EESBL402- PCB Fabrication and Circuit Testing

**Program Outcomes addressed:**

1. PO2: Problem analysis
2. PO4: Conduct investigations of complex problems
3. PO5: Modern tool usage
4. PO7: Ethics
5. PO8: Individual and team work
6. PO11: Life-long learning

**Course Objectives:**

1. To acquire knowledge about components and subsystems used in industrial automation.
2. To develop the proficiency essential for seamlessly integrating and monitoring subsystems of industrial automation.

| Module | Details | Hrs | CO |
|---|---|---|---|
| | **Course Introduction**<br>In the Industrial Automation Lab course, students will explore the fundamentals of programmable logic controllers (PLCs), IoT, and robotics with a focus on real-world industrial applications. The hands-on experience includes developing and troubleshooting ladder logic programs for PLCs, integrating industrial output field devices, configuring sensor networks, connecting to cloud-based platforms, and working with autonomous systems commonly used in modern manufacturing and process industries. | | |
| **01.** | **Industrial Automation and Programmable Logic Controller**<br>***Learning Objective:***<br>*To impart knowledge on fundamentals of industrial automation, identify PLC hardware components, and develop basic to advanced PLC programs using appropriate instructions and programming techniques for automation applications.* | **22** | CO1 |
| | **Content:**<br>**Industrial Automation:**<br>Importance of Industrial Automation, Levels of Industrial Automation, Key Components of Industrial Automation, Types of Industrial Automation, Role of Electrical Engineers in Industrial Automation.<br>**PLC Hardware and Programming Basics:**<br>Familiarization of block diagram of a PLC based system, Components of a PLC system, Selection criteria for PLC hardware, PLC wiring and installation considerations, PLC Programming Basics, Introduction to PLC programming languages. Basic programming instructions (Input, Output, Timer, Counter, etc.)<br>**Advanced PLC Programming:**<br>Data manipulation instructions (Math, Compare, Move, etc.), Program control instructions (Jump, Subroutine, etc.), Sequential and combinatorial logic programming, Programming Jump-to-subroutine & return operations in PLC. | | |
| | **Theme for Designing Multiple Experiments:** | | |

| | | | |
|---|---|---|---|
| | Develop and execute PLC ladder logic for various systems like motor control, conveyor belt control, liquid level control, traffic light control with sensors actuators and other control devices. | | |
| | ***Learning Outcomes:***<br>*A learner will be able to demonstrate the ability to design, develop, and implement PLC programs using appropriate hardware, instructions, and programming techniques to meet technical and operational requirements of industrial automation while effectively collaborating in a team environment. (P.I.-2.1.2, P.I.-2.2.2, P.I.- 4.1.4, P.I.- 4.3.1, P.I.-8.1.1, P.I.-11.3.1, P.I.-11.2.2)* | | |
| **02.** | **Introduction to Internet of Things (IoT) and Robotics**<br>***Learning Objective:***<br>*To develop ability to integrate sensor data, connectivity, and autonomous systems to create simple IoT and robotic solutions that enhance automation and decision-making in diverse industrial and everyday environments.* | **20** | CO2 |
| | **Content:**<br>• **IoT in Industrial Automation:** Concepts of Industrial IoT, its applications, and its significance in modern industrial processes. Integration of different components into a cohesive IoT system and analyse data collected. Hands-on experience in developing elementary IoT solutions using sensors, actuators, microcontrollers, and communication protocols.<br>• **Basic Robot Control:** Control of robotic platforms using manual commands and simple algorithms. Understanding components like actuators, sensors, and controllers that enable robot movement and interaction. Concepts include programming logic, sensor integration, and mechanical design. | | |
| | **Theme for Designing Multiple Experiments:**<br>Design and development of IoT-based home automation systems with integrated safety and security features, incorporating sensor technology for environment perception, obstacle detection, and navigation. Additionally, development of autonomous navigation algorithms and path planning using sensor data to enhance system intelligence and adaptability. | | |
| | ***Learning Outcomes:***<br>*A learner will be able to*<br>*Apply IoT and robotic system technologies to develop automated solutions for smart manufacturing, integrating sensors, programming logic, and modern engineering tools while collaborating effectively in a team environment. (P.I.-2.1.2, P.I.-2.2.2, P.I.-5.1.1, P.I.- 5.1.2, P.I.-8.1.1, P.I.-8.3.1, P.I.-11.2.1, P.I.-11.3.1)* | | |
| **03.** | **Integration of IoT and Robotics**<br>***Learning Objective:***<br>*To impart ability to design communication and data exchange between smart devices like IoT and autonomous robots, enhancing automation, decision-making, and efficiency in various applications.* | **18** | CO3 |
| | **Content:**<br>Data Collection and Analysis: Collect sensor data from robotic systems, transmit it to the cloud. Remote Monitoring, Control and Task Automation: Enable remote monitoring and control of robotic systems via IoT platforms allowing for real-time supervision and intervention. | | |
| | **Theme for Designing Multiple Experiments:**<br>Design and implement automation tasks such as pick-and-place operations or assembly tasks using robotic arms and IoT. | | |
| | ***Learning Outcomes:***<br>*A learner will be able to* | | |

| | | | |
|---|---|---|---|
| | *Apply data analysis techniques, ethical considerations, and modern IoT tools to implement remote monitoring and control of robotic systems while effectively conducting experiments and collaborating within a team. (P.I.- 4.1.4, P.I.- 4.3.1, P.I.- 7.1.1, P.I.- 7.2.2, P.I.-8.1.1, P.I.- 8.2.1, P.I.- 11.2.2)* | | |
| | | ***60*** | |

**Performance Indicators:**

| **P.I. No.** | **P.I. Statement** |
|---|---|
| 2.1.2 | Identify engineering systems, variables, and parameters to solve the problems. |
| 2.2.2 | Identify, assemble and evaluate information and resources. |
| 2.3.1 | Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy. |
| 4.1.4 | Establish a relationship between measured data and underlying physical principles. |
| 4.3.1 | Use appropriate procedures, tools and techniques to conduct experiments and collect data. |
| 5.1.1 | Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities. |
| 5.1.2 | Adapt the tools and techniques to solve engineering problems. |
| 7.1.1 | Identify situations of unethical professional conduct and propose ethical alternatives. |
| 7.2.2 | Examine and apply moral & ethical principles to known case studies |
| 8.1.1 | Recognize a variety of working and learning preferences; appreciate the value of diversity on a team |
| 8.2.1 | Demonstrate effective communication, problem solving, and conflict resolution and leadership skills. |
| 9.3.1 | Present results as a team, with smooth integration of contributions from all individual efforts. |
| 11.2.1 | Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current |
| 11.2.2 | Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field |
| 11.3.1 | Source and comprehend technical literature and other credible sources of information |

**Course Outcomes:**

Learner will be able to

1. Integrate and interface components and subsystems used in industrial Automation using PLC.
2. Design /implement basic IoT and robotic systems for simple applications.
3. Design various components and subsystems used in industrial automation, and understand their integration within complete automated systems.

| CO ID | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EESBL603.1 | | 3 | | 3 | 3 | | | 3 | | | 3 |
| EESBL603.2 | | 3 | | | 3 | | | 3 | | | 3 |
| EESBL603.3 | | | | 3 | | | 3 | 3 | | | 2 |
| **Average** | | 3 | | 3 | 3 | | 3 | 3 | | | 3 |

**Text Books:**

1. Introduction to programmable logic controllers by Gary Dunning. 2nd edition
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
3. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020.
4. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
5. Robert J Schilling, Fundamentals of Robotics, Prentice Hall India, 2000.

**Reference Books:**

1. PLC Programming for Industrial Automation by K Collins · 2014
2. Adrian McEwen, Hakim Cassimally Designing the Internet of Things , John Wiley, 2014
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
4. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
5. K. K.Appu Kuttan, Robotics, I K International, 2007.
6. Edwin Wise, Applied Robotics, Cengage Learning, 2003.

**Other Resources:**

1. NPTEL/ Swayam Course: Robotics and Control: Theory and Practice by Prof. N. Sukavanam and Prof.M. Felix Orlando, IIT Roorkee.
   Web Link: https://onlinecourses.nptel.ac.in/noc25_me69/preview

**CONTINUOUS ASSESSMENT (50 Marks)**

*Suggested breakup of distribution*

**Laboratory Exercises: 15 Marks**

**Internal Assessment: 10 Marks**

As a part of Internal Assessment, students will do course mini project as a team to inculcate teamwork. Students will be tasked with developing a small-scale system using Python. This project-based assessment will require students to apply their knowledge and skills gained throughout the course to design and implement a functional system using PLC, IoT and robotics language.

**Course Project Rules:**

**1. Group Size:** Groups of 2 to 4 members allowed.

**2. Project Proposal:** Detailed proposal with scope, objectives.

**3. Project Requirements:** Develop using PLC/IoT/Robotics.

**4. Presentation:**

- Present project features, challenges faced, and solutions.
- Q&A session for evaluation.

**5. Evaluation Criteria:**

- Adherence to requirements and objectives.
- Effective presentation and Q&A skills.

**Regularity and active participation: 05 Marks**

**Practical Test: (20 Marks)**

- Practical Test 1 (Based on first 50% of practical list) – 10 Marks

- Practical Test 2 (Based on remaining 50% of practical list) – 10 Marks

**END SEMESTER ASSESSMENT (Practical and Oral Examination) (50Marks)**

- Two examiners, one Internal and one External will do the evaluation.
- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to draw circuit diagram, observation table with relevant formula. It will be checked by the examiners and evaluated out of 10 Marks.
- Then the student will be allowed to start with the performance of the experiment.
- Students will be given 1 hour to complete the circuit connections/simulation and take readings. The connections and output are verified by the examiners. The weightage is 10 Marks
- Students will do sample calculations, draw relevant graphs and write conclusion of the experiment. It will be checked by the examiners and evaluated out of 10 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 20 Marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| MNP | EEMNP604 | MINI PROJECT- 2B | 01 |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering Tool Usage
6. PO6: The Engineer the world
7. PO7: Ethics
8. PO8: Individual & team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-long learning

**Course Objectives:**

1. To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

**Course Outcomes:**

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

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in
   - Research/white paper/article/blog writing/publication, etc.
   - Business plan for entrepreneurship product creation
   - Patent filing/copyright.
8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

**Guidelines for the Mini Project**

Mini project may be carried out in one or more form of following:
Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.

- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.
- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

**In-Semester Continuous Assessment and End-Semester Examination Guidelines**

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester V (50 marks):
    - 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
    - 15 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
    - 25 marks for the Final Report & Presentation
    - 05 marks for Regularity and Active participation
- Continuous Assessment marks distribution in semester VI (50 marks):
    - 15 marks for the In-Semester Two Presentations
    - 05 marks for Participation in Project Competitions, TPP, etc.
    - 25 marks for the Final Report & Presentation
    - 05 marks for Regularity and Active participation

The review/progress monitoring committee will assess projects based on the following criteria.

**Semester V:**

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
    - The first review will focus on finalizing the problem statement (topic approval).
    - The second review will centre on finalizing the proposed solution.

**Semester VI:**

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
    - The first review will assess the readiness to build a working prototype.
    - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

**End-Semester Examination in Semester VI (50 marks):**

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| ELC | ELC601 | RESEARCH METHODOLOGY | 02 |

<table>
<tr><th colspan="6">Examination Scheme</th></tr>
<tr><th colspan="3">Distribution of Marks</th><th colspan="2" rowspan="2">Exam Duration (Hrs.)</th><th rowspan="3">Total Marks</th></tr>
<tr><th colspan="2">In-semester Assessment</th><th rowspan="2">End Semester Exam (ESE)</th></tr>
<tr><th>Continuous Assessment</th><th>Mid-Semester Exam (MSE)</th><th>MSE</th><th>ESE</th></tr>
<tr><td>50</td><td>--</td><td>--</td><td>--</td><td>--</td><td>50</td></tr>
</table>

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer & The World.
4. PO7: Ethics
5. PO8: Individual & team work
6. PO9: Communication
7. PO11: Life-long learning

**Course Objectives:**

1. To gain the knowledge of use research tools and techniques to design research projects and form the hypothesis.
2. To familiarize students about the literature review practice for identifying the research gap.
3. To gain the knowledge about collection of data and qualitative/ quantitative analysis of data and results
4. To understand the key practices in preparation of a research report / paper.
5. To foster ethical practices in research and publications

| Module | Details | Hrs |
|---|---|---|
| **00** | **Course Introduction:**<br>This course aims to introduce students to the important aspects of research. The course is intended to make students aware of formal research and to overcome common misconceptions in research that may be present in their minds. At the end of this course, students shall be able to take up research activities in a more systematic and formal manner right from the beginning. This course on Research Methodology learned through experiential learning mechanism can play a significant and holistic role in contributing to the personal and professional development of students. | **1** |
| **1** | **Fundamentals of Research Methodology** | **4-5** |
| | **Content:**<br>Types of Research, Research approaches, Empirical research methods, Significance of research, Research design, Case study method, Sampling technique, Sources of data, Selection of research problem, Research Ethics and Empiricism | |

| | | |
|---|---|---|
| | *Exercise: A group discussion on what is research and ethics in research with related case studies shall be conducted.* | |
| **2** | **Formulation of a Research Problem & Hypothesis formulation** | **4-5** |
| | **Content:**<br>Selection and formulation of a research problem, Objectives of formulation, Criteria of a good research problem, Literature Review Process and Formulation of Research Questions<br>Hypothesis-Characteristics and Hypothesis Testing –Logic and Importance<br>*Exercise: Groups of students shall make Technical Presentations on Selection of a research problem and Hypothesis formulations based on topics given.* | |
| **3** | **Research Design** | **4-5** |
| | **Content:**<br>The Research framework, Research design: Need, Characteristics & Components; Experimental and non-experimental designs, Experimental and non-experimental hypothesis testing. Classification schemes for research design, Principles of experimental designs, Writing rationale for a research<br>*Exercise: Students shall prepare the framework of research methods and techniques to conduct a study on a given real life case study covering key elements of the module.* | |
| **4** | **Sampling Method** | **3-4** |
| | **Content:**<br>Probability or random sampling, Cluster sampling, Area sampling, Multi-stage sub-sampling, Random sampling with probability proportional to size, Non-probability sampling.<br>*Exercise: A real life case study shall be demonstrated to students covering key elements of the module shall be covered.* | |
| **5** | **Data Collection & Data Analysis** | **4-5** |
| | **Content:**<br>Sources of data, Collection of data, Measurement and scaling technique, Collection of data from appropriate sources (primary and secondary), Correlation and causation, Classification of quantitative analysis. Selection and analysis of multi-variate methods, Performing data analysis and presentation of results, Case study method.<br>*Exercise: Group of students shall carry out exercise of real life data collection on a given research problem and data analysis and submit the report* | |
| **6** | **Report Writing and Journal Publication** | **3-4** |

| | | |
|---|---|---|
| | **Content:**<br>Preparation of a research report, Formats and Contents of report: Literature review, Presentation of research work, Research Design & Analysis, Results, Findings, and Contribution, Significance of research, and Conclusion.<br>Mechanics of writing papers in Peer-reviewed Journals / Reputed Conferences. Ethics in Publication.<br><br>*Exercise: Students shall prepare & submit a paper (4-5 pages) in a standard format (suitable universally accepted journal publication format) based on the exercises / research case study carried out in this course.* | |
| | ***Course Conclusion*** | **1** |
| | **Total** | **30** |

**Course Outcome**: Learner will be able to

CO1: Identify and demonstrate the importance of research process in science and technology domains
CO2: Perform literature reviews using print and online databases.
CO3: Analyse the data using qualitative and quantitative methods
CO4: Identify and prepare the key elements of a research report/ paper
CO5: Illustrate the rationale for research and publication ethics

**Text Books:**


1. C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, New Age International Publisher, 2014.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage Publication, 2018
3. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2014


**Reference Books:**


1. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Ed., SAGE, 2018.Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2005.
2. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
3. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
4. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
5. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006


**Other Resources**:

NPTEL Course: Research Methodology By Prof. Edamana Prasad, Prof. Prathap Haridoss (IIT Madras) Weblink https://onlinecourses.nptel.ac.in/noc25_ge28/preview

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LLC | LLC6011 | ART OF LIVING | 02 |

**Program Outcomes addressed**:

1. PO6 : The Engineer and The World
2. PO7 : Ethics
3. PO9 : Individual and Collaborative Team work
4. PO9: Communication
5. PO11: Life-long learning

**Course Objectives :**

1. To provide a comprehensive understanding of the principles of the Art of Living and their relevance to holistic well-being.
2. To equip participants with practical techniques like Sudarshan Kriya, yoga, and mindfulness for stress management and emotional balance
3. To enable participants to apply the Art of Living principles to enhance relationships, productivity, and life purpose.

| Module | Details |
|---|---|
| 01. | **Introduction to the Art of Living**<br>Understanding the Mind and Stress, Breath and Life Energy, Basics of Yoga and Guided Meditation |
| 02. | **Sudarshan Kriya and Breathing Techniques**<br>Introduction to Sudarshan Kriya, Practicing Rhythmic Breathing Techniques |
| 03. | **Emotional Well-being**<br>Understanding and Balancing Emotions, Forgiveness and Gratitude Practices, Guided Meditation for Emotional Healing |
| 04. | **Relationships and Social Connections**<br>Compassion and Effective Communication, Stress-free Relationships, Group Activities for Trust and Collaboration |
| 05. | **Living with Purpose and Awareness**<br>Discovering Life Purpose, Mindfulness Practices, Time Management and Productivity |
| 06. | **Sustaining the Practices**<br>Developing a Daily Routine, Advanced Breathing Techniques, Reflections, and Closing Meditation |
| **Total no. of hours**: **30** | |

**Course Outcomes :**

1. Gain insights into managing stress and emotions through breathwork and meditation
2. Develop skills for building harmonious relationships and enhancing emotional intelligence.
3. Cultivate mindfulness, compassion, and clarity in daily life.
4. Sustain the Art of Living practices for long-term well-being and self-discovery.

**Text Books :**


1. “Celebrating Silence” by Sri Sri Ravi Shankar (1999, Sri Sri Publications Trust)
2. “The Heart of Yoga: Developing a Personal Practice” by T.K.V. Desikachar (1995, Inner Traditions International)
3. “The Miracle of Mindfulness” by Thich Nhat Hanh (1975, Beacon Press)


**Reference Books :**


1. “Wisdom for the New Millennium” by Sri Sri Ravi Shankar (2000, Sri Sri Publications Trust)
2. “The Healing Power of the Breath” by Richard P. Brown and Patricia L. Gerbarg (2012, Shambhala Publications)

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LLC | LLC6012 | Yoga and Meditation | 02 |

**Course Objectives :**

1. To raise awareness of the therapeutic and preventive benefits of Yoga and Meditation
2. To nurture Holistic wellness through the harmony of body, mind and self
3. To advocate for the application of Yogic science in the treatment and prevention of psychosomatic and Lifestyle disorders.
4. To inspire the practice of Yogic Science tools for fostering health and well-being in daily life
5. To promote the art of purposeful and mindful living by cultivating a deep sense of oneness with the self, nature and the world.

| MODULE | DETAILS |
|---|---|
| **1.** | **Introduction to Yoga and Meditation**<br>Definition of Yoga, Importance of Yoga for Human life, Literature of Yoga: Yoga Sutra, Bhagavat Gita – Synthesis of Yoga, Hathapradipika etc.<br>Challenges of health in students & youth - Studies, Yogic concept of Health and Meditation, Concept of Body and Disease in Yoga, Dimensions of Health- Physical, Mental, Social and Spiritual,<br>Different types of yoga (Karma, Gyaan, Ashtanga, Bhakti), Eight limbs of ashtanga yoga. |
| **2.** | **Yoga and Wellness**<br>Yoga and Medical perspectives – Health related fitness, Yoga for common ailments, Scientific Researches in Yoga, Yogic anatomy of Human body<br>Asanas – Definitions and classifications, Scientific reasoning behind the asanas, Yoga for Stress, Technostress and Lifestyle management. Mental Disturbances and Preventive, Curative Aspect of Yoga for Mental wellness. |
| **3.** | **Essentials of Yoga Practices**<br>Difference between Yoga and Exercise, Obstacles in the path of Yogic Practices, Disciplines in Yogic practices – Prayers, Yama, Niyama, Place, Time, Diet, Schedule, Sequence for Yogic Practices.<br>Yogasanas: Surya Namaskara, Standing asanas and Sitting asanas, Different groups of Yogasanas – Relaxation, Meditative, Digestive etc. Psycho-physiological effects and health benefits of Yogasana, Function and effect of Asanas - Digestive system, Respiratory system, Excretory system, Circulatory system, Nervous system etc. |

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| 4. | **Meditation – Role of Breath and Pranayama**<br>Yogic anatomy, Wellness and Triguna system, Science of Pranayama – 'Prana', the vital principle, Prana and air element, Awareness - Breath Awareness, Different types of Breathing, Breath Control, Breath and Postures, Rhythmic Breathing, Pranic body in the five-fold body (Panchakosha), Power of breath, Difference between Pranayama and breathing, Prana and nervous system, Fivefold function of prana, Benefits of pranayama |
| 5. | **Fundamental aspects of Meditation**<br>Pranayama and deep breathing - Concept of Inhalation (Puraka),<br>Retention (Kumbhaka), & Exhalation (Rechaka); Important Pranayamas; Pranayama and Meditation; Mind and Meditation; Inner Instrument – Mind, Constituents of Mind - Mana, Buddhi, Ahankar and Chitta(Consciousness), Magnitude of Mind, Buddhi – the determinative faculty; Body-Mind complex; Mind Cleansing; Yogic Meditation and Mindfulness meditations; Yogic Process and Outcome of Meditation – Pratyahara, Dharana and Dhyana; Scientific studies on Meditation and Healing. |
| 6. | **Meditation Tools and Techniques**<br>Why Meditate - States of Mind, Mind over Body – Processing Thoughts, Preparing for Meditation – Posture, Shanti prayers, Pranayama, Training the Mind: Practicing tools- Bhramari Pranayama, Sacred Pranav (Om) mantra, Mantra Japa/ajapa, Types of Mindfulness Meditations, Yoga Nidra, Body scan meditation, etc. Benefits of Meditation |

**Course Outcomes:**

1. Gain comprehensive insights about the necessity of yoga for daily life.
2. Obtain a simplified understanding of the impact of mindful breathing on health wellbeing.
3. Acquire knowledge of 'practice and principles' of simple awareness meditation for Mental wellness
4. Gain required knowledge to improve overall health and immune system
5. Practice simple asanas and meditation techniques to improve concentration, self- confidence and inner peace

**Text Books:**

1. Light on the Yoga Sutras of Patanjali by B.K. Iyengar (Publisher: Orient Longman Pvt. Ltd. Mumbai)
2. Pranayama - The Art & Science by Dr. Nagendra H R (Publisher: Swami Vivekananda Yoga Prakashan, Bangalore)
3. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

**Recommended Books**

1. Pranayama-Science of Breath by Gharote, M. (Publisher: The Lonavla Yoga Institute, India)
2. Svatmarama's HathaYogaPradeepika by Gyan Shankar Sahay (Publisher: Yogic Heritage, India)
3. Yoga for Health and Peace by Padamshree Sadashiv Nimbalkar (Publisher: Yoga Vidya Niketan, Mumbai)

**Other Resources:**

1. NPTEL Course: Yoga and Positive Psychology for Managing career and life by Prof.

Ashish Pandey, IIT Bombay.
Weblink https://archive.nptel.ac.in/courses/110/101/110101165/

2. SWAYAM Course: Yoga for Concentration by By Dr H R Nagendra, Dr Manjunath N K and Dr Apar Avinash Saoji from Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore. Weblink: https://onlinecourses.swayam2.ac.in/aic23_ge05/preview

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LLC | LLC6013 | Health and Wellness | 02 |

**Course Objectives :**

1. To advocate for the significance of Holistic wellness
2. To enhance all dimensions of wellness through the lens of scientific temper
3. To foster integrative medicine through mindful lifestyle choices and guided practices
4. To promote the integration of scientific research with ancient wellness practices & techniques

| MODULE | DETAILS |
|---|---|
| 1. | **Foundations of Health Well-being**<br>Defining Health and Wellness, Dimensions of wellness Determinants of Health behavior, Health in everyday life<br>Constitution of your body, Medical Anatomy of physical body Layers of your Body: Physical, Physiological, Psyche<br>Yogic anatomy of Physiological and Psyche layers, Triguna system |
| 2. | **Physical Wellbeing**<br>Management of Ailments: Common, Acute, chronic Integrative medicines: Ayurveda, Naturopathy, Yoga etc. Preventive care for illness, Lifestyle, Dietary habits, Repair and Rejuvenation |
| 3. | **Emotional Wellness**<br>Types of Emotions, Symptoms of emotional wellness<br>Studies on challenges of emotional wellness: Sleep, Stress, Resilience, eating habits, attention deficit, Digital fatigue, Communications etc.<br>Emotions and physical wellness<br>Understanding the trinity of senses, sense objects and emotions,<br>Studies on breath regulation, Role of breath in emotions, Yogic methods to emotional wellness |
| 4. | **Mental Wellness**<br>What is Mental Wellness, Dimensions of mental Wellness Scientific studies on Mental disorder issues: Depression, anxiety,<br>behavioural disorder, addiction, self-disconnection, suicidal thoughts etc. Mind-Body issues: Mental Wellness, Mental illness and Physical illness, Constitution of Mind – Manas, Buddhi, ahankara, Chitta, Consciousness Intelligence and Mental Wellness, Modifications of Mind<br>Paths to Mental Wellness: Regulating Thoughts, Meditation tools and process - Pranayama, Pratyahara, Dharna, Dhyana, Mindfulness meditation, Chakra meditation, Sabdh(mantra) Meditation, spiritual engagements |

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|---|---|
| 5. | **Intellectual Wellness**<br>Mind, Intelligence and Intellectual Wellness Aspects of Intellect, incapacitate Intellect, Examining Intellectual Wellness, Nurturing Intellectual Wellness |
| 6. | **Spiritual Wellness**<br>Yogic understanding of term 'spiritual'<br>Relationship: Physical, Physiological, Psyche, Consciousness (Spiritual) Symptoms of spiritual wellness<br>Studies on Spiritual wellness and Body Healing<br>Practices for spiritual wellness: Prayers, Yoga and Meditation, spiritual engagements |

**Course Outcome**:
1. Gain a comprehensive understanding of Holistic Health
2. Acquire essential knowledge to regulate thoughts and behavior.
3. Apply holistic health tools for emotional stability and healthy mind
4. Develop proficiency in applying cognitive faculty for intellectual pursuits
5. Acquire holistic wisdom for attaining inner peace in daily life

**Text Books**
1. Nature Cure for All: Natural Remedies for Health Disorders (Publisher: Nisargopachar Gramsudhar Trust, Pune)
2. Towards the Wellness of Body, Mind and Self – Conference Proceedings Editor - Dr. Jayanti Chavan (Publisher: Institute of Science and Religion, Navi Mumbai)
3. Ayurveda & Panchakarma – The Science of Healing and Rejuvenation by Dr. Sunil
4. V. Joshi (Publisher: Motilal Banarsidass Publishing House, Delhi)

**Reference books**
1. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health (Publisher: SVYP, Bangalore)
2. Text book of Kriya Yoga – The Cosmic Engineering of Life in the light of Medical Science by Yogacharyya Dr. Chanchal Roy Devsharmman
3. (Publisher: Motilal Banarsidass Publishing House, Delhi)
4. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

**Other Resources**:
1. NPTEL Course: Adolescent Health And Well-Being: A Holistic Approach by Dr. Sumana Samanta, Dr. Parmeshwar Satpathy, IIT Kharagpur. Weblink https://nptel.ac.in/courses/127105236
2. NPTEL Course: The Science of Happiness and Wellbeing by By Prof. Priyadarshi Patnaik, Prof. Manas K. Mandal from IIT Kharagpur. Weblink https://onlinecourses.nptel.ac.in/noc23_hs06/preview

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LLC | LLC6014 | DIET AND NUTRITION | 02 |

**Program Outcomes addressed**:

1. PO6 : The Engineer and The World
2. PO7: Ethics
3. PO11: Life-long learning

**Course Objectives :**

1. To provide students with a comprehensive understanding of nutrition principles and their application in promoting optimal health.
2. To develop critical thinking skills to evaluate nutritional information and make informed decisions.
3. To apply knowledge of nutrition education and counselling to promote healthy nutrition practices in individuals and group.
4. To demonstrate an understanding of role of nutrition in disease prevention and management.

| Module | Details |
|---|---|
| **01.** | **Nutrition for wellness -1**<br>Introduction to nutrition, food pyramid, Macros: Carbohydrates, Protein and fats, Micros: Vitamins A C E K and D, Minerals-Calcium, Iron and Zinc Importance of hydration, signs and symptoms, stages of dehydration. |
| **02.** | **Nutrition wellness -2**<br>Introduction to mindful eating, plate concept, understanding physical and emotional hunger, eating disorder-Anorexia nervosa, bulimia nervosa and binge eating. |
| **03.** | **Exercise and fitness**<br>Introduction to exercise and its importance, types of exercise its classification, side effects of over exercising, Impact of sedentary lifestyle on body composition. |
| **04.** | **Sleep and relaxation**<br>Flow of circadian rhythm, sleep cycle, stages of sleep, sides effects, sleeping disorder-sleep apnea, insomnia, sleep hygiene routine and foods inducing sleep |
| **05.** | **Managing stress**<br>Introduction to stress, causes, effects of stress, management of stress, foods and adaptogenic foods for stress management. |
| **06.** | **The lifestyle flow**<br>Morning/ wake up rituals, meal flow i.e in which order to eat, post meal flow, bedtime rituals – how should your last hour of the day look like |
| **Total no. of hours**: **30** | |

**Course Outcomes :**

1. Understand the fundamentals of nutrition and its role in promoting wellness.
2. Apply mindful eating practices to manage physical and emotional hunger.
3. Assess the importance of exercise and its impact on health and fitness
4. Gain insights into sleep hygiene and manage sleep-related disorders.
5. Develop strategies for stress management using nutrition and adaptogenic foods.

6. Assess the importance of exercise and its impact on health and fitness

**Text Books :**

1. Nutrition and dietetics by C.S. shah: covers various aspects of nutrition, including nutrient metabolism, dietary planning and diet therapy.
2. Dietetics by B. Srilakshmi- covers aspects of dietetics including nutrition, food science and diet therapy.

**Reference Books :**

1. Nutrition science by B. Shrilakshmi: provides an overview of nutrition, nutrient metabolism and dietary patterns
2. Food science by B. Shrilakshmi covers food, including food composition, food processing and food safety.

| Course Type | Course Code | Course Name | Credits |
|---|---|---|---|
| LLC | LLC6015 | PERSONALITY DEVELOPMENT | 02 |

**Program Outcomes addressed**:
1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-long learning

**Course Objectives :**
1. To enhance self-awareness and self-confidence in the students.
2. To develop effective communication, leadership, and interpersonal skills.
3. To equip students with stress management and time management techniques.
4. To foster teamwork, problem-solving, and decision-making abilities.
5. To prepare students for professional life through resume building, interview skills, and networking.
6. To instil a growth mindset and adaptability in personal and professional contexts.

| Module | Details |
|---|---|
| 01. | **Self-Awareness and Emotional Intelligence**<br>Understanding personality traits and self-assessment, Importance of emotional intelligence (EI) in personal and professional success, Strategies to enhance EI and self-awareness. |
| 02. | **Communication Skills**<br>Fundamentals of verbal and non-verbal communication, Public speaking, presentation skills, and storytelling, Listening skills and constructive feedback. |
| 03. | **Leadership and Teamwork**<br>Understanding importance of self-confidence, leadership styles, and their applications, Building effective teams and managing conflicts, Developing collaboration and networking skills. |
| 04. | **Stress and Time Management**<br>Recognizing stressors and managing stress effectively, Prioritization and goal-setting techniques, Tools for efficient time management and productivity. |
| 05. | **Professional Development**<br>Importance of presentation skills, resume writing, cover letter, and LinkedIn optimization, Interview preparation: Mock interviews and common questions, Networking skills and professional etiquette |
| 06. | **Personal Growth and Adaptability**<br>Developing a growth mindset and embracing lifelong learning, Cultivating resilience and adaptability to change, Setting long-term personal and professional goals |
| **Total no. of hours**: **30** | |

**Course Outcomes :** By the end of this course, students will be able to:
1. Demonstrate increased self-awareness and emotional intelligence.
2. Communicate effectively in professional and personal contexts.
3. Exhibit leadership and teamwork skills in various scenarios.
4. Manage time and stress efficiently to enhance productivity.
5. Prepare a professional resume, excel in interviews, and network effectively.
6. Develop resilience, adaptability, and a growth-oriented mind-set.

**Text Books :**

1. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ / What Makes a Leader: Why Emotional Intelligence Matters
2. Stephen R. Covey, The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change

**Reference Books :**

1. Dale Carnegie, How to Win Friends and Influence People.
2. Anthony Robbins, Awaken the Giant Within: How to Take Immediate Control of Your Mental, Emotional, Physical, and Financial Destiny!
3. David J. Schwartz, The Magic of Thinking Big.
4. Robin Sharma, The Monk who sold his Ferrari.
5. Dorie Clark, Reinventing You: Define Your Brand, Imagine Your Future.
6. Gangadhar Joshi, Campus to Corporate: Your Roadmap to Employability.

**Other Resources**

1. Videos and TED Talks by Simon Sinek, Brené Brown, Malcolm Gladwell and other motivational speakers
2. Online courses on communication and leadership (e.g., Coursera, LinkedIn Learning, EdX).