

Amrutvahini Sheti and Shikshan Vikas Sanstha's

**AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER**

Amrutnagar, Ghulewadi, Sangamner - 422608



(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)

## Curriculum Structure and Syllabus of Second Year B. Tech. Electrical Engineering



(Effective from Academic Year 2026-27)



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BoS, Electrical Engineering  
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Sangamner-422608



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## Abbreviation

AEC - Ability Enhancement Course  
AICTE - All India Council for Technical Education  
CEP - Community Engagement Project  
EEM - Entrepreneurship/Economics/Management Courses  
MDM - Multidisciplinary Minor  
MOOC - Massive Open Online Course  
NEP - National Education Policy  
NPTEL - National Programme on Technology Enhanced Learning  
OE - Open Elective  
PCC - Program Core Course  
CCC – Cocurricular Course  
PEO - Programme Educational Objectives  
PSO - Program Specific Outcomes  
SWAYAM - Study Webs of Active-learning for Young Aspiring Minds  
UGC - University Grants Commission  
VEC - Value Education Course  
VSE - Vocational and Skill Enhancement Course  
WK - Knowledge and Attitude Profile  
CCE - Comprehensive and Continuous Evaluation  
ISO - International Organization for Standardization  
EOMS - Educational Organization Management System

## **Institute Vision**

To create opportunities for rural students to become able engineers and technocrats through continual excellence in engineering education.

## **Institute Mission**

Our mission is to create self-disciplined, physically fit, mentally robust and morally strong engineers and technocrats with high degree of integrity and sense of purpose who are capable to meet challenges of ever advancing technology for the benefit of mankind and nature.

We, the management, the faculty and staff, therefore promise to strive hard and commit ourselves to achieve this objective through a continuous process of learning and appreciation of needs of time.

## **Department Vision**

To produce co apprehensively trained, socially responsible electrical engineers to build the nation's imprint on the world's stage.

## **Department Mission**

M1: To provide quality education at under graduate level in electrical engineering with state of art technological hub

M2: To enrich professional skills of students for meeting current & future need of industry for social & economical development of the nation.

M3: To maintain an environment which fosters holistic development and strengthens the Morality & ethics of the learners.

  
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## ISO 21001:2018 - EOMS Policy

We, at AVCOE Sangamner, are committed to:

- Provide quality technical education to the rural students
- Provide conducive environment for all round development of the students.
- Develop as a premier institute for technical education & research as per the needs and expectations of all stake holders.
- Comply all applicable requirements.
- Develop students into technocrats having social responsibility.
- Keep abreast about the advances in technology and innovation.
- Enhance industry-institute interaction.
- Managing intellectual property.
- Maintain hygiene, health and safety for applicable requirements.
- Achieve continual improvement in academic and administrative processes.
- We shall strive to maintain Educational Organizational Management System.

## Knowledge and Attitude Profile

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

|     |                                                                                                                                                                                                                       |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WK1 | A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.                                                                              |
| WK2 | Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.         |
| WK3 | A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.                                                                                                            |
| WK4 | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.              |
| WK5 | Knowledge, including efficient resource use, environmental impacts, whole- life cost, re-use of resources, net zero carbon, and similar Concepts, that supports engineering design and operations in a practice area. |

|     |                                                                                                                                                                                                                                                                                                  |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WK6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.                                                                                                                                                                                              |
| WK7 | Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.                                                                            |
| WK8 | Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.                                                                                                        |
| WK9 | Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes. |



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## Program Outcomes (POs)

|      |                                            |                                                                                                                                                                                                                                                                             |
|------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PO1  | Engineering knowledge                      | Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.                           |
| PO2  | Problem analysis                           | Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)                                                                  |
| PO3  | Design / Development of Solutions          | complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)                            |
| PO4  | Conduct Investigations of Complex Problems | Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).                                                                    |
| PO5  | Engineering Tool Usage                     | Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)                                                         |
| PO6  | The Engineer and The World                 | Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).                               |
| PO7  | Ethics                                     | Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)                                                                                                                           |
| PO8  | Individual and Collaborative Team work     | Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.                                                                                                                                                                       |
| PO9  | Communication                              | Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences |
| PO10 | Project Management and Finance             | Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.                                      |
| PO11 | Life-Long Learning                         | Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)                                  |



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## **Program Educational Objectives (PEOs):**

**PEO1:** Design, test and enhance electrical systems with the help of solid foundation in mathematics, science and engineering fundamentals.

**PEO2:** Accomplish the needs of industry by analyzing, designing and creating novel product with the help of modern engineering software and hardware tools and engineering principles.

**PEO3:** Involve effectively as individuals and as a team member in multi-disciplinary projects and excel them in professional ethics and leadership qualities.

**PEO4:** Engage in life-long learning, career enhancement, leadership qualities & professional attitudes for societal benefits.

## **Program Specific Outcomes (PSOs):**

**A graduate of the Computer Engineering Program will demonstrate-**

**PSO1:** Specify, design, prototype and test advanced electrical networks that performs control operation of drives.

**PSO2:** Formulate analyze and select appropriate technologies for implementation in modern transmission and distribution system.

**PSO3:** Built and implement programming logic for industrial process and automation.

  
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## Preface

It gives me immense pleasure to present the autonomous curriculum for the Second Year B.Tech in Electrical Engineering, introduced by the Department of Electrical Engineering. This curriculum has been meticulously designed to address the dynamic requirements of the power, energy, automation, and electrical engineering sectors while providing students with a strong academic and technical foundation.

The curriculum emphasizes the development of fundamental concepts, analytical thinking, practical skills, innovation, and problem-solving abilities. It incorporates contemporary and industry-relevant courses that enable students to gain expertise in core areas of electrical engineering, including electrical machines, power systems, control systems, power electronics, renewable energy technologies, and automation. Special emphasis has been placed on Outcome-Based Education (OBE), experiential learning, laboratory practice, and project-based learning to prepare students for the challenges of modern engineering practice.

The syllabus has been developed with valuable inputs from faculty members, industry professionals, academicians, and members of the Board of Studies. Their collective efforts have ensured that the curriculum remains aligned with current technological advancements, industry expectations, and future trends in the field of Electrical Engineering.

I am confident that this curriculum will equip students with strong technical knowledge, professional competence, ethical values, and lifelong learning skills. It will foster creativity, leadership, and a spirit of innovation, enabling graduates to contribute effectively to society and excel in their professional careers, higher education, research, and entrepreneurial endeavors.

I sincerely appreciate the dedicated efforts of all faculty members, subject experts, and Board of Studies members who contributed to the successful design and implementation of this autonomous curriculum. I extend my best wishes to all students and faculty members for its successful execution and for achieving excellence in the field of Electrical Engineering.

**Dr. S. S. Kadlag**

Head, Department of Electrical Engineering

Amrutvahini College of Engineering, Sangamner

(An Autonomous Institute affiliated with Savitribai Phule Pune University)

  
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## Program codes:

The institute has assigned a unique program code to each branch.

Table 1 – Program codes

| Sr. No.     | Program code           | Code |
|-------------|------------------------|------|
| UG Programs |                        |      |
| 1           | Electrical Engineering | EE   |

## Subject code nomenclature:

The following nomenclature demonstrates the subject codes:

- **R-Year** (of designing/revising syllabus) – **Program code** (as given in table 1) - **Course Type** (as per NEP) – **Course Number** (101 – FY B. Tech Subject 1, 201 - SY B. Tech Subject 1, 301 - TY B. Tech Subject 1, 401 - B. Tech Subject 1 etc.)

## Guidelines for Examination Scheme:

The evaluation of students shall be based on continuous academic performance in a course based on Comprehensive Continuous Evaluation (CCE) and End Semester Examination (ESE). Components of the Examination System:

### Comprehensive Continuous Evaluation (CCE):

- CCE of 40 marks based on all the Units of course.
- To design a Comprehensive Continuous Evaluation scheme for a theory subject of 40 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

**Table 2: Allocation of marks & structure for 3-Credit Subject**

| Sr. No. | Examination                                                                                         | Conduction Marks | Marks | Coverage of Units                  |
|---------|-----------------------------------------------------------------------------------------------------|------------------|-------|------------------------------------|
| 1       | <b>CCE –I</b><br>(Class test – 1)                                                                   | 32               | 16    | Units 1 & Unit 2<br>(8 Marks/Unit) |
| 2       | <b>CCE –II</b><br>(Assessment tools: Case Study, presentation, Open book test etc.)                 | 32               | 16    | Units 3 & Unit 4<br>(8 Marks/Unit) |
| 3       | <b>CCE –III</b><br>(Assessment tools: Assignments, seminar, quiz, course project, field visit etc.) | 08               | 08    | Unit 5                             |

The distribution of marks across various assessment tools and their mapping to COs is detailed in the table below.

**Table 3: Allocation of marks & pattern for 3-Credit subjects**

| Exam         | Assessment                 | CO1       | CO2       | CO3       | CO4       | CO5       |
|--------------|----------------------------|-----------|-----------|-----------|-----------|-----------|
| <b>CCE1</b>  | Written Test (Units 1 & 2) | 8         | 8         | –         | –         | –         |
| <b>CCE2</b>  | Continuous Assessment*     | –         | –         | 8         | 8         | –         |
| <b>CCE3</b>  | Continuous Assessment*     | –         | –         | –         | –         | 8         |
| <b>ESE</b>   | Written Examination        | 12        | 12        | 12        | 12        | 12        |
| <b>Total</b> | <b>100 Marks</b>           | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> |

**Table 4: Allocation of marks & pattern for 2-Credit subjects**

| Exam         | Assessment                 | CO1       | CO2       | CO3       | CO4       |
|--------------|----------------------------|-----------|-----------|-----------|-----------|
| <b>CCE1</b>  | Written Test (Units 1 & 2) | 10        | 10        | –         | –         |
| <b>CCE2</b>  | Continuous Assessment*     | –         | –         | 10        | –         |
| <b>CCE3</b>  | Continuous Assessment*     | –         | –         | –         | 10        |
| <b>ESE</b>   | Written Examination        | 15        | 15        | 15        | 15        |
| <b>Total</b> | <b>100 Marks</b>           | <b>25</b> | <b>25</b> | <b>25</b> | <b>25</b> |

**\*Continuous Assessment:** The course instructor may use any suitable assessment tool such as Assignment, Quiz, Seminar, Case Study, Open Book Test, Course Project, Presentation, Field Visit, or Viva-Voce for CCE2 and CCE3.

#### **Evaluation and Feedback:**

- **Unit Test:** Student answer papers will be evaluated promptly, and constructive feedback will be provided highlighting strengths and areas for improvement.
- **Assignments / Case Study:** Student submissions will be assessed as per the given rubric, and meaningful feedback will be provided to help students understand their performance and scope for enhancement.
- **Seminar Presentation:** Students will be evaluated based on content accuracy, delivery, and responses during the Q&A session. Feedback will be shared on communication skills and conceptual understanding.
- **Open Book Test:** Evaluation will focus on the depth of analysis and the ability to apply concepts. Feedback will emphasize students' critical thinking and problem-solving skills.
- **Mini Project:** Students will be assessed on problem identification, design approach, implementation quality, and documentation. Innovation, teamwork, and practical application of concepts will be strongly considered.
- **Field Visit:** Evaluation will be based on the student's report and reflection, focusing on understanding of real-world practices and their relevance to the course outcomes. Marks will reflect clarity, insight, and active participation.

#### **1. End Semester Examination (ESE):**

The ESE is a compulsory examination for all students. The ESE examination will be conducted at the end of the semester by the institute Department of Examination and Evaluation (DEE). The ESE will be based on 100% syllabus (Unit 1 to Unit 5). The ESE shall be of 60 marks (12 Marks / Unit) conducted for all theory courses as mentioned in the programme structure.

  
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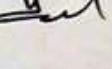
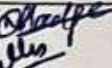
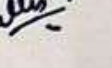
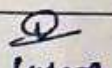
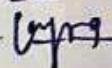
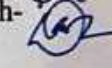
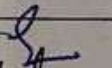
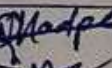
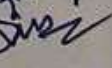
## Syllabus Structure

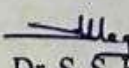
| Course Code     | Course Type                                           | Name of the Subject                           | Teaching Scheme (Hrs./week) |    |     |     |       | Examination Scheme and Marks |     |     |    |    |       | Credit |    |     |       |
|-----------------|-------------------------------------------------------|-----------------------------------------------|-----------------------------|----|-----|-----|-------|------------------------------|-----|-----|----|----|-------|--------|----|-----|-------|
|                 |                                                       |                                               | TH                          | PR | TUT | SL  | Total | CCE                          | ESE | TW  | PR | OR | TOTAL | TH     | PR | TUT | TOTAL |
| Semester-III    |                                                       |                                               |                             |    |     |     |       |                              |     |     |    |    |       |        |    |     |       |
| R25-EE-PCC-201  | Program Core course - 1                               | Measuring Instruments & Smart Sensors         | 3                           |    |     | 45  | 90    | 40                           | 60  |     |    |    | 100   | 3      |    |     | 3     |
| R25-EE-PCC-202  | Program Core course - 2                               | Analog and Digital Electronics                | 3                           |    |     | 45  | 90    | 40                           | 60  |     |    |    | 100   | 3      |    |     | 3     |
| R25-EE-PCC-203  | Program Core course - 3                               | Transmission & Distribution System            | 3                           |    |     | 45  | 90    | 40                           | 60  |     |    |    | 100   | 3      |    |     | 3     |
| R25-EE-MDM-204  | Multidisciplinary Minor - 1                           | Applied Mathematics                           | 3                           |    |     | 45  | 90    | 40                           | 60  |     |    |    | 100   | 3      |    |     | 3     |
| R25-EE-OEC-205  | Open Elective - 1                                     | Open Elective - I                             | 2                           |    |     | 30  | 60    | 40                           | 60  |     |    |    | 100   | 2      |    |     | 2     |
| R25-EE-HSSM-206 | Enterpreneurship/Economics/ Management course         | Engineering Economics                         | 1                           | 2  |     | 15  | 60    | 25                           |     | 25  |    |    | 50    | 1      | 1  |     | 2     |
| R25-EE-EVC-207  | Value Education Course                                | Universal Human Values & Ethics               | 2                           |    |     | 30  | 60    | 50                           |     |     |    |    | 50    | 2      |    |     | 2     |
| R25-EE-PCC-208  | Program Core Course-Lab                               | Measuring Instruments & Smart Sensors Lab     |                             | 2  |     |     | 30    |                              |     | 25  | 25 |    | 50    |        | 1  |     | 1     |
| R25-EE-PCC-209  | Program Core Course Lab / Multidisiplinary Course-Lab | Analog and Digital Electronics Lab            |                             | 2  |     |     | 30    |                              |     | 25  | 25 |    | 50    |        | 1  |     | 1     |
| R25-EE-ECEP-210 | Comunity Engagement Project / Field Project           | Energy Literacy & Electrical safety education |                             | 4  |     |     | 60    |                              |     | 50  |    |    | 50    |        | 2  |     | 2     |
|                 |                                                       |                                               | 17                          | 10 | 0   | 255 | 660   | 275                          | 300 | 125 | 50 | 0  | 750   | 17     | 5  | 0   | 22    |

| Semester-IV      |                                               |                                                  |                             |    |     |     |       |                              |     |    |    |    |       |        |    |     |       |
|------------------|-----------------------------------------------|--------------------------------------------------|-----------------------------|----|-----|-----|-------|------------------------------|-----|----|----|----|-------|--------|----|-----|-------|
| Course Code      | Course Type                                   | Name of the Subject                              | Teaching Scheme (Hrs./week) |    |     | SL  | Total | Examination Scheme and Marks |     |    |    |    |       | Credit |    |     |       |
|                  |                                               |                                                  | TH                          | PR | TUT |     |       | CCE                          | ESE | TW | PR | OR | TOTAL | TH     | PR | TUT | TOTAL |
| R25-EE-PCC-211   | Program Core course - 4                       | AC & DC Machines                                 | 3                           |    |     | 45  | 90    | 40                           | 60  |    |    |    | 100   | 3      |    |     | 3     |
| R25-EE-PCC-212   | Program Core course - 5                       | Network Analysis                                 | 3                           |    |     | 45  | 90    | 40                           | 60  |    |    |    | 100   | 3      |    |     | 3     |
| R25-EE-PCC-213   | Program Core course - 6                       | Numerical Methods and Computer Programming       | 2                           |    |     | 30  | 60    | 40                           | 60  |    |    |    | 100   | 2      |    |     | 2     |
| R25-EE-OEC-214   | Open Elective - 2                             | Open Elective - II                               | 2                           |    |     | 30  | 60    | 40                           | 60  |    |    |    | 100   | 2      |    |     | 2     |
| R25-EE-MDM-215   | Multidisciplinary Minor - 2                   | Fundamentals of Data Science & Machine Learning  | 2                           |    |     | 30  | 60    | 40                           | 60  |    |    |    | 100   | 2      |    |     | 2     |
| R25-EE-VSEC- 216 | Vocational Skill Course                       | Electrical Workshop & Engineering Materials      | 1                           | 2  |     | 15  | 60    | 25                           |     | 25 |    |    | 50    | 1      | 1  |     | 2     |
| R25-EE-AEC-217   | Ability Enhancement Course                    | Modern Indian Language and Technical Writing     | 1                           | 2  |     | 15  | 60    |                              |     | 50 |    |    | 50    | 1      | 1  |     | 2     |
| R25-EE-HSSM- 218 | Entrepreneurship/Economics/ Management course | Industrial Organization and Management           | 2                           |    |     | 30  | 60    | 50                           |     |    |    |    | 50    | 2      |    |     | 2     |
| R25-EE-PCC-219   | Program Core Course- Lab                      | AC & DC Machines Lab                             |                             | 2  |     |     | 30    |                              |     |    | 25 |    | 25    |        | 1  |     | 1     |
| R25-EE-PCC-220   | Program Core Course Lab                       | Numerical Methods and Computer Programming Lab   |                             | 2  |     |     | 30    |                              |     |    | 25 |    | 25    |        | 1  |     | 1     |
| R25-EE-VEC-221   | Value Education Course                        | Environmental Awareness for Electrical Engineers | 2                           |    |     | 30  | 60    | 50                           |     |    |    |    | 50    | 2      |    |     | 2     |
|                  |                                               |                                                  | 18                          | 8  | 0   | 255 | 660   | 325                          | 300 | 75 | 50 | 0  | 750   | 18     | 4  | 0   | 22    |

  
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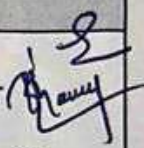
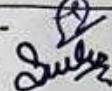
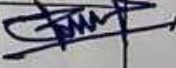
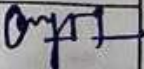
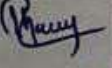
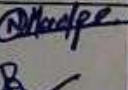
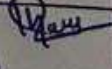
  
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| Sr. No.               | Name of the course                            | Course Code    | Syllabus Design Teams                                                                                                                                                                                                                                                                                                             |
|-----------------------|-----------------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Semester - III</b> |                                               |                |                                                                                                                                                                                                                                                                                                                                   |
| 1                     | Measuring Instruments & Smart Sensors         | R25-EE-PCC-201 | Dr. K. V. Bhadane - <br>Prof. K. C. Mule -                                                                                                                  |
| 2                     | Analog and Digital Electronics                | R25-EE-PCC-202 | Prof. N. V. Hadpe - <br>Dr. S. C. Sahoo -                                                                                                                   |
| 3                     | Transmission & Distribution System            | R25-EE-PCC-203 | Prof. Vijay Kumar - <br>Prof. Y. U. Kakad -                                                                                                                 |
| 4                     | Applied Mathematics                           | R25-EE-MDM-204 | Prof. D. N. Kalokhe - <br>Prof. S. S. Deshmukh -                                                                                                            |
| 5                     | Project Management                            | R25-EE-OEC-205 | Dr. S. C. Sahoo - <br>Prof. D. D. Gaikwad -                                                                                                                 |
| 6                     | Engineering Economics                         | R25-EE-EEM-206 | Prof. S. V. Kolhe -                                                                                                                                                                                                                          |
| 7                     | Universal Human Values & Ethics               | R25-EE-VEC-207 | Prof. S. G. Pawar -                                                                                                                                                                                                                          |
| 8                     | Measuring Instruments & Smart Sensors Lab     | R25-EE-PCC-208 | Dr. K. V. Bhadane - <br>Prof. K C Mule -                                                                                                                |
| 9                     | Analog and Digital Electronics Lab            | R25-EE-PCC-209 | Prof. N. V. Hadpe - <br>Dr. S. C. Sahoo -                                                                                                               |
| 10                    | Energy Literacy & Electrical safety education | R25-EE-CEP-210 | Prof. M. S. Gadakh - <br>Prof. K. C. Mule - <br>Dr. A. S. Pande -  |

  
Dr. S. S. Kadlag  
Head of Department

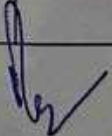


  
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| Sr. No.              | Name of the course                                 | Course Code    | Syllabus Design Teams                                                                                                                                                                                                                                                                                                             |
|----------------------|----------------------------------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Semester - IV</b> |                                                    |                |                                                                                                                                                                                                                                                                                                                                   |
| 1                    | AC and DC Machines                                 | R25-EE-PCC-211 | Dr. K. V. Bhadane - <br>Prof. D. D. Gaikwad -                                                                                                               |
| 2                    | Network Analysis                                   | R25-EE-PCC-212 | Prof. S. G. Pawar - <br>Dr. S. C. Sahoo -                                                                                                                   |
| 3                    | Numerical Methods and Computer Programming         | R25-EE-PCC-213 | Prof. N. V. Hadpe - <br>Prof. S. V. Kolhe -                                                                                                                 |
| 4                    | Principles of Data Science & Machine Learning      | R25-EE-MDM-214 | Prof. V. D. Shinde -                                                                                                                                                                                                                           |
| 5                    | Sustainable Rural Entrepreneurship and Development | R25-EE-OEC-215 | Prof. Y. U. Kakad -                                                                                                                                                                                                                            |
| 6                    | Electrical Workshop & Engineering Materials        | R25-EE-VSC-216 | Prof. Vijay Kumar - <br>Dr. A. S. Pande - <br>Prof. Y. U. Kakad -  |
| 7                    | Modern Indian Language and Technical Writing       | R25-EE-AEC-217 | Prof. V. D. Shinde - <br>Dr. A. A. Pathare - <br>25/8/26                                                                                                |
| 8                    | Industrial Organization and Management             | R25-EE-EEM-218 | Dr. K. V. Bhadane - <br>Prof. S. G. Pawar -                                                                                                             |
| 9                    | AC and DC Machines Lab                             | R25-EE-PCC-219 | Dr. K. V. Bhadane - <br>Prof. D. D. Gaikwad -                                                                                                           |
| 10                   | Numerical Methods and Computer Programming Lab     | R25-EE-PCC-220 | Prof. N. V. Hadpe - <br>Prof. S. V. Kolhe -                                                                                                             |
| 11                   | Environmental Awareness for Electrical Engineers   | R25-EE-VEC-221 | Prof. D. D. Gaikwad - <br>Dr. A. S. Pande -                                                                                                             |

  
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Head of Department



  
Dr. P. R. Baviskar  
Chairman, Academic Council

**SECOND YEAR ENGINEERING**

**SEMESTER-III**

**ELECTRICAL ENGINEERING**





|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                          |                 |               |                           |                       |                      |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|---------------------------|-----------------------|----------------------|-----------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>S. Y. B. Tech Electrical Engineering</b>                                                                                                                                                                                                              |                 |               | <b>Semester:</b>          | <b>III</b>            |                      |           |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Measuring Instruments &amp; Smart Sensors</b>                                                                                                                                                                                                         |                 |               | <b>Course Code:</b>       | <b>R25-EE-PCC-201</b> |                      |           |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                          |                 |               | <b>Examination Scheme</b> |                       |                      |           |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Practical</b>                                                                                                                                                                                                                                         | <b>Tutorial</b> | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>            | <b>TW</b>            | <b>PR</b> |
| 03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                          | -               | 3             | 40                        | 60                    |                      |           |
| <b>Course Description:</b><br>This course introduces the fundamentals of Electrical measuring instruments, electronic measurements, sensors, and smart sensing technologies. It covers measurement techniques, transducers, signal conditioning, sensors and IoT-based smart sensor applications used in modern industrial and automation systems.                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                          |                 |               |                           |                       |                      |           |
| <b>Relevance:</b><br>This course is relevant for understanding modern measurement techniques, sensors, and smart monitoring systems used in Electrical system, automation, IoT, healthcare, robotics, and industrial applications. It helps students to develop practical skills in electrical system and instrumentation, sensor interfacing, and intelligent sensing technologies required in Industry 4.0 and smart engineering systems.                                                                                                                                                                                          |                                                                                                                                                                                                                                                          |                 |               |                           |                       |                      |           |
| <b>Prerequisite:</b><br>1. Basic knowledge of Electrical and Electronic Engineering fundamentals,<br>2. circuit analysis, semiconductor devices, and analog electronics.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                          |                 |               |                           |                       |                      |           |
| <b>Bridge Content:</b><br>Basics of electrical circuits, Ohm’s law, Kirchhoff’s laws, AC and DC fundamentals, semiconductor devices, analog electronics, and introductory concepts of sensors and measurement systems.                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                          |                 |               |                           |                       |                      |           |
| <b>Course Objectives:</b> This course aims to<br>1. <b>Familiarize</b> students with a variety of measurement instruments used in engineering applications, such as voltmeters, ammeters, wattmeter’s, mustimeters, oscilloscopes, and signal analyzers.<br>2. <b>Measure</b> the active and reactive power of 3-phase circuit using one wattmeter/ two/three wattmeter method.<br>3. <b>Calibrate</b> static single and three phase energy meter.<br>4. <b>Learn</b> about various types of measurement techniques, instruments and sensors.<br>5. <b>Apply</b> proper methods of measurement and use of sensors in instrumentation |                                                                                                                                                                                                                                                          |                 |               |                           |                       |                      |           |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                          |                 |               |                           |                       |                      |           |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Course Outcome</b>                                                                                                                                                                                                                                    |                 |               |                           |                       | <b>Bloom’s Level</b> |           |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Understand</b> the various characteristic and <b>Categorized</b> measuring instruments along with range extension techniques.                                                                                                                         |                 |               |                           |                       | <b>2</b>             |           |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Determining</b> measurement techniques for measurement of resistance, inductance and capacitance.                                                                                                                                                     |                 |               |                           |                       | <b>3</b>             |           |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Demonstrate</b> construction, working principle of electro dynamo type and induction type instruments for measurement of power and <b>Demonstrate</b> construction, working principle of integrating instruments for measurement of energy and power. |                 |               |                           |                       | <b>3</b>             |           |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Classify</b> transducer and <b>choosing</b> it for measurement of Physical parameters in real time.                                                                                                                                                   |                 |               |                           |                       | <b>3</b>             |           |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                         |                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Analyze</b> the given electrical network by measuring voltage, current, frequency, power, energy using power quality analyzer & DSO. | <b>4</b>          |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                         |                   |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Measuring Instruments and Instrument Transformer</b>                                                                                 | <b>9 Hrs. CO1</b> |
| Measuring Instruments: Classification of instruments: absolute and secondary instruments. Types of secondary instruments: indicating, integrating, and recording. Essentials in indicating instruments: deflecting, controlling and damping systems. Construction, working principle, torque equation, advantages and disadvantages of Permanent Magnet Moving Coil (PMMC) and Moving Iron (MI) instruments. Instrument Transformers: Construction, connection of CT & PT in the circuit, advantages and need of CT / PT for range extension of MI Instruments                                                    |                                                                                                                                         |                   |
| Exemplars / Practical Applications and usage: A case study of HT consumer measuring system with MI Ammeter, Voltmeter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                         |                   |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Measurement of Resistance, Inductance and Capacitance</b>                                                                            | <b>9 Hrs. CO2</b> |
| Measurement of Resistance: Classification of resistances. Measurement of low resistance by Kelvin Double Bridge and Ammeter-voltmeter method. Measurement of medium resistance by Wheatstone bridge. Measurement of high resistance by loss of charge method and Megger. Measurement of Inductance and Capacitance: Sources and detectors for A.C. bridge, general equation for bridge balance, Maxwell's Inductance Bridge, Maxwell's Inductance – Capacitance Bridge, Schering Bridge.                                                                                                                          |                                                                                                                                         |                   |
| Exemplars / Practical Applications and usage: Resistance, inductance, capacitance of various apparatus used in day to day life.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                         |                   |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Measurement of Power and Energy</b>                                                                                                  | <b>9 Hrs. CO3</b> |
| Measurement of Power: Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type single phase wattmeter, poly-phase wattmeter, Active & reactive power measurement in a three-phase system for balanced and unbalanced load using one, two and three wattmeter method. Measurement of Energy: Block diagram and operation of single phase and three phase static/digital energy meter. TOD meter. Concept of Infrared Energy Meter. Necessity of Calibration, Calibration of wattmeter & energy meter.                                     |                                                                                                                                         |                   |
| Exemplars / Practical Applications and usage: Measurement of Power and Energy in Residential and Industrial consumer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                         |                   |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Transducers</b>                                                                                                                      | <b>9 Hrs. CO4</b> |
| Transducers: Introduction, classification, basic requirements for transducers selection, and its applications. Pressure Measurement: Introduction, Pressure measurement using electrical methods: resistive, inductive, capacitive. Level Measurement: Introduction and importance of level measurement. Methods of level measurement: resistive, inductive, capacitive, and ultrasonic. Measurement of liquid level using float. Displacement Measurement: LVDT & RVDT: construction, working, specifications, advantages and disadvantages, applications, absolute and incremental encoder, digital tachometer. |                                                                                                                                         |                   |
| Exemplars / Practical Applications and usage: Vacuum Pressure, Industrial Vacuum Systems, Process Industries. Domestic Water Tanks, Oil Tanks, Chemical Tanks, Marine Applications. Robotics, Military and Aerospace.                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                         |                   |

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| Unit 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Smart Sensors and Digital Instruments | 9 Hrs. | CO5 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|--------|-----|
| <p>Smart Sensors: Introduction to sensors, proximity sensor, motion sensor, Radar and LIDAR sensor, smart plant sensor, smart climate sensor, air quality detection sensor, Smoke Sensor, Temperature sensor, Hall effect sensor, Piezoelectric sensor, current and voltage sensor.</p> <p><b>Digital Instruments;</b> Block diagram and operation of digital Voltmeter, Multimeter, and Frequency meter, Power Quality Analyzer and Digital Storage Oscilloscope, Basics of Data Acquisition System (DAS).</p> <p>Exemplars / Practical Applications and usage: Voltmeter, Ammeter, Energy meter, Multimeter etc.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                       |        |     |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                       |        |     |
| <ol style="list-style-type: none"> <li>1. A. K. Sawhney, "A Course in Electrical and Electronic Measurements &amp; Instrumentation", Dhanpat Rai &amp; Co.</li> <li>2. J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", S. K. Kataria &amp; Sons</li> <li>3. R. K. Jain, "Mechanical and Industrial Measurements", Khanna Publishers.</li> <li>4. B. C. Nakra &amp; K. K. Chaudhari, "Instrumentation Measurement and Analysis", Tata McGraw Hill.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                       |        |     |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                       |        |     |
| <ol style="list-style-type: none"> <li>1. E. W. Golding &amp; F. C. Widdies, "Electrical Measurements &amp; Measuring Instruments", Reem Publications.</li> <li>2. Dr. Rajendra Prasad, "Electronic Measurements &amp; Instrumentation", Khanna Publishers.</li> <li>3. Fundamentals of Electrical Measurements by C.T. Baldwin, Publisher- George G. Harrap &amp; Co Ltd</li> <li>4. Problems In Electrical Engineering by Smith S, Parker, Asia Publications</li> <li>5. Instrumentation: Devices and Systems by C. Rangan, G Sarma, V.S.V. Mani, McGraw Hill Education</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                       |        |     |
| <b>MOOCs Links and additional reading material:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                       |        |     |
| <ol style="list-style-type: none"> <li>1. NPTEL Course on Electrical Measurement and Electronic Instruments by Prof. Avishek Chatterjee<br/>NPTEL-SWAYAM Course Link: <a href="https://onlinecourses.nptel.ac.in/noc25_ee123/preview">https://onlinecourses.nptel.ac.in/noc25_ee123/preview</a></li> <li>2. NPTEL Course on Sensors and Actuators by Prof. Ravindra Gettu, Indian Institute of Technology Madras – NPTEL-SWAYAM Course Link: <a href="https://onlinecourses.nptel.ac.in/noc19_ee41/preview">NPTEL Courses Portal: https://onlinecourses.nptel.ac.in/noc19_ee41/preview</a></li> <li>3. NPTEL Course on Industrial Instrumentation by Prof. Alok Barua, Indian Institute of Technology Kharagpur – NPTEL Course Link: <a href="https://nptel.ac.in/courses/108105064">https://nptel.ac.in/courses/108105064</a></li> <li>4. NPTEL Course on Principles of Measurement by Prof. Ashok Kumar and Prof. B. Krishna Gandhi, Indian Institute of Technology Roorkee – NPTEL Course Link: <a href="https://nptel.ac.in/courses/112107242">https://nptel.ac.in/courses/112107242</a></li> <li>5. NPTEL Course on Sensors and Actuators by Prof. Hardik Jeetendra Pandya, Indian Institute of Science (IISc) Bangalore – NPTEL Course Link: <a href="https://onlinecourses.nptel.ac.in/noc19_ee41/preview">https://onlinecourses.nptel.ac.in/noc19_ee41/preview</a></li> <li>6. <a href="http://www.isa.org">www.isa.org</a></li> <li>7. <a href="http://ocw.mit.edu">ocw.mit.edu</a></li> <li>8. <a href="http://ctms.engin.umich.edu/CTMS">ctms.engin.umich.edu/CTMS</a></li> </ol> |                                       |        |     |
| <b>Strength of CO-PO-PSO Mapping</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                       |        |     |

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| CO   | PO1         | PO2         | PO3         | PO4         | PO5         | PO6 | PO7 | PO8         | PO9         | PO10 | PO11 | PSO1        | PSO2        | PSO3        |
|------|-------------|-------------|-------------|-------------|-------------|-----|-----|-------------|-------------|------|------|-------------|-------------|-------------|
| CO1  | 2           | 3           | 2           | 1           | 3           | -   | -   | -           | 3           | -    | -    | -           | 3           | 2           |
| CO2  | 3           | 3           | 2           | 1           | 3           | -   | -   | -           | 3           | -    | -    | -           | 3           | 2           |
| CO3  | 3           | 3           | 2           | 1           | 3           | -   | -   | 2           | 1           | -    | -    | -           | 1           | 2           |
| CO4  | 3           | 3           | 2           | 1           | 3           | -   | -   | -           | 3           | -    | -    | 2           | 3           | 2           |
| CO5  | 3           | 3           | 2           | 1           | 3           | -   | -   | -           | 3           | -    | -    | 2           | 3           | 2           |
| Avg. | <b>2.83</b> | <b>3.00</b> | <b>2.00</b> | <b>1.00</b> | <b>3.00</b> | -   | -   | <b>2.00</b> | <b>2.67</b> | -    | -    | <b>2.00</b> | <b>2.50</b> | <b>2.00</b> |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam  | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|-------|-------|-------|-------|-------|-------|
| CCE 1 | 8     | 8     | -     | -     | -     |
| CCE 2 | -     | -     | 8     | 8     | --    |
| CCE 3 | -     | -     | -     | -     | 8     |
| ESE   | 12    | 12    | 12    | 12    | 12    |
| Total | 20    | 20    | 20    | 20    | 20    |

**Assessment Pattern**

| BT Level | CCE |     |     |     |     | ESE |     |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          | CO1 | CO2 | CO3 | CO4 | CO5 | CO1 | CO2 | CO3 | CO4 | CO5 |
|          | 8   | 8   | 8   | 8   | 8   | 12  | 12  | 12  | 12  | 12  |
| L1       | √   | √   | √   | √   | √   | √   | √   | √   | √   | √   |
| L2       | √   | √   | √   | √   | √   | √   | √   | √   | √   | √   |
| L3       | -   | √   | √   | √   | √   | -   | √   | √   | √   | √   |
| L4       | -   | -   | -   | -   | √   | -   | -   | -   | -   | √   |
| L5       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| L6       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

This course serves as a prerequisite for / maps with the following future courses:

- Advanced Electrical Measurements
- Instrumentation and Control Systems
- Industrial Automation and PLC
- Process Instrumentation
- Power System Protection and Switchgear
- Smart Sensors and IoT Applications
- Embedded and Real-Time Systems
- Electrical Testing and Maintenance
- Control Engineering
- Energy Management Systems

- Job Mapping:
- Instrumentation Engineer
- Electrical Maintenance Engineer

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- Calibration and Testing Engineer
- Automation Engineer
- Control System Engineer
- Electrical Design Engineer
- Field Service Engineer
- Quality Control Engineer
- Power System Testing Engineer
- IoT and Smart Sensor Engineer

Job opportunities that one can get after learning this course: After completing this course, students can pursue opportunities in the following areas:

- Instrumentation Engineer
- Electrical Testing Engineer
- Calibration Engineer
- Automation Engineer
- Control System Engineer
- Maintenance Engineer
- Field Service Engineer



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|                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                         |                 |               |                           |               |                       |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|---------------------------|---------------|-----------------------|-----------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                          | <b>S. Y. B. Tech (Electrical Engineering)</b>                                                                           |                 |               | <b>Semester:</b>          |               | <b>III</b>            |           |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Analog and Digital Electronics</b>                                                                                   |                 |               | <b>Course Code:</b>       |               | <b>R25-EE-PCC-202</b> |           |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                         |                 |               | <b>Examination Scheme</b> |               |                       |           |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Practical</b>                                                                                                        | <b>Tutorial</b> | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>    | <b>TW</b>             | <b>PR</b> |
| 03                                                                                                                                                                                                                                                                                                                                                                                                                       | -                                                                                                                       | -               | 03            | 40                        | 60            | -                     | -         |
| <b>Course Description:</b> Analog and Digital Electronics deals with electronic circuits used to process analog and digital signals. It covers semiconductor devices, logic gates, and basic circuits used in modern electronic systems and control applications.                                                                                                                                                        |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>Course Relevance:</b> Analog and Digital Electronics is important because it provides the basic knowledge needed to understand and design modern electronic systems. It helps students learn circuit design, troubleshooting, and applications in computers, communication, automation, and control systems, forming a strong foundation for advanced engineering studies and careers.                                |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>Prerequisite:</b><br>1. Numbering system, Logic Gates and flip flops<br>2. Diode and BJT                                                                                                                                                                                                                                                                                                                              |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>Bridge Content:</b><br>1. Binary Addition and Subtraction<br>2. Internal Structure of IC741,<br>3. Basics of Diode                                                                                                                                                                                                                                                                                                    |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>Course Objectives:</b> This course aims to:<br><br>1. <b>Use</b> K map for Boolean algebra reduction and design digital circuit<br>2. <b>Construct</b> sequential and combinational circuits using flip flops and K map<br>3. <b>Develop</b> the concept of basics of operational Amplifier and its applications<br>4. <b>Understand</b> IC 555 timer and its applications<br>5. <b>Design</b> uncontrolled rectifier |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                              |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Course Outcome</b>                                                                                                   |                 |               |                           |               | <b>Bloom's Level</b>  |           |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Simplify</b> complex logic expression by using Boolean algebra and design combinational digital circuit using K-Map. |                 |               |                           |               | <b>3</b>              |           |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Design</b> logical, sequential digital circuit using K-Map.                                                          |                 |               |                           |               | <b>3</b>              |           |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Apply</b> and analyze applications of OPAMP in open and closed loop conditions.                                      |                 |               |                           |               | <b>4</b>              |           |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Understand</b> different analog circuits e.g. filters, IC555 and voltage regulators                                  |                 |               |                           |               | <b>2</b>              |           |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Design</b> uncontrolled rectifier with given specifications                                                          |                 |               |                           |               | <b>3</b>              |           |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Design of combinational circuit</b>                                                                                  |                 |               |                           | <b>9 Hrs.</b> | <b>CO1</b>            |           |
| Booleans algebra, Karnaugh map: structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map. Design of combinational circuits using Boolean expression and K-map, encoder, decoder, half and full adder                                                                                                                                                                      |                                                                                                                         |                 |               |                           |               |                       |           |
| <b>Exemplars / Practical Applications and usage:</b><br>Traffic Light Control System, Elevator Control Logic, Keyboard Key Press Encoding, Seven-Segment Display, Basic Calculator                                                                                                                                                                                                                                       |                                                                                                                         |                 |               |                           |               |                       |           |

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| Unit 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Design of Sequential circuit             | 9 Hrs. | CO2 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|--------|-----|
| Introduction to sequential circuits. Design of synchronous (K-map) and asynchronous counters. Up down counters, N modulo counters, shift registers, ring and twisted ring counters                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                          |        |     |
| <b>Exemplars / Practical Applications and usage:</b><br>Washing Machine Controller, Digital Clocks and Timers, Event Counting and Frequency Dividers                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                          |        |     |
| Unit 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Operational Amplifier Applications       | 9 Hrs. | CO3 |
| Open loop and close loop configuration of Op-Amp. Applications of Op-Amp zero crossing detectors, Comparator, Schmitt trigger, V-I and I-V converters, Instrumentation amplifier, peak detector, Waveform generation using Op-amp - sine, square, saw tooth and triangular generator                                                                                                                                                                                                                                                                                                                                   |                                          |        |     |
| <b>Exemplars / Practical Applications and usage:</b><br>Precision Control Systems, Sine Wave Detection in Inverters, LED Brightness Control, Audio processing                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                          |        |     |
| Unit 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Filters and voltage regulators           | 9 Hrs. | CO4 |
| Active filters-Its configuration with frequency response, Analysis of first order low pass and high pass filters using OPAMP, IC 555 –construction, working and modes of operation-astable and monostable multi vibrators, Sequence generator, voltage regulators using IC78xx, 79xx, LM 317, Voltage regulator using OPAMP                                                                                                                                                                                                                                                                                            |                                          |        |     |
| <b>Exemplars / Practical Applications and usage:</b><br>Audio Equalizers, Blinking LEDs, Square wave generator, Power supply, Battery charger                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                          |        |     |
| Unit 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Diode rectifier (Uncontrolled Rectifier) | 9 Hrs. | CO4 |
| Single phase half wave rectifier with R, RL loads. Single phase full wave Rectifier-Centre tap and bridge rectifier supplying R and RL load and performance parameters. Three phase full wave bridge rectifier with R load.                                                                                                                                                                                                                                                                                                                                                                                            |                                          |        |     |
| <b>Exemplars / Practical Applications and usage:</b><br>Power adapters for calculators, Power supply in Phone chargers & laptops, DC Drives power supply                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                          |        |     |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                          |        |     |
| <ol style="list-style-type: none"> <li>1. Floyd and Jain, “Digital Fundamentals”, Pearson Education.</li> <li>2. R. P. Jain, “Digital Electronics”, Tata McGraw Hill, New Delhi.</li> <li>3. Gaikwad R., “Operational Amplifier”, PHI New Delhi.</li> <li>4. Floyd, “Electronics Devices”, Pearson Education</li> <li>5. Fundamental of digital circuits, 4th Edition, by A. Anand Kumar, PHI learning private limited publication.</li> </ol>                                                                                                                                                                         |                                          |        |     |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                          |        |     |
| <ol style="list-style-type: none"> <li>1. Tokheim, “Digital Electronics-Principles and Application”, 6th edition, Tata McGraw Hill, New Delhi.</li> <li>2. A Jaico and Charles H. Roth, “Fundamentals of Logic Design” Jr. Fourth Edition.</li> <li>3. James, “Operational Amplifier and Linear Integrated Circuits Theory and Application.”</li> <li>4. P. S. Bimbhra, “Power Electronics”, Khanna Publications.</li> <li>5. Foundations of Analog and Digital Electronic Circuits by Agarwal, Publisher</li> </ol>                                                                                                   |                                          |        |     |
| <b>MOOCs Links and additional reading material:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                          |        |     |
| <ol style="list-style-type: none"> <li>1. NPTEL course on Digital Electronics Circuit, IIT, Kharagpur.<br/><a href="https://nptel.ac.in/courses/108105132/">https://nptel.ac.in/courses/108105132/</a></li> <li>2. NPTEL course on Integrated circuit, MOSFET, OPAMP and their applications IISC Bangalore,<br/><a href="https://nptel.ac.in/courses/108/108/108108111/">https://nptel.ac.in/courses/108/108/108108111/</a></li> <li>3. NPTEL course on power electronics by IIT Kharagpur.<br/><a href="https://nptel.ac.in/courses/108/105/108105066/">https://nptel.ac.in/courses/108/105/108105066/</a></li> </ol> |                                          |        |     |



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**CO-PO-PSO Mapping**

| CO   | PO1 | PO2 | PO3  | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 2   | 2   | 1    | -   | 2   | -   | -   | -   | -   | -    | 2    | -    | 3    | 2    |
| CO2  | 2   | 2   | 3    | -   |     | -   | -   | -   | -   | -    | 2    | -    | 3    | 2    |
| CO3  | 2   | 2   | -    | -   | 2   | -   | -   | -   | -   | -    | 2    | -    | 1    | 2    |
| CO4  | 2   | 2   | -    | -   |     | -   | -   | -   | -   | -    | 2    | 2    | 3    | 2    |
| CO5  | 2   | 2   | 3    | -   | 2   | -   | -   | -   | -   | -    | 2    | 2    | 3    | 2    |
| Avg. | 2   | 2   | 2.33 | -   | 2   | -   | -   | -   | -   | -    | 2    | 2    | 2.6  | 2    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam       | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|------------|-------|-------|-------|-------|-------|
| CCE        |       |       |       |       |       |
| CT1        | 8     | 8     |       |       |       |
| Assignment |       |       | 8     | 8     |       |
| Quiz       |       |       |       |       | 8     |
| ESE        | 12    | 12    | 12    | 12    | 12    |
| Total      | 20    | 20    | 20    | 20    | 20    |

**Assessment Pattern**

| BT Level | CCE |     |     |     |     | ESE |     |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          | CO1 | CO2 | CO3 | CO4 | CO5 | CO1 | CO2 | CO3 | CO4 | CO5 |
|          | 8   | 8   | 8   | 8   | 8   | 12  | 12  | 12  | 12  | 12  |
| L1       | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| L2       | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| L3       | ✓   | ✓   | ✓   | -   | ✓   | ✓   | ✓   | ✓   | -   | ✓   |
| L4       | -   | -   | ✓   | -   | -   | -   | -   | ✓   | -   | -   |
| L5       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| L6       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

**This course serves as a prerequisite for / maps with the following future courses:**

1. Power Electronics,
2. Control System,
3. Advanced Electrical Drives and Control

**Job Mapping:**

Job opportunities that one can get after learning this course: Electrical Maintenance, Logic Circuit Designer, Electronics Repairing Workshop, etc.

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                          |                                        |        |                    |              |        |                |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|--------|--------------------|--------------|--------|----------------|--|
| Program:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                          | S. Y. B. Tech (Electrical Engineering) |        |                    | Semester:    |        | III            |  |
| Course:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                          | Transmission & Distribution Systems    |        |                    | Course Code: |        | R25-EE-PCC-203 |  |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                          |                                        |        | Examination Scheme |              |        |                |  |
| Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Practical                                                                                                                                | Tutorial                               | Credit | CCE                | ESE          | TW     | PR             |  |
| 03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -                                                                                                                                        | -                                      | 3      | 40                 | 60           | -      | -              |  |
| <b>Course Description:</b><br>This course focuses on the generation, transmission, distribution, and utilization of electrical power. This course is essential for designing, maintaining reliable and efficient electrical power systems.                                                                                                                                                                                                                                                                                                                      |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| <b>Relevance:</b><br>It builds a strong foundation in supporting industries, infrastructure, renewable energy integration, and meeting the growing global demand for electricity.                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| <b>Prerequisite:</b><br>Knowledge of AC Fundamental and Engineering Mathematics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| <b>Bridge Content:</b><br>Basic Electrical Engineering, Power Generation Technology, Electrical Engineering Material.                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| <b>Course Objectives:</b> This course aims to<br>1. <b>Learn</b> the basics of electrical power systems, various electrical terms related with power system and understand various types of tariffs.<br>2. <b>Get</b> knowledge of mechanical and electrical design of overhead and underground transmission systems.<br>3. <b>Understand</b> the representation of transmission lines for performance evaluation.<br>4. <b>Identify</b> and explain the components of distribution substations and various busbar layouts used in power distribution networks. |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| <b>Course Outcomes:</b> After learning the course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| CO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Course Outcome                                                                                                                           |                                        |        |                    |              |        | Bloom's Level  |  |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Illustrate the electrical terminology related to power plant & tariffs used in India.                                                    |                                        |        |                    |              |        | 2              |  |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Calculate electrical & mechanical aspects of a given underground cable & overhead transmission line.                                     |                                        |        |                    |              |        | 3              |  |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Compute the inductance and capacitance of a given 3-phase overhead transmission line with symmetrical & unsymmetrical conductor Spacing. |                                        |        |                    |              |        | 3              |  |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Analyze the performance of short & medium overhead transmission line using ABCD parameters with T and $\pi$ model.                       |                                        |        |                    |              |        | 4              |  |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Identify various components and structure of distribution system.                                                                        |                                        |        |                    |              |        | 2              |  |
| Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| Unit 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Basics of Power Systems and its tariff                                                                                                   |                                        |        |                    |              | 9 Hrs. | CO1            |  |
| Basics of power systems: Structure of electrical power system, Concept of regional and National GRID. Different factors associated with generating stations, Load curve and Load duration curve, Concept of base load and peak load stations.<br>Tariff: Introduction of Tariff, various consumer categories and implemented tariff such as two-part tariff, three-part tariff (Numerical on two-part and three-part tariff), Power factor tariff, Time of day tariff, Introduction to Availability based tariff (ABT).                                         |                                                                                                                                          |                                        |        |                    |              |        |                |  |
| Exemplars / Practical Applications and usage: Power plants, Renewable energy, Domestic, Industrial meter for tariffs.                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                          |                                        |        |                    |              |        |                |  |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                    |               |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|---------------|------------|
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Underground Cables and Overhead line Design</b> | <b>9 Hrs.</b> | <b>CO2</b> |
| Underground Cables: Overview on Construction and Classification of Cables, Dielectric stresses in single core cable, Importance of grading of cables.<br>Mechanical Design of Overhead lines: Main components of overhead lines, Calculation of sag for equal and unequal supports, effect of ice and wind loading (with its numerical).<br>Overhead Line Insulators: Types of insulators (Pin type, Post Insulator, Suspension type, Strain type, Shackle type) their construction and their applications. Potential distribution over suspension insulators, String efficiency, (Numerical on string efficiency and up to four discs), Methods of improving string efficiency (Descriptive treatment only).                                    |                                                    |               |            |
| <b>Exemplars / Practical Applications and usage:</b> Urban power distribution, connecting renewable energy projects like solar/wind farms, Transmission line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                    |               |            |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Transmission Line Parameters</b>                | <b>9 Hrs.</b> | <b>CO3</b> |
| Resistance, Skin and proximity effect., Inductance- Internal and external flux linkages of single conductor, Inductance of single phase two wire line, Concept of Inductance of three phase line with symmetrical and unsymmetrical spacing with transposition, Necessity of transposition, Inductance of bundled conductors. Capacitance- Electric potential at single charged conductor, Potential at conductor in a group of charged conductors, Capacitance of single-phase line (with and without effect of earth's surface), need of transposition for capacitance calculations, Capacitance of three phase line with symmetrical and unsymmetrical spacing with transposition, Concept of G.M.R and G.M.D for inductance and capacitance. |                                                    |               |            |
| <b>Exemplars / Practical Applications and usage:</b> Power System Modeling & Analysis, Transmission line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                    |               |            |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Performance of Transmission Line</b>            | <b>9 Hrs.</b> | <b>CO4</b> |
| Classification of lines based on length and voltage levels such as short, medium and long lines, Performance of short transmission lines with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal $\pi$ ' and 'Nominal T' circuits using R, L and C parameters.<br>Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of efficiency and regulation of short and medium lines. Ferranti effect.                                                                                                                                                                                                                                                     |                                                    |               |            |
| <b>Exemplars / Practical Applications and usage:</b> Designing, Operating, and Maintaining power system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                    |               |            |
| <b>Unit 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Distribution System</b>                         | <b>9 Hrs.</b> | <b>CO5</b> |
| Classification of supply systems, AC Distribution System: Types of primary and secondary distribution systems, Economics of power transmission: Economic choice of conductor (Kelvin's law). Distribution Feeders: Radial and ring types of primary feeder's voltage levels. Components of Distribution Substation and Busbar Layouts.                                                                                                                                                                                                                                                                                                                                                                                                           |                                                    |               |            |
| <b>Exemplars / Practical Applications and usage:</b> Residential & Commercial Power Supply, Industrial Power Distribution, Renewable Energy Integration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                    |               |            |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                    |               |            |
| 1. V. K. Mehta, Rohit Mehta, "Principles of Power System", S. Chand Publication.<br>2. J. B. Gupta, "Transmission and Distribution", S. K. Kataria and Sons, New Delhi.<br>3. J. B. Gupta, "Generation and Economic Considerations. K. Kataria & Sons, New Delhi.<br>4. Dr. B. R. Gupta, "Generation of Electrical Energy", S. Chand Publication.<br>5. A Chakraborty, M. L. Soni, P.V. Gupta, U. S. Bhatnagar, "A textbook on Power System Engineering", Dhanpat rai & Co, Delhi.<br>6. S. N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India.                                                                                                                                                        |                                                    |               |            |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                    |               |            |
| 1. Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                    |               |            |



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2. D. Das, "Electrical Power System", New Age Publication
3. W. D. Stevenson, "Power System Analysis", Tata McGraw Hill Publications.
4. M. V. Deshpande, "Elements of Power Station Design", Wheeler Publishing.
5. I.J. Nagrath and D. P. Kothari, "Modern Power System Analysis", Tata McGraw Hill

**MOOCs Links and additional reading material:**

1. NPTEL course on Power System Engineering, IIT Kharagpur  
<https://nptel.ac.in/courses/108/105/108105104/>
2. NPTEL course on Power System Analysis, IIT Kharagpur  
<https://nptel.ac.in/courses/108/105/108105067/>
3. NPTEL Power System Analysis, IIT Kharagpur  
<https://www.youtube.com/playlist?list=PLRWKj4sFG7-6gWwDMLI0Wy5DDRqyKP1uQ>
4. MAHADISCOM Website for tariff:  
<https://wss.mahadiscom.in/wss/wss?uiActionName=getEnergyBillCalculator>

\*Add additional rows as per requirement

**Strength of CO-PO-PSO Mapping**

| CO   | PO1 | PO2 | PO3 | PO4 | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|-----|-----|------|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 3   | 3   | 2   | 2   | 2    | 2   | 2   | -   | 1   | 2    | 2    | 1    | 2    | -    |
| CO2  | 3   | 3   | 3   | 3   | -    | 2   | 2   | -   | -   | -    | 2    | -    | 3    | -    |
| CO3  | 3   | 3   | 3   | 3   | -    | -   | -   | -   | -   | -    | 2    | 1    | 2    | -    |
| CO4  | 3   | 3   | 3   | 3   | 1    | 2   | 2   | -   | -   | 2    | 2    | 2    | 3    | -    |
| CO5  | 3   | 3   | 2   | 2   | 2    | 2   | 2   | -   | -   | 2    | 2    | 2    | 2    | -    |
| Avg. | 3   | 3   | 2.6 | 2.6 | 1.67 | 2   | 2   | -   | 1   | 2    | 2    | 1.5  | 2.40 | -    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam  | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|-------|-------|-------|-------|-------|-------|
| CCE 1 | 8     | 8     | -     | -     | -     |
| CCE 2 | -     | -     | 8     | 8     | --    |
| CCE 3 | -     | -     | -     | -     | 8     |
| ESE   | 12    | 12    | 12    | 12    | 12    |
| Total | 20    | 20    | 20    | 20    | 20    |

**Assessment Pattern**

| BT Level | CCE |     |     |     |     | ESE |     |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          | CO1 | CO2 | CO3 | CO4 | CO5 | CO1 | CO2 | CO3 | CO4 | CO5 |
|          | 8   | 8   | 8   | 8   | 8   | 12  | 12  | 12  | 12  | 12  |
| L1       | √   | √   | √   | √   | √   | √   | √   | √   | √   | √   |
| L2       | √   | √   | √   | √   | √   | √   | √   | √   | √   | √   |
| L3       | -   | √   | √   | √   | -   | -   | √   | √   | √   | -   |
| L4       | -   | -   | -   | √   | -   | -   | -   | -   | √   | -   |
| L5       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| L6       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

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This course serves as a prerequisite for maps with the following future courses:

- Power System Operation & Control
- Switchgear & Protection
- High Voltage Engineering
- Smart Grid Technology
- Renewable Energy Systems
- Industrial Power Distribution
- Energy Management & Audit
- Power Quality Engineering

Job Mapping:

After studying this course, students will be able to work in the following job roles/sectors:

- Transmission Line Engineer
- Distribution System Engineer
- Substation Engineer
- Electrical Maintenance Engineer
- Site Engineer (Electrical)
- Electrical Design Engineer
- Utility Engineer in Power Distribution Companies
- Testing & Commissioning Engineer
- Operation & Maintenance Engineer
- Energy Audit Assistant
- Junior Engineer (Electrical) in Government/Private Utilities

Job opportunities that one can get after learning this course:

- The course also supports career opportunities in power generation plants, transmission utilities, distribution companies, renewable energy sectors, and industrial electrical installations.

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                     |        |                    |     |                |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------|--------|--------------------|-----|----------------|----|
| Program:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           | S. Y. B. Tech       |        | Semester:          |     | I              |    |
| Course:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           | Applied Mathematics |        | Course Code:       |     | R25-EE-MDM-204 |    |
| Teaching Scheme (Hrs./Week)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                     |        | Examination Scheme |     |                |    |
| Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Practical | Tutorial            | Credit | CCE                | ESE | TW             | PR |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | --        | --                  | 03     | 40                 | 60  | --             | -- |
| <b>Course Description</b><br>This course, Applied Mathematics provides essential mathematical tools for electrical engineering applications with focus on signal processing, system modeling, and autonomous systems. It covers probability, statistics, differential equations, and transform techniques such as Laplace, Fourier, and Z-transforms. The course helps students analyze signals, model dynamic systems, and handle uncertainty in engineering problems.                                                                                                                                                           |           |                     |        |                    |     |                |    |
| <b>Course Relevance</b><br>This course is essential for Electrical Engineering as it builds the mathematical foundation required for analyzing signals, modeling systems, and designing control and autonomous systems. It directly supports subjects such as control systems, signal processing, communication, and modern intelligent electrical systems. The concepts of probability, statistics, differential equations, and transforms (Laplace, Fourier, and Z-transform) are widely used in understanding system behavior, processing data, and solving real engineering problems in both continuous and discrete domains. |           |                     |        |                    |     |                |    |
| <b>Prerequisite:</b> <ul style="list-style-type: none"><li>• Engineering Mathematics (especially calculus and basic differential equations)</li><li>• Basic algebra and trigonometry</li><li>• Fundamentals of electrical circuits</li><li>• Basic knowledge of complex numbers and functions</li></ul>                                                                                                                                                                                                                                                                                                                           |           |                     |        |                    |     |                |    |
| <b>Bridge Content</b><br><br>To prepare students for this course, the following revision topics are recommended: <ul style="list-style-type: none"><li>• Basics of calculus (limits, differentiation, integration)</li><li>• Introduction to differential equations (first-order basics)</li><li>• Complex numbers and their operations</li><li>• Basic probability concepts</li><li>• Matrix and algebra fundamentals</li><li>• Elementary circuit concepts (Ohm’s law, KCL, KVL)</li></ul>                                                                                                                                      |           |                     |        |                    |     |                |    |
| <b>Course Objectives:</b><br><br>The objectives of this course are to: <ul style="list-style-type: none"><li>• Provide mathematical foundations required for analysis of electrical and autonomous systems.</li><li>• Develop understanding of probability and statistics for handling uncertainty and data analysis.</li><li>• Enable students to analyse signals in time and frequency domains using Laplace, Fourier, and Z-transforms.</li></ul>                                                                                                                                                                              |           |                     |        |                    |     |                |    |

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- Build skills to model and solve higher-order linear differential equations in engineering systems.
- Prepare students to apply mathematical tools in signal processing, system modelling, and control applications.

**Course Outcomes:** On completion of the course, learner will be able to :-

| CO  | Course Outcome                                                                                               | Bloom's Level |
|-----|--------------------------------------------------------------------------------------------------------------|---------------|
| CO1 | <b>Apply</b> probability concepts to model and analyze uncertainty in engineering systems.                   | 3             |
| CO2 | <b>Use</b> statistical methods to interpret, analyze, and model engineering data effectively.                | 3             |
| CO3 | <b>Apply</b> Laplace transform techniques to analyze and solve differential equations in electrical systems. | 3             |
| CO4 | <b>Analyze</b> signals in time, frequency, and discrete domains using Fourier and Z-transform methods.       | 3             |
| CO5 | <b>Solve</b> higher-order linear differential equations to model and understand dynamic engineering systems. | 3             |

| Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |        |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------|-----|
| Unit 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Probability Theory         | 9 Hrs. | CO1 |
| Random experiments and events; axioms of probability; conditional probability and Bayes' theorem; random variables (discrete and continuous); expectation, variance, and standard deviation, probability distributions (Binomial, Poisson, Normal); Hypothesis using chi-square, Z-test, T-test.                                                                                                                                                                                                                                                                            |                            |        |     |
| <b>Exemplars / Practical Applications, Usage:</b> <ul style="list-style-type: none"> <li>□ <b>Probability distributions</b> are used to analyze uncertainty in signals, system performance, and component behavior in electrical engineering.</li> <li>□ <b>Hypothesis testing</b> is used to make decisions about system accuracy, performance, and quality based on experimental data.</li> </ul>                                                                                                                                                                         |                            |        |     |
| <b>Assignments:</b> <ol style="list-style-type: none"> <li>1. Probability theory is used to model uncertainty in electrical systems such as noise, signal variation, and component failures.</li> <li>2. Binomial distribution is used to model the number of bit errors in digital communication systems, Poisson distribution is used to represent rare events such as noise spikes and packet arrivals in communication networks, Normal distribution is used to model continuous variations like thermal noise and measurement errors in electrical signals.</li> </ol> |                            |        |     |
| Unit 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Statistics & Data Analysis | 9 Hrs. | CO2 |
| Measures of central tendency (mean, median, mode); measures of dispersion (variance, standard deviation); correlation coefficient; linear regression; Moments, skewness, kurtosis.                                                                                                                                                                                                                                                                                                                                                                                          |                            |        |     |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                     |               |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|---------------|------------|
| <b>Exemplars / Practical Applications, Usage:</b>                                                                                                                                                                                                                                                                                                                                                                               |                                                     |               |            |
| <p>□ <b>Measures of dispersion</b> (range, variance, standard deviation) are used to quantify the spread of electrical signals or noise levels around the mean value in circuit and communication systems.</p> <p>□ <b>Linear regression</b> is used to model and predict the relationship between electrical parameters (e.g., voltage vs current) for system design and performance estimation.</p>                           |                                                     |               |            |
| <b>Assignments:</b>                                                                                                                                                                                                                                                                                                                                                                                                             |                                                     |               |            |
| <p>1. Measures of dispersion are used to analyze the spread of electrical data such as voltage, current, and noise signals.</p> <p>2. Moments are used to describe statistical properties of electrical signals such as mean and variance, Skewness is used to measure asymmetry in signal or noise distributions, Kurtosis is used to identify the presence of peaks or extreme values in electrical signal distributions.</p> |                                                     |               |            |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Laplace Transform</b>                            | <b>9 Hrs.</b> | <b>CO3</b> |
| Definition of Laplace transform; properties of Laplace transform; inverse Laplace transform; Laplace transform of standard functions; application to linear differential equations; transfer function.                                                                                                                                                                                                                          |                                                     |               |            |
| <b>Exemplars / Practical Applications, Usage:</b>                                                                                                                                                                                                                                                                                                                                                                               |                                                     |               |            |
| <p>□ <b>Laplace Transform</b> is used in circuit analysis to handle initial conditions directly while solving for voltages and currents.</p> <p>□ <b>Laplace Transform</b> is used to model and analyze dynamic systems like motors, generators, and feedback control systems.</p>                                                                                                                                              |                                                     |               |            |
| <b>Assignments:</b>                                                                                                                                                                                                                                                                                                                                                                                                             |                                                     |               |            |
| <p>1. Laplace Transform is used to solve differential equations representing electrical circuits and control systems.</p> <p>2. Laplace Transform is used to solve differential equations representing electrical circuits and control systems.</p>                                                                                                                                                                             |                                                     |               |            |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Fourier and Z-Transform</b>                      | <b>9 Hrs.</b> | <b>CO4</b> |
| Fourier transform; properties of Fourier transform; discrete-time signals; Z-transform; properties of Z-transform; region of convergence; inverse Z-transform, Wavelet transform (Introductory), optimization technique (Introductory)                                                                                                                                                                                          |                                                     |               |            |
| <b>Exemplars / Practical Applications, Usage:</b>                                                                                                                                                                                                                                                                                                                                                                               |                                                     |               |            |
| <p>□ <b>Fourier Transform</b> is used to convert time-domain electrical signals into frequency-domain representation for analyzing signal spectra in communication systems.</p> <p>□ <b>Z-Transform</b> is used to analyze discrete-time signals and systems in digital signal processing and digital communication.</p>                                                                                                        |                                                     |               |            |
| <b>Assignments:</b>                                                                                                                                                                                                                                                                                                                                                                                                             |                                                     |               |            |
| <p>1. Fourier Transform is used in power systems to detect harmonics and waveform distortion.</p> <p>2. Z-Transform is used to solve difference equations in digital filters and sampled-data systems.</p>                                                                                                                                                                                                                      |                                                     |               |            |
| <b>Unit 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Linear Differential Equations – Higher Order</b> | <b>9 Hrs.</b> | <b>CO5</b> |
| Linear differential equations of higher order; complementary function; particular integral by Shortcut method (Five cases) and method of variation of parameters. Applications in electrical engineering (RLC circuits, transient analysis, and dynamic system modeling).                                                                                                                                                       |                                                     |               |            |
| <b>Exemplars / Practical Applications, Usage:</b>                                                                                                                                                                                                                                                                                                                                                                               |                                                     |               |            |
| □ <b>Linear differential equations</b> are used to determine current and voltage responses in circuits subjected to                                                                                                                                                                                                                                                                                                             |                                                     |               |            |

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step, impulse, or sinusoidal inputs.

- **Linear differential equations** are used to model and analyze transient and steady-state behavior of electrical circuits such as RC, RL, and RLC circuits.

#### Assignments:

1. Linear differential equations are used in signal processing to describe how electrical systems respond to input signals, aiding in the design of filters and communication systems.
2. Linear differential equations are used in electrical engineering to model the behavior of circuits such as RC, RL, and RLC circuits, where they describe the relationship between voltage and current over time for analyzing transient and steady-state responses.

#### Course Projects:

1.----

#### Textbooks:

- E. Kreyszig, Advanced Engineering Mathematics, 10th ed. Hoboken, NJ, USA: Wiley, 2011, ISBN: 978-0470458365.
- B. S. Grewal, Higher Engineering Mathematics, 44th ed. New Delhi, India: Khanna Publishers, 2018, ISBN: 978-9352605958.
- D. G. Zill, Advanced Engineering Mathematics, 6th ed. Burlington, MA, USA: Jones & Bartlett Learning, 2018, ISBN: 978-1284206241.
- P. V. O'Neil, Advanced Engineering Mathematics, 7th ed. Boston, MA, USA: Cengage Learning, 2012, ISBN: 978-1133109037.
- R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3rd ed. New Delhi, India: Narosa Publishing House, 2009, ISBN: 978-8173197819.

#### Reference Books:

- R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5th ed. New Delhi, India: Narosa Publishing House, 2016, ISBN: 978-9384588861.
- H. K. Dass and Er. Rajnish Verma, Engineering Mathematics, 2nd ed. New Delhi, India: S. Chand Publishing, 2014, ISBN: 978-8121927810.
- M. P. Attenborough, Mathematics for Electrical Engineering and Computing. Oxford, UK: Newnes (Elsevier), 2003, ISBN: 978-0750657727.

#### MOOCs /NPTEL Links and additional reading material:

1. **Probability Theory:** By Prof. Abhay Gopal Batt , IIT Delhi.  
<https://youtu.be/dHdAk0UlrE?si=mtfuiJYUjDBipVtO>
2. **Statistics & Data Analysis :** By Prof. By Prof. Abhay Gopal Batt , IIT Delhi  
[https://youtu.be/1wHaJQ\\_I57M?si=1oh7-4yClabwY4-b](https://youtu.be/1wHaJQ_I57M?si=1oh7-4yClabwY4-b)
3. **Laplace Transform :** By Prof. Indrava Roy , IIT Mumbai.  
<https://youtu.be/d7NF-8vVv4?si=5By-Vg6VsJh0gi0V>



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4. **Fourier and Z-Transform** :By Dr.S.K.Gupta , IIT Roorkee.  
<https://youtu.be/HoGNkZclxDU?si=zN5R4VzRUdFNFr8h>
5. **Linear Differential Equations –Higher Order**:By Prof. A.K.Nandkumar , IIS Bangalore.  
[https://youtu.be/NICU-9kudkQ?si=GFvalF\\_dzMP6m1wC](https://youtu.be/NICU-9kudkQ?si=GFvalF_dzMP6m1wC)

| Strength of CO-PO-PSO Mapping |             |             |     |     |     |     |             |             |             |      |             |
|-------------------------------|-------------|-------------|-----|-----|-----|-----|-------------|-------------|-------------|------|-------------|
| CO                            | PO1         | PO2         | PO3 | PO4 | PO5 | PO6 | PO7         | PO8         | PO9         | PO10 | PO11        |
| CO1                           | 3           | 3           | -   | -   | -   | -   | 2           | 2           | 1           | -    | 2           |
| CO2                           | 3           | 3           | -   | -   | -   | -   | 2           | 2           | 1           | -    | 2           |
| CO3                           | 2           | 2           | -   | -   | -   | -   | 2           | 2           | 1           | -    | 2           |
| CO4                           | 3           | 3           | -   | -   | -   | -   | 2           | 2           | 1           | -    | 2           |
| CO5                           | 2           | 2           | -   | -   | -   | -   | 2           | 2           | 1           | -    | 2           |
| <b>Avg.</b>                   | <b>2.60</b> | <b>2.60</b> | -   | -   | -   | -   | <b>2.00</b> | <b>2.00</b> | <b>1.00</b> | -    | <b>2.00</b> |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

#### Assessment Pattern

| BT Level | CCE |     |             |                |                             |                          | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
|          | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. |     |
| K1       | ✓   | ✓   | ✓           | ---            | ✓                           | ✓                        | ✓   |
| K2       | ✓   | ✓   | ✓           | ---            | ✓                           | ---                      | ✓   |
| K3       | ✓   | ✓   | ✓           | ---            | ✓                           | ---                      | ✓   |
| K4       | --- | --- | ---         | ---            | ---                         | ---                      | --- |
| K5       | --- | --- | ---         | ---            | ---                         | ---                      | --- |
| K6       | --- | --- | ---         | ---            | ---                         | ---                      | --- |

#### Assessment Table:

| EXAM                                | Assessment tool             | CO1       | CO2       | CO3       | CO4       | CO5       |
|-------------------------------------|-----------------------------|-----------|-----------|-----------|-----------|-----------|
| Knowledge and Attitude Profile (WK) |                             | ----      | ----      | ----      | ----      | ----      |
| CCE                                 | CT1                         | 08        | 08        | ----      | ----      | ----      |
|                                     | CT2                         | ----      | ----      | 08        | 08        | ----      |
|                                     | Assignments                 | ----      | ----      | ----      | ----      | ----      |
|                                     | Course Project              | ----      | ----      | ----      | ----      | ----      |
|                                     | Field Activity / Case Study | ----      | ----      | ----      | ----      | 04        |
|                                     | Quiz / Presentation etc.    | ----      | ----      | ----      | ----      | 04        |
| ESE                                 | 60                          | 12        | 12        | 12        | 12        | 12        |
| <b>Total</b>                        | <b>100</b>                  | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> |

#### Unit wise Weightage:

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| Exam                                            | Unit1     | Unit2     | Unit3     | Unit4     | Unit5     |
|-------------------------------------------------|-----------|-----------|-----------|-----------|-----------|
| CT1                                             | 8         | 8         | ---       | ---       | ---       |
| CT2                                             | ---       | ---       | 8         | 8         | ---       |
| Assessment by Teacher<br>by using any two tools | ---       | ---       | ---       | ---       | 8         |
| ESE                                             | 12        | 12        | 12        | 12        | 12        |
| <b>Total</b>                                    | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> | <b>20</b> |

This course serves as a prerequisite for / maps with the following future courses:

1. Modeling and simulation
2. Real-world data analysis
3. Mechanical/electrical system design
4. Advanced software tools like MATLAB, ANSYS, CFD, and ML algorithms
5. **GATE Exam/ CAT Exam /Aptitude Tests**

**Job Mapping:**

Job opportunities that one can get after learning this course:

1. Applied Mathematician
2. Computational Scientist
3. Numerical Analyst
4. Data Analyst
5. Tool Design Engineer



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------|---------------------------|---------------------|------------|------------------------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                     | <b>S. Y. B. Tech</b>         |               | <b>Semester:</b>          |                     | <b>III</b> |                        |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                     | <b>Engineering Economics</b> |               |                           | <b>Course Code:</b> |            | <b>R25-EE-HSSM-206</b> |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                     |                              |               | <b>Examination Scheme</b> |                     |            |                        |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Practical</b>                                                                                                                                                                    | <b>Tutorial</b>              | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>          | <b>TW</b>  | <b>PR</b>              |
| 01 Hr                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 02 Hr                                                                                                                                                                               | ---                          | 2             | 25                        | ---                 | 25         | ----                   |
| <b>Course Description and Relevance:</b> Engineering Economics is an interdisciplinary course that integrates engineering principles with economic and financial analysis for effective decision-making in engineering and industrial applications. The course provides fundamental knowledge of cost analysis, time value of money, capital budgeting, financial management, market structures, and industrial economics. It enables students to evaluate the economic feasibility and profitability of engineering projects using analytical and practical approaches.                                                                                                                                                                               |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Prerequisite:</b><br>1. Basic Mathematics, Basic Economics, General Engineering Knowledge                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Bridge Content:</b><br>1. Basic concepts of Mathematics used in economic calculations (percentage, ratio, simple equations, logarithms, and interest calculations).<br>2. Basics of financial transactions, banking, loans, and investment concepts relevant to engineering economics.<br>3. Overview of engineering projects and industrial processes for understanding economic decision-making applications.                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Course Objectives:</b> The course aims to<br>1. Provide students with a fundamental understanding of engineering economics concepts and economic decision-making tools used in engineering applications.<br>2. Develop the ability to evaluate engineering projects using cost estimation, depreciation analysis, capital budgeting techniques, and financial resources.<br>3. Impart knowledge of market structures, pricing strategies, government policies, taxation, accounting principles, and financial analysis for effective managerial decision-making.<br>4. Familiarize students with engineering ethics, sustainability, industrial development, entrepreneurship, and emerging economic trends relevant to modern engineering practice |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Course Outcome</b>                                                                                                                                                               |                              |               |                           |                     |            | <b>Bloom's Level</b>   |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Explain</b> fundamental concepts of engineering economics, cost analysis, time value of money, and economic decision-making for engineering applications.                        |                              |               |                           |                     |            | 2                      |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Apply</b> cost estimation, depreciation methods, capital budgeting techniques, and sources of finance for evaluating engineering investments and projects.                       |                              |               |                           |                     |            | 3                      |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Analyze</b> market structures, pricing strategies, government policies, taxation, accounting principles, and financial performance for engineering and industrial organizations. |                              |               |                           |                     |            | 4                      |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Evaluate</b> engineering decisions considering ethics, sustainability, industrial economics, innovation, entrepreneurship, and emerging economic trends.                         |                              |               |                           |                     |            | 4                      |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Fundamentals of Engineering Economics</b>                                                                                                                                        |                              |               |                           | <b>4 Hrs.</b>       | <b>CO1</b> |                        |
| <b>Basic Concepts:</b> Definition of Engineering Economics, Importance of Engineering Economics in Decision Making, Cost Estimation, Investment Analysis, Profitability Assessment, Optimization of Resources, Risk Management, Engineering Economics vs. Traditional Economics, Principles and Applications of Engineering Economics in Various Fields.                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Industrialization and Economic Development:</b> Role of Engineers in Economic Growth.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Cost Concepts:</b> Fixed, Variable, Marginal, Sunk and Opportunity Costs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Time Value of Money:</b> Present Worth, Future Worth, Annuities and Compounding Techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |
| <b>Break-even Analysis:</b> Cost-Volume-Profit Analysis, Contribution Margin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                     |                              |               |                           |                     |            |                        |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------|-------------|
| Exemplars / Practical Applications and usage: Manufacturing cost estimation , Product pricing analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                               |               |             |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Cost Estimation, Capital Budgeting and Finance</b>         | <b>4 Hrs.</b> | <b>CO2</b>  |
| <b>Cost Estimation Techniques:</b> Direct and Indirect Costs.<br><b>Depreciation Methods:</b> Straight Line, Declining Balance and Sum of Years' Digits.<br><b>Capital Budgeting:</b> Payback Period, Net Present Value (NPV), Internal Rate of Return (IRR)<br><b>Replacement Analysis:</b> Economic Life and Useful Life of Equipment.<br><b>Sources of Finance:</b> Equity, Debt, Venture Capital and Working Capital Management.                                                                                                                                                                              |                                                               |               |             |
| Exemplars / Practical Applications and usage: Bank loan EMI calculations ,Production break-even analysis<br>Investment feasibility analysis, Machine replacement decision using NPV and IRR                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                               |               |             |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Market Structures, Government Policies and Accounting</b>  | <b>4 Hrs.</b> | <b>CO 3</b> |
| <b>Types of Market Structures:</b> Perfect Competition, Monopoly, Oligopoly and Monopolistic Competition.<br><b>Pricing Strategies:</b> Cost-Based Pricing, Market-Based Pricing, Penetration Pricing, Skimming Pricing, Power Sector Market Structures.<br><b>Government Policies and Taxation:</b> GST, Income Tax, Corporate Tax, Incentives for Industries. (only overview)<br><b>Inflation and Its Impact on Engineering Projects.</b><br><b>Basic Accounting Principles:</b> Balance Sheet, Profit and Loss Statement, Cash Flow.<br><b>Financial Ratios:</b> Liquidity, Profitability and Solvency Ratios. |                                                               |               |             |
| Exemplars / Practical Applications and usage:<br>Calculation of GST and taxation impact on product pricing and project cost estimation. Case study on inflation effects in construction, manufacturing, and infrastructure engineering projects.                                                                                                                                                                                                                                                                                                                                                                  |                                                               |               |             |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Engineering Ethics, Sustainability and Emerging Trends</b> | <b>3 Hrs.</b> | <b>CO4</b>  |
| <b>Public Sector vs. Private Sector Enterprises.</b><br><b>Engineering Ethics and Professionalism:</b> Corporate Social Responsibility (CSR), Sustainable Development.<br><b>Emerging Trends in Engineering :</b> Green Economics and Circular Economy, Economy and Sustainable Business Practices, Industry 4.0 and Economic Impacts., Startup and Innovative Economics.                                                                                                                                                                                                                                         |                                                               |               |             |
| Exemplars / Practical Applications and usage: Startup feasibility analysis, Sustainable manufacturing case study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                               |               |             |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                               |               |             |
| 1.Engineering Economics by R. Panneerselvam Publisher- PHI learning private limited<br>2.Fundamentals of Engineering Economics (2nd Edition) by Chan S. Park<br>3. Principles of Engineering Economic Analysis by John A. White, Kenneth E. Case, and David B. Pratt                                                                                                                                                                                                                                                                                                                                              |                                                               |               |             |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                               |               |             |
| 1. Principles of Engineering Economy by Eugene L. Grant<br>2. Applied Economic Analysis for Technologists, Engineers, and Managers by Michael S. Bowman<br>3. Engineering Economy: Analysis of Capital Expenditures by Gerald W. Smith<br>4. Engineering Economics for Capital Investment Analysis by Tung Au and Thomas P. Au<br>5.Schaum's Outline of Engineering Economics by Jose A. Sepulveda and William E. Souder                                                                                                                                                                                          |                                                               |               |             |
| <b>e-Books :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                               |               |             |
| 1. Engineering Economics – Open Textbook, by Schmid & Vanderby<br>2. Engineering Economy (7th Edition) by William G. Sullivan, Elin M. Wicks and C. Patrick Koelling.<br>3. Fundamentals of Engineering Economics (4th Edition), by Chan S. Park                                                                                                                                                                                                                                                                                                                                                                  |                                                               |               |             |
| <b>MOOCs Links and additional reading material:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                               |               |             |
| 1. <a href="https://www.youtube.com/watch?v=84Ejjd9YP8I&amp;t=1s">https://www.youtube.com/watch?v=84Ejjd9YP8I&amp;t=1s</a> :Engineering Economic Analysis –NPTEL (IIT Roorkee) by Prof. Pradeep K. Jha                                                                                                                                                                                                                                                                                                                                                                                                            |                                                               |               |             |

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2. [https://www.youtube.com/playlist?list=PLJoALJA\\_KMOCRRx-0Di7hTJj2vI2XnYNT](https://www.youtube.com/playlist?list=PLJoALJA_KMOCRRx-0Di7hTJj2vI2XnYNT) : Construction Economics & Finance – NPTEL (IIT Guwahati) by Dr. Bulu Pradhan  
 3. <https://www.youtube.com/watch?v=9aX-4xp3oq8> : Basic concepts of Engineering Economy, SWAYAM Prabha IIT Madras Channels

**List of Practical: Perform any 8 experiments listed below. Experiment no.5,10 and experiment no. 12 are Compulsory.**

|                        |                                                        |               |               |
|------------------------|--------------------------------------------------------|---------------|---------------|
| <b>Experiment No.1</b> | Study of Engineering Cost Concepts and Cost Estimation | <b>CO 1,2</b> | <b>2 Hrs.</b> |
|------------------------|--------------------------------------------------------|---------------|---------------|

Objective: To understand various engineering cost concepts and perform cost estimation for engineering products or projects.

Associated Tasks:

1. Classify fixed, variable, direct, indirect, sunk, and opportunity costs.
2. Prepare cost estimation sheet for a simple engineering application.

Exemplars and Utility:

1. Manufacturing cost analysis for electrical/electronic products.
2. Budget planning and pricing decisions in industries.

|                        |                                                                   |             |               |
|------------------------|-------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.2</b> | To Analyze Electrical Energy Billing and Energy Cost Optimization | <b>CO 2</b> | <b>2 Hrs.</b> |
|------------------------|-------------------------------------------------------------------|-------------|---------------|

Objective: To analyze electricity bills and evaluate energy consumption from an economic perspective.

Associated Tasks:

1. Study tariff structure and calculate electricity consumption charges.
2. Analyze methods for reducing electrical energy cost and improving efficiency.

Exemplars and Utility:

1. Domestic and industrial electricity bill analysis.
2. Energy conservation and cost optimization planning.

|                        |                                                                 |               |               |
|------------------------|-----------------------------------------------------------------|---------------|---------------|
| <b>Experiment No.3</b> | To analyze Time Value of Money Analysis using Spreadsheet Tools | <b>CO 1,2</b> | <b>2 Hrs.</b> |
|------------------------|-----------------------------------------------------------------|---------------|---------------|

Objective: To analyze the time value of money using spreadsheet tools for engineering economic decisions.

Associated Tasks:

1. Calculate Present Worth (PW) and Future Worth (FW) values.
2. Perform EMI and compound interest calculations using spreadsheets.

Exemplars and Utility:

1. Loan repayment and investment planning analysis.
2. Financial planning for equipment procurement and industrial projects.

|                        |                                                                  |             |               |
|------------------------|------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.4</b> | To determine Break-even Analysis and Cost-Volume-Profit Analysis | <b>CO 1</b> | <b>2 Hrs.</b> |
|------------------------|------------------------------------------------------------------|-------------|---------------|

Objective: To determine break-even point and analyze profitability using cost-volume-profit relationships.

Associated Tasks:

1. Calculate contribution margin and break-even point.
2. Plot break-even graph using spreadsheet tools.

Exemplars and Utility:

1. Production planning and sales target analysis.
2. Profitability evaluation of engineering manufacturing units.

|                        |                                                             |             |               |
|------------------------|-------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.5</b> | To calculate Depreciation Calculation using Various Methods | <b>CO 2</b> | <b>2 Hrs.</b> |
|------------------------|-------------------------------------------------------------|-------------|---------------|

Objective: To calculate depreciation of engineering assets using different depreciation methods.

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-------------|---------------|
| <p>Associated Tasks:</p> <ol style="list-style-type: none"> <li>1. Compute depreciation using Straight Line Method and Declining Balance Method.</li> <li>2. Compare depreciation values obtained by different methods.</li> </ol> <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> <li>1. Financial valuation of industrial equipment and machinery.</li> <li>2. Asset replacement and maintenance planning.</li> </ol>                                                                                                |                                                                    |             |               |
| <b>Experiment No.6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | To Evaluate Capital Budgeting using NPV, IRR and Payback Period    | <b>CO 2</b> | <b>2 Hrs.</b> |
| <p>Objective: To evaluate engineering investment projects using capital budgeting techniques.</p> <p>Associated Tasks:</p> <ol style="list-style-type: none"> <li>1. Calculate Net Present Value (NPV) and Internal Rate of Return (IRR).</li> <li>2. Determine Payback Period for engineering projects.</li> </ol> <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> <li>1. Economic feasibility analysis of industrial investments.</li> <li>2. Selection of profitable engineering projects and equipment.</li> </ol> |                                                                    |             |               |
| <b>Experiment No.7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Preparation and Analysis of Financial Statements of organizations. | <b>CO 2</b> | <b>2 Hrs.</b> |
| <p>Objective: To prepare and analyze basic financial statements of organizations.</p> <p>Associated Tasks:</p> <ol style="list-style-type: none"> <li>1. Prepare Balance Sheet and Profit &amp; Loss Statement.</li> <li>2. Analyze financial performance using accounting data.</li> </ol> <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> <li>1. Financial health assessment of engineering industries.</li> <li>2. Industrial accounting and business performance evaluation.</li> </ol>                            |                                                                    |             |               |
| <b>Experiment No.8</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | To Interpret Financial Ratios for Industrial Applications          | <b>CO 3</b> | <b>2 Hrs.</b> |
| <p>Objective: To evaluate industrial financial performance using financial ratio analysis.</p> <p>Associated Tasks:</p> <ol style="list-style-type: none"> <li>1. Calculate liquidity, profitability, and solvency ratios.</li> <li>2. Interpret financial condition based on ratio analysis.</li> </ol> <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> <li>1. Comparative analysis of industrial/company performance.</li> <li>2. Investment and creditworthiness evaluation.</li> </ol>                             |                                                                    |             |               |
| <b>Experiment No.9</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | To Study Market Structures and Analyze e-Tendering Systems         | <b>CO 3</b> | <b>2 Hrs.</b> |
| <p>Objective: To understand e-tendering procedures and economic aspects of engineering procurement systems.</p> <p>Associated Tasks:</p> <ol style="list-style-type: none"> <li>1. Study components and procedures of e-tendering systems.</li> <li>2. Analyze cost estimation, bidding, and procurement processes.</li> </ol> <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> <li>1. Government electrical project tender analysis.</li> <li>2. Industrial procurement and contractor bidding systems.</li> </ol>     |                                                                    |             |               |
| <b>Experiment No.10</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | To study GST and Inflation Impact Analysis on Engineering Projects | <b>CO 3</b> | <b>2 Hrs.</b> |
| <p>Objective: To study the impact of taxation and inflation on engineering project costs and profitability.</p> <p>Associated Tasks:</p>                                                                                                                                                                                                                                                                                                                                                                                                |                                                                    |             |               |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------|---------------|
| 1. Calculate GST and taxation effects on engineering products/projects.<br>2. Analyze inflation impact on project budgeting and material cost.<br>Exemplars and Utility:<br>1. Engineering project cost estimation under varying economic conditions.<br>2. Financial planning and budgeting for industrial projects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                           |               |               |
| <b>Experiment No.11</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To Conduct Techno-Economic Feasibility Analysis of Solar Power System     | <b>CO 3,4</b> | <b>2 Hrs.</b> |
| Objective: To perform techno-economic feasibility analysis of engineering projects using spreadsheet tools.<br><br>Associated Tasks:<br>1. Estimate project cost, revenue, and profitability.<br>2. Prepare spreadsheet-based feasibility report and graphical analysis.<br>Exemplars and Utility:<br>1. Feasibility analysis of solar power, EV charging, or industrial projects.<br>2. Decision-making support for engineering investments and startups.                                                                                                                                                                                                                                                                                                                                     |                                                                           |               |               |
| <b>Experiment No.12</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Case Study on Industrial Economics, Sustainability and Engineering Ethics | <b>CO 4</b>   | <b>2 Hrs.</b> |
| Objective: To understand the broader economic and social role of engineers.<br><br>Associated Tasks: <b>Activity</b> (Any One): make a Presentation and report on following<br>1. Economic impact of renewable energy projects.<br>2. Public Sector vs Private Sector enterprise comparison. Corporate Social Responsibility (CSR) practices.<br>3. Circular Economy and Green Economics.<br>4. Industry 4.0 applications in manufacturing.<br>5. Engineering ethics case study<br>Exemplars and Utility:<br>1. Techno-economic assessment of renewable energy projects, smart manufacturing systems, and sustainable industrial practices.<br>2. Analysis of ethical, environmental, and societal aspects influencing engineering decisions in modern industries and infrastructure projects. |                                                                           |               |               |

| Strength of CO-PO-PSO Mapping |                 |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-------------------------------|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| CO                            | PO <sub>1</sub> | PO2  | PO3  | PO4  | PO5  | PO6  | PO7  | PO8  | PO9  | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO <sub>1</sub>               | 2               | 2    | 1    | –    | –    | –    | –    | –    | –    | 2    | 1    | –    | 1    | –    |
| CO <sub>2</sub>               | 2               | 3    | 2    | 1    | 2    | –    | –    | –    | –    | 3    | 1    | 1    | 2    | 1    |
| CO <sub>3</sub>               | 1               | 3    | 1    | 2    | 1    | 2    | –    | –    | 1    | 3    | 1    | –    | 2    | –    |
| CO <sub>4</sub>               | –               | 2    | 1    | –    | –    | 3    | 3    | 1    | 2    | 2    | 3    | 1    | 1    | 1    |
| Avg.                          | 1.67            | 2.50 | 1.25 | 1.50 | 1.50 | 1.67 | 1.50 | 1.00 | 1.50 | 3.33 | 2.00 | 1.00 | 2.00 | 1.00 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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**Assessment Pattern**

| BT Level            | CCE  |      |       |       |
|---------------------|------|------|-------|-------|
|                     | CCE1 | CCE1 | CCE 2 | CCE 2 |
| CO                  | CO1  | CO2  | CO3   | CO4   |
| Unit wise Weightage | 6    | 6    | 6     | 7     |
| L1                  | ✓    | --   | --    | ✓     |
| L2                  | ✓    | ✓    | ✓     | ✓     |
| L3                  | ✓    | ✓    | ✓     | ✓     |
| L4                  | --   | --   | ✓     | ✓     |
| L5                  | --   | --   | --    | --    |
| L6                  | --   | --   | --    | --    |

**This course serves as a prerequisite for / maps with the following future courses:**

Entrepreneurship Development, Project Management, Industrial Management, Operations Research, Energy Management and Auditing, Renewable Energy Systems, Smart Grid and Power System Economics, MBA and Management Studies, Finance and Business Analytics related courses, Industrial Engineering and Production Management.

**Job Mapping:**

Job opportunities that one can get after learning this course: Project Engineer, Cost Estimation Engineer, Financial and Economic Analyst, Production Planning Engineer, Industrial Consultant, Operations Executive, Business Analyst, Energy Auditor, Procurement and Supply Chain Executive, Entrepreneur / Startup Founder, Project Coordinator, Techno-Economic Analyst, Industrial Management Trainee, Renewable Energy Project Analyst, Engineering Services and Administrative Roles.


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| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                   | <b>S. Y. B. Tech (Electrical Engineering)</b> |               |                           | <b>Semester:</b>    |               | <b>I</b>              |                      |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                   | <b>Universal Human Values &amp; Ethics</b>    |               |                           | <b>Course Code:</b> |               | <b>R25-EE-VEC-207</b> |                      |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                   |                                               |               | <b>Examination Scheme</b> |                     |               |                       |                      |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Practical</b>                                                                                                                                  | <b>Tutorial</b>                               | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>          | <b>TW</b>     | <b>PR</b>             |                      |
| 02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | --                                                                                                                                                |                                               | 2             | 50                        | --                  | --            | --                    |                      |
| <b>Course Description and Relevance:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Course Description</b> This course on Value Education introduces students to the process of self-exploration and understanding human values for leading a harmonious and meaningful life. It focuses on understanding the human being as the coexistence of self and body, identifying basic human aspirations, and developing harmony within oneself, in family, society, and nature. The course also emphasizes ethical living, mutual fulfilment, self-regulation, and professional ethics through a holistic perspective of existence. |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Course Relevance</b> This course on Value Education introduces students to the process of self-exploration and understanding human values for leading a harmonious and meaningful life. It focuses on understanding the human being as the coexistence of self and body, identifying basic human aspirations, and developing harmony within oneself, in family, society, and nature. The course also emphasizes ethical living, mutual fulfilment, self-regulation, and professional ethics through a holistic perspective of existence.   |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Prerequisite:</b><br>Student Induction Program (SIP)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Bridge Content: --</b><br>Basic Human Values                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Course Objectives:</b> After learning of the course students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| 1. Develop an understanding of value education through the process of self-exploration and self-awareness.                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| 2. Enable students to understand the coexistence of self and body, and to identify their basic human aspirations and needs.                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| 3. Cultivate the ability to build harmonious relationships with others based on trust, respect, and mutual understanding in family and society.                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| 4. Create awareness about the interconnectedness and harmony existing in nature and the entire existence, promoting responsible and sustainable living.                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Course Outcome</b>                                                                                                                             |                                               |               |                           |                     |               |                       | <b>Bloom's Level</b> |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Recognize</b> the concept of self-exploration as the process of value education and see they have the potential to explore on their own right. |                                               |               |                           |                     |               |                       | 2                    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Explore</b> the human being as the coexistence of self and body to see their real needs/basic aspirations clearly.                             |                                               |               |                           |                     |               |                       | 2                    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Explain</b> the relationship between oneself and the other self as the essential part of relationship and harmony in the family.               |                                               |               |                           |                     |               |                       | 2                    |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Interpret</b> the interconnectedness, harmony and mutual fulfilment inherent in nature and the entire existence.                               |                                               |               |                           |                     |               |                       | 3                    |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Introduction to Value Education</b>                                                                                                            |                                               |               |                           |                     | <b>7 Hrs.</b> | <b>CO1</b>            |                      |
| Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - the Basic Human Aspirations and their Fulfilment, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity - Current Scenario, Method to Fulfil the Basic Human Aspirations                                                                                                                                                                                                                |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Exemplars / Practical Applications and usage:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| Discussion on modern lifestyle stress despite material growth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Harmony in the Human Being</b>                                                                                                                 |                                               |               |                           |                     | <b>7 Hrs.</b> | <b>CO2</b>            |                      |
| Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                   |                                               |               |                           |                     |               |                       |                      |

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the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Program to Ensure self-regulation and Health

**Exemplars / Practical Applications and usage:**

Prepare a personal health and self-regulation plan to improve their mental and physical well-being in daily life.

|               |                                          |               |            |
|---------------|------------------------------------------|---------------|------------|
| <b>Unit 3</b> | <b>Harmony in the Family and Society</b> | <b>8 Hrs.</b> | <b>CO3</b> |
|---------------|------------------------------------------|---------------|------------|

Harmony in the Family - the Basic Unit of Human Interaction "Trust" - the Foundational Value in Relationship, 'Respect' - as the Right Evaluation, Values in Human-to-Human Relationship, Understanding Harmony in Society, Vision for the Universal Human Order

**Exemplars / Practical Applications and usage:**

List the important relationships in their life (family, friends, teachers) and identify values like trust and respect in each relationship

|               |                                          |               |            |
|---------------|------------------------------------------|---------------|------------|
| <b>Unit 4</b> | <b>Harmony in the Nature (Existence)</b> | <b>8 Hrs.</b> | <b>CO4</b> |
|---------------|------------------------------------------|---------------|------------|

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence, Professional ethics in the light of Right understanding, Strategies for transition towards Value based Life and Profession

**Exemplars / Practical Applications and usage:**

Students should conduct group activities for tree plantation/campus garden maintenance/waste segregation campaigns/water conservation awareness, and submit a brief report with photographs and observations demonstrating their contribution towards harmony with nature.

**Comprehensive Continuous Evaluation (CCE) components for the course:**

**1. Course Projects (Mini/Micro Project):**

Comprehensive Continuous Evaluation (CCE) of this course has to be done through the separate activities related to the subject syllabus.

- In order to connect the content of this course with practice, **minimum four activities (12-13 Marks each)** must be conducted with active involvement of the students from the following activities.
- The comprehensive continuous assessment should be strictly based on the participation of the students in the following activities.

**List of activities:**

**1. Exploring Human Consciousness (Unit-1)**

Watch and discuss the documentary video "Story of Stuff". It is about the materials economy – its motivation, process and outcome. (Source: <http://storyofstuff.org/movies/story-of-stuff>)

**Expected Outcome:**

The students start finding that right understanding is the basic need of human being; followed by relationship and physical facility. They also start feeling that lack of understanding of human values is the root cause

**2. Exploring right understanding (Unit-1)**

Make a list of your desires. Now for each item on the list, find out what would be necessary to fulfil it, i.e. will it require: (a) Right understanding? (b) Relationship (right feeling)? (c) Physical facility?

**Expected Outcome:**

Students start feeling that lack of understanding of human values is the root cause of all problems and the sustained solution could emerge only through understanding of human values and value-based living.



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**3. Exploring Natural Acceptance (Unit-1)**

Observation within the faculty of 'Natural Acceptance', based on which you can verify what is right or what is not right for you. Make a list of the problems in your family. For each problem, find out the most significant reason: is it related to lack of right understanding, lack of feelings in relationship or lack of physical facility? Also, find out how much time and effort you have devoted for each in the last one week.

**Expected Outcome:**

The students are able to see that self-verification must be based on their natural acceptance. In many cases, their actual living is not in accordance with their natural acceptance. In addition, lack of feeling in relationship is the major cause of problems in their family and with friends.

**4. Exploring the difference of Needs of Self and Body (Unit-2)**

Take the list of desires you made in Activity 2. Update it if required. Now classify the desires as being related to the need of the Self or need of the Body.

**Expected Outcome:**

The students are able to relate their desires to need of the Self and the Body distinctly. They are able to see that the Self and the Body are two distinct realities, and large parts of their desires are related to the need of the Self (and not the Body).

**5. Exploring Sources of Imagination in the Self (Unit-2)**

Recall the times that your body has been ill (in disharmony) in the last 3 years. What steps were taken to restore the harmony of the Body? If you were to take full responsibility for your body, (i.e. you had the feeling of self-regulation), what kind of daily schedule would you have? Approximately how much time would you allocate for keeping your body in good health?

**Expected Outcome:**

The students are able to list down activities related to proper upkeep of the Body and practice them in their daily routine. They are also able to appreciate the plants growing in and around the campus, which can be beneficial in maintaining their health and even curing common ailments.

**6. Exploring the Feeling of Trust (Unit-3)**

Show & discuss the video "Right Here Right Now". It is a short film directed by Anand Gandhi about human behaviour and its propagation. Part 1: <https://www.youtube.com/watch?v=OVAokeqQuFM> Part 2: <https://www.youtube.com/watch?v=gIYJePEEnvUY>.

**Expected Outcome:**

The students are able to see that the natural acceptance (intention) of everyone is to be happy and make others happy! It is the competence is lacking in themselves and in others. They are able to distinguish between reaction and response, appreciate the need for 100% response in human-human interaction and make effort towards it.

**7. Exploring the Feeling of Respect (Unit-3)**

List out ten or more of your interactions with other people in your family and friends in the last one week. Now analyse these interactions were over-evaluation, under/ otherwise evaluation or right evaluation of the other? In each interaction, were you comfortable within, uncomfortable within or unaware of your state?

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**Expected Outcome:**

The students are able to see that respect is the right evaluation (of intention and competence). Only right evaluation leads to fulfillment in relationship. Over evaluation leads to ego and under/otherwise evaluation leads to depression.

**8. Exploring Systems to fulfil Human Goal (Unit-3)**

Assuming that you would like to see your hostel/ educational institution/ workplace/ neighborhood as a model of human society, write down its goal(s) and the system to achieve these goals.

**Expected Outcome:**

The students are able to see that as a family, a society, the comprehensive human goal is naturally acceptable to all. They are able to see that the systems required for their fulfilment include; Education-Sanskar, Health Self-regulation, Production-Work, Justice-Preservation and Exchange-Storage. Meaningful participation by every individual, every family, every family cluster... every village, town, city... country and the whole world is required in these systems for the human goals to be fulfilled.

**9. Exploring the Four Orders of Nature (Unit-4)**

Watch and discuss the documentary video “An Inconvenient Truth”. It is about global climate change presented by Former US Vice President Al Gore. He raises the question “What were you doing when you had the time to do something?” (Source: <http://an-inconvenient-truth.com/>)

**Expected Outcome:**

The students are able to appreciate the interconnectedness, interdependence and the relationship of mutual fulfilment existing in nature. They are able to see that they have a natural acceptance to participate in a mutually fulfilling manner in nature.

**10. Exploring Co-existence in Existence (Unit-4)**

Observe your Self. Are you in space? Are you getting energy from the body? Is your energy dependent on the body? When your body is sick, does your energy to think diminish? Are you energized in space? Is the body dictating you? Are you self-organized in space?

**Expected Outcome:**

The students are able to obtain a holistic vision about the existence. It is in the form of co-existence, rather than a chaos. Every unit is energized, self-organised and is participating with other units in an orderly manner for mutual-fulfilment. It is only the human being without right understanding, which is violating this underlying co-existence. They are able to appreciate the need to understand the co-existence in existence.

**11. Exploring Ethical Human Conduct (Unit-4)**

Watch and discuss the video “Hiware Bazaar”. It is a documentary about a progressive village in Maharashtra, India about how good governance, along with the people of the village have made significant change in their society (Source: <https://www.youtube.com/watch?v=cb0Qvh9BJ0s>)

**Expected Outcome:**

The students are able to clearly visualise the co-relation between lack of Human Values and the prevailing problems. They are also able to visualise tangible steps and a roadmap for moving in the cherished direction – for a humane society.

**12. Exploring Humanistic Models in Education (Unit-4)**

By careful analysis, identify some important features to make our education more humanistic. What are the right expectations in terms of the outcome from humanistic education? Explain with justification.



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**Expected Outcome:**

The students are able to detail out various social systems essential for their own fulfilment, as well as the fulfilment of future generations. In particular, they are able to visualise the education system required for individual, and then societal transformation. They are also able to appreciate those many efforts made in the tradition that were in line with desirable human goals. Thus, they are able to learn from tradition and develop a deep sense of gratitude for the effort, for the people, for the tradition, culture etc.

**13. Exploring Steps of Transition towards Universal Human Order (Unit-4)**

Suggest ways in which you can use your knowledge of Technology/ Engineering/ Management/Medicine etc. for universal human order, from your family order to the world family order. Evaluate your state before and after the course in terms of (a) Thought (b) Behavior (c) Work (d) Realization

**Expected Outcome:**

The students are able to visualise an appropriate utilization of the knowledge in their respective streams to ensure mutually enriching and sustainable systems. They are able to sincerely evaluate the course and the transformation achieved in this process. They are also able to make use of this understanding for moving towards a happy and prosperous life, including an ethical conduct of their profession.

**Textbooks:**

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 3rd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-
2. The Teacher's Manual Teachers Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

**Reference Books:**

1. P. L. Dhar, R. R. Gaur, 1990, Science and Humanism, Commonwealth Publishers A Jaico and Charles H. Roth, "Fundamentals of Logic Design" Jr. Fourth Edition.
2. A. Nagaraj, 1999, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak
3. B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
4. A. N. Tripathy, 2003, Human Values, New Age International Publishers
5. E. G. Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University
6. B. L. Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
7. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.
8. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

**MOOCs Links and additional reading material:**

1. NPTEL Course on "Exploring Human Values: Visions of Happiness and Perfect Society" Web course by Prof. A. K. Sharma, Department of Humanities and Social Sciences, IIT Kanpur. <https://nptel.ac.in/courses/109104068>
2. Swayam Course on "Understanding Human Being Nature and Existence Comprehensively" by Dr. Kumar Sambhav, Director, UP Institute of Design (UPID), Noida.
3. Understanding Human Being Nature and Existence Comprehensively - Course


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**CO-PO-PSO Mapping**

| CO   | PO1  | PO2  | PO3 | PO4 | PO5 | PO6  | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|------|------|-----|-----|-----|------|-----|-----|------|------|------|------|------|------|
| CO1  | 1    | 1    | 2   | -   | 1   | 2    | 3   | 2   | 1    | 2    | 3    | -    | -    | -    |
| CO2  | 1    | 1    | 2   | -   | 1   | 2    | 3   | 2   | 2    | 2    | 3    | -    | -    | -    |
| CO3  | 1    | 1    | 2   | -   | 1   | 2    | 3   | 3   | 2    | 3    | 3    | -    | -    | -    |
| CO4  | 2    | 2    | 2   | -   | 1   | 3    | 3   | 3   | 2    | 3    | 3    | -    | -    | -    |
| Avg. | 1.25 | 1.25 | 2   | -   | 1   | 2.25 | 3   | 2.5 | 1.75 | 2.5  | 3    | -    | -    | -    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam         | Unit1     | Unit2     | Unit3     | Unit4     |
|--------------|-----------|-----------|-----------|-----------|
| <b>CCE</b>   |           |           |           |           |
| CCE1         | 12        | 13        |           |           |
| CCE2         |           |           | 12        | 13        |
| <b>Total</b> | <b>12</b> | <b>13</b> | <b>12</b> | <b>13</b> |

**Assessment Pattern**

| BT Level  | CCE |     |     |     |     | ESE |     |     |     |     |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|           | CO1 | CO2 | CO3 | CO4 | CO5 | CO1 | CO2 | CO3 | CO4 | CO5 |
|           | 12  | 13  | 12  | 13  | -   | -   | -   | -   | -   | -   |
| <b>L1</b> | √   | √   | √   | √   | -   | -   | -   | -   | -   | -   |
| <b>L2</b> | √   | √   | √   | √   | -   | -   | -   | -   | -   | -   |
| <b>L3</b> | -   | -   | -   | √   | -   | -   | -   | -   | -   | -   |
| <b>L4</b> | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| <b>L5</b> | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| <b>L6</b> | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

This course serves as a prerequisite for / maps with the following future courses:

1. Sustainable Development
2. Humanities and Social Sciences (HSS)

**Job Mapping:**

Job opportunities that one can get after learning this course:

1. Human Resource (HR) Specialist
2. Public Relations (PR) Manager
3. Counselor / Life Coach
4. Sustainability Consultant

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                              |                 |               |                                    |            |           |                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|------------------------------------|------------|-----------|----------------------|
| <b>Program:</b> S. Y. B. Tech Electrical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                              |                 |               | <b>Semester:</b> III               |            |           |                      |
| <b>Course:</b> Measuring Instruments & Smart Sensors Lab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                              |                 |               | <b>Course Code:</b> R25-EE-PCC-208 |            |           |                      |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                              |                 |               | <b>Examination Scheme</b>          |            |           |                      |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Practical</b>                                                                                                                                                             | <b>Tutorial</b> | <b>Credit</b> | <b>CCE</b>                         | <b>ESE</b> | <b>TW</b> | <b>PR/ OR</b>        |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 02                                                                                                                                                                           | -               | 01            | -                                  | -          | 25        | 25                   |
| <b>Course Description:</b><br>The Measuring Instruments & Smart Sensors Lab course provides practical knowledge of electrical and electronic measuring instruments, sensors, and smart sensing systems. The course focuses on hands-on experimentation with electrical and electronic measurement methodology and techniques, calibration methods, signal conditioning, and sensor interfacing used in modern automation and industrial applications. Students learn to analyze instrument performance, accuracy, and real-time data acquisition using various smart sensors and measuring devices. |                                                                                                                                                                              |                 |               |                                    |            |           |                      |
| <b>Relevance:</b><br>The <b>Measuring Instruments &amp; Smart Sensors Lab</b> is relevant for developing practical skills in Electrical and Electronics measurement, monitoring, and automation systems used in industries. It helps students understand the working of Electrical meters, modern sensors, instrumentation techniques, data acquisition, and control systems, which are essential in fields such as electronics, robotics, IoT, industrial automation, and process control.                                                                                                         |                                                                                                                                                                              |                 |               |                                    |            |           |                      |
| <b>Prerequisite:</b><br>Basic knowledge of electrical and electronic circuits, fundamentals of electrical and electronics laws, sensors and instrumentation, measurement concepts, and familiarity with laboratory safety.                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                              |                 |               |                                    |            |           |                      |
| <b>Bridge Content:</b><br>Revision of basic electrical and electronic components, measurement fundamentals, sensor principles, signal conditioning concepts, introduction to instrumentation and data acquisition systems.                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                              |                 |               |                                    |            |           |                      |
| <b>Course Objectives:</b> This course aims to <ol style="list-style-type: none"> <li>1. <b>Learn</b> the extension range of ammeter, voltmeter and wattmeter using CT &amp; PT.</li> <li>2. <b>Calculate</b> the low resistance (R) and low inductance (L)</li> <li>3. <b>Measure</b> and <b>determine</b> the active/reactive power in 3-phase circuit using one wattmeter/ two wattmeter method.</li> <li>4. <b>Calibrate</b> 1-phase static energy meter.</li> <li>5. <b>Understand</b> the applications of DSO</li> </ol>                                                                       |                                                                                                                                                                              |                 |               |                                    |            |           |                      |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                              |                 |               |                                    |            |           |                      |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Course Outcome</b>                                                                                                                                                        |                 |               |                                    |            |           | <b>Bloom's Level</b> |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Determine</b> and <b>extend</b> the range of ammeters, voltmeters, and wattmeter in electrical circuits using Current Transformers (CTs) and Potential Transformers (PTs) |                 |               |                                    |            |           | 3                    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Measure</b> the low value of resistance & inductance of a given electrical circuit using Kelvin's double bridge and Maxwell's bridge respectively.                        |                 |               |                                    |            |           | 3                    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Calculate</b> active and reactive power in three-phase balanced and unbalanced loads using one-wattmeter and two wattmeter methods.                                       |                 |               |                                    |            |           | 4                    |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Calibrate</b> a single-phase static energy meter under different power factor conditions-lagging, leading, and unity                                                      |                 |               |                                    |            |           | 3                    |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Measure</b> voltage, current, power, frequency, and analyze transient response and frequency spectrum (FFT) of electrical signals using a Digital Storage                 |                 |               |                                    |            |           | 3                    |



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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------|----------------|
| Oscilloscope (DSO).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                          |            |                |
| <b>List of Practical: Perform any eight experiments from the following list:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                          |            |                |
| <b>Experiment No. 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Extension of ammeter range using CT, voltmeter range using PT and watt meter range using CT / PT.</b> | <b>CO1</b> | <b>Hrs. 02</b> |
| <p><b>Objective:</b> To study and perform the extension of the measuring range of ammeter, voltmeter, and wattmeter using Current Transformers (CTs) and Potential Transformers (PTs) in electrical circuits.</p> <p><b>Associated Tasks:</b></p> <ul style="list-style-type: none"> <li>➤ Connect CTs and PTs properly in the circuit.</li> <li>➤ Measure current using an ammeter with CT.</li> <li>➤ Measure voltage using a voltmeter with PT.</li> <li>➤ Measure power using a wattmeter with CT/PT combination.</li> <li>➤ Calculate actual current, voltage, and power values using transformer ratios.</li> <li>➤ Compare measured and calculated readings.</li> </ul> <p><b>Exemplars :</b></p> <ul style="list-style-type: none"> <li>➤ Extension of a 5 A ammeter to measure 100 A using a CT.</li> <li>➤ Extension of a 300 V voltmeter to measure 11 kV using a PT.</li> <li>➤ Measurement of high power in industrial loads using CT/PT connected wattmeter.</li> </ul> <p><b>Utility:</b></p> <ul style="list-style-type: none"> <li>➤ Used in high-voltage and high-current power systems.</li> <li>➤ Ensures safe measurement of electrical quantities.</li> <li>➤ Widely applied in substations, industries, and power distribution systems.</li> <li>➤ Helps in accurate monitoring and protection of electrical equipment.</li> </ul> |                                                                                                          |            |                |
| <b>Experiment No. 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Measurement of low resistance using Kelvin's Double Bridge.</b>                                       | <b>CO2</b> | <b>Hrs. 02</b> |
| <p><b>Objective:</b> Accurately measures low resistance using Kelvin's Double Bridge by minimizing errors due to lead and contact resistances.</p> <p><b>Associated Tasks:</b></p> <ul style="list-style-type: none"> <li>➤ Connect the Kelvin's Double Bridge circuit correctly.</li> <li>➤ Adjust the bridge to obtain balance condition.</li> <li>➤ Measure the unknown low resistance value.</li> <li>➤ Calculate resistance using bridge equations.</li> <li>➤ Observe and analyze measurement accuracy.</li> </ul> <p><b>Exemplars:</b></p> <ul style="list-style-type: none"> <li>➤ Measurement of bus bar resistance.</li> <li>➤ Measurement of transformer winding resistance.</li> <li>➤ Testing resistance of thick conductors and electrical contacts.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                          |            |                |

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|                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                |            |                |
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| <b>Utility:</b> <ul style="list-style-type: none"> <li>➤ Enables precise measurement of very low resistances.</li> <li>➤ Reduces errors caused by connecting leads and contacts.</li> <li>➤ Used in electrical laboratories, industries, and maintenance testing.</li> <li>➤ Helps in quality assessment of electrical components.</li> </ul>                                                                         |                                                                                                                                |            |                |
| <b>Experiment No. 3</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>Measurement of inductance using Maxwell's bridge.</b>                                                                       | <b>CO2</b> | <b>Hrs. 02</b> |
| <b>Objective:</b><br>To measure the inductance of an unknown coil accurately using Maxwell's Bridge method.                                                                                                                                                                                                                                                                                                           |                                                                                                                                |            |                |
| <b>Associated Tasks:</b> <ul style="list-style-type: none"> <li>➤ Connect the Maxwell's Bridge circuit correctly.</li> <li>➤ Balance the bridge by adjusting circuit parameters.</li> <li>➤ Measure and calculate the unknown inductance.</li> <li>➤ Observe bridge balance conditions.</li> <li>➤ Analyze measurement accuracy and errors.</li> </ul>                                                                |                                                                                                                                |            |                |
| <b>Exemplars :</b> <ul style="list-style-type: none"> <li>➤ Measurement of inductance of coils and chokes.</li> <li>➤ Testing inductive components in AC circuits.</li> <li>➤ Verification of unknown inductors in laboratories.</li> </ul>                                                                                                                                                                           |                                                                                                                                |            |                |
| <b>Utility:</b> <ul style="list-style-type: none"> <li>➤ Enables accurate measurement of inductance.</li> <li>➤ Used in electrical and electronics laboratories.</li> </ul>                                                                                                                                                                                                                                           |                                                                                                                                |            |                |
| <b>Experiment No. 4</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>Study of programmable LCR meter; Measure L, C, R, Q Factor, dissipation factor, and power factor of the given component</b> | <b>CO2</b> | <b>Hrs. 02</b> |
| <b>Objective:</b> To study the programmable LCR meter and measure L, C, R, Q-factor, dissipation factor, and power factor of electrical components.                                                                                                                                                                                                                                                                   |                                                                                                                                |            |                |
| <b>Associated Tasks:</b> <ul style="list-style-type: none"> <li>➤ Operate the programmable LCR meter.</li> <li>➤ Select suitable measurement parameters and ranges.</li> <li>➤ Connect components correctly for testing.</li> <li>➤ Measure inductance, capacitance, and resistance values.</li> <li>➤ Observe Q-factor, dissipation factor, and power factor.</li> <li>➤ Record and analyze the readings.</li> </ul> |                                                                                                                                |            |                |
| <b>Exemplars :</b> <ul style="list-style-type: none"> <li>➤ Measurement of resistor, capacitor, and inductor values.</li> <li>➤ Determination of Q-factor of coils.</li> <li>➤ Analysis of capacitor dissipation factor.</li> </ul>                                                                                                                                                                                   |                                                                                                                                |            |                |
| <b>Utility:</b> <ul style="list-style-type: none"> <li>➤ Enables accurate testing of passive components.</li> <li>➤ Used in electrical and electronics laboratories.</li> <li>➤ Useful in component quality analysis and troubleshooting.</li> <li>➤ Supports circuit design and maintenance applications.</li> </ul>                                                                                                 |                                                                                                                                |            |                |

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| <b>Experiment No. 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Measurement of active &amp; reactive power in three phase balanced circuit using one wattmeter method with two-way switch.</b> | <b>CO3</b> | <b>Hrs. 02</b> |
| <p><b>Objective:</b> To measure active and reactive power in a three-phase balanced circuit using the one-wattmeter method with a two-way switch.</p> <p><b>Associated Tasks:</b></p> <ul style="list-style-type: none"> <li>➤ Study the one-wattmeter method for three-phase power measurement.</li> <li>➤ Connect the wattmeter and two-way switch properly in the circuit.</li> <li>➤ Measure wattmeter readings for different switch positions.</li> <li>➤ Calculate active and reactive power using the measured readings.</li> <li>➤ Verify the balanced load condition.</li> <li>➤ Analyze the obtained results.</li> </ul> <p><b>Exemplars :</b></p> <ul style="list-style-type: none"> <li>➤ Measurement of power in balanced three-phase resistive loads.</li> <li>➤ Determination of reactive power in inductive three-phase circuits.</li> <li>➤ Verification of one-wattmeter method calculations.</li> </ul> <p><b>Utility:</b></p> <ul style="list-style-type: none"> <li>➤ Reduces the number of instruments required for three-phase power measurement.</li> <li>➤ Useful for balanced load analysis in power systems.</li> <li>➤ Widely applied in electrical laboratories and industrial testing.</li> <li>➤ Helps in understanding three-phase power measurement techniques.</li> </ul> |                                                                                                                                   |            |                |
| <b>Experiment No. 6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Measurement of three phase active &amp; reactive power by two wattmeter method.</b>                                            | <b>CO3</b> | <b>Hrs. 02</b> |
| <p><b>Objective:</b> To measure three-phase active and reactive power using the two-wattmeter method.</p> <p><b>Associated Tasks:</b></p> <ul style="list-style-type: none"> <li>➤ Connect the two wattmeters properly in the three-phase circuit.</li> <li>➤ Measure wattmeter readings under different load conditions.</li> <li>➤ Calculate active and reactive power values.</li> <li>➤ Observe the effect of power factor on readings.</li> <li>➤ Analyze the obtained results.</li> </ul> <p><b>Exemplars;</b></p> <ul style="list-style-type: none"> <li>➤ Measurement of power in balanced three-phase loads.</li> <li>➤ Determination of reactive power in inductive circuits.</li> <li>➤ Verification of two-wattmeter method calculations.</li> </ul> <p><b>Utility:</b></p> <ul style="list-style-type: none"> <li>➤ Enables accurate measurement of three-phase power.</li> <li>➤ Applicable for balanced and unbalanced loads.</li> <li>➤ Widely used in electrical laboratories and industries.</li> <li>➤ Helps in analysis of three-phase power systems.</li> </ul>                                                                                                                                                                                                                        |                                                                                                                                   |            |                |
| <b>Experiment No. 7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Calibration of single-phase static energy meter at different power factors.</b>                                                | <b>CO4</b> | <b>Hrs. 02</b> |
| <p><b>Objective:</b> To calibrate a single-phase static energy meter at unity, lagging, and leading power factor conditions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                   |            |                |

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**Associated Tasks:**

- Connect the energy meter calibration circuit correctly.
- Apply different power factor conditions.
- Measure and record meter readings.
- Compare readings with standard values.
- Calculate percentage error and correction factor.
- Analyze meter performance.

**Exemplars:**

- Calibration at unity power factor.
- Testing under lagging and leading load conditions.
- Verification of meter accuracy.

**Utility:**

- Ensures accurate electrical energy measurement.
- Used in meter testing and maintenance.
- Important in power distribution and billing systems.
- Helps evaluate meter performance under different load conditions

|                         |                                                      |            |                    |
|-------------------------|------------------------------------------------------|------------|--------------------|
| <b>Experiment No. 8</b> | <b>To study and plot the characteristics of LVDT</b> | <b>CO2</b> | <b>Hrs.<br/>02</b> |
|-------------------------|------------------------------------------------------|------------|--------------------|

**Objective:** To study the working of an LVDT and plot its displacement versus output voltage characteristics.

**Task & Example:**

- Connect the LVDT setup correctly.
- Vary the core position and measure output voltage.
- Record displacement and output readings.
- Plot the characteristics curve.
- Analyze linearity and sensitivity.

**Exemplars:**

- Measurement of linear displacement.
- Plotting LVDT calibration characteristics.
- Determination of sensitivity and linear range.

**Utility:**

- Enables accurate displacement measurement.
- Used in automation and industrial control systems.
- Useful for position sensing applications.
- Helps in sensor calibration and instrumentation studies.

|                         |                                                                                             |            |                    |
|-------------------------|---------------------------------------------------------------------------------------------|------------|--------------------|
| <b>Experiment No. 9</b> | <b>Measurement of voltage, current, time period, frequency &amp; phase angle using DSO.</b> | <b>CO5</b> | <b>Hrs.<br/>02</b> |
|-------------------------|---------------------------------------------------------------------------------------------|------------|--------------------|

**Objective:** To measure voltage, current, time period, frequency, and phase angle of electrical signals using a Digital Storage Oscilloscope (DSO).

**Task & Example: Associated Tasks**

- Connect the DSO and input signals correctly.

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| <ul style="list-style-type: none"> <li>➤ Observe voltage and current waveforms.</li> <li>➤ Measure time period and frequency of signals.</li> <li>➤ Determine phase angle between two waveforms.</li> <li>➤ Record and analyze waveform characteristics.</li> </ul> <p><b>Exemplars</b></p> <ul style="list-style-type: none"> <li>➤ Measurement of AC signal voltage and current.</li> <li>➤ Determination of frequency and time period.</li> <li>➤ Measurement of phase difference between signals.</li> </ul> <p><b>Utility:</b></p> <ul style="list-style-type: none"> <li>➤ Provides accurate waveform analysis.</li> <li>➤ Used in electrical and electronics laboratories.</li> <li>➤ Helpful in troubleshooting and signal testing.</li> <li>➤ Supports study of time-domain signal characteristics.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                  |            |                |
| <b>Experiment No. 10</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Study of Digital Storage Oscilloscope:</b><br><b>a. Different modes in DSO such as Roll, Average, Peak detection</b><br><b>b. Capture transients c. FFT analysis d. Various MATH operations</b>                                                                               | <b>CO5</b> | <b>Hrs. 02</b> |
| <p><b>Objective:</b> To study various functions and analysis features of a Digital Storage Oscilloscope (DSO) such as Roll, Average, Peak Detection, transient capture, FFT analysis, and MATH operations.</p> <p><b>Task &amp; Example:</b></p> <p><b>Associated Tasks</b></p> <ul style="list-style-type: none"> <li>➤ Operate the DSO in different display modes.</li> <li>➤ Capture and observe transient signals.</li> <li>➤ Perform FFT analysis of electrical signals.</li> <li>➤ Apply MATH operations on waveforms.</li> <li>➤ Analyze and interpret displayed results.</li> </ul> <p><b>Exemplars</b></p> <ul style="list-style-type: none"> <li>➤ Observation of signals using Roll and Average modes.</li> <li>➤ Detection of transient waveforms using Peak Detection.</li> <li>➤ Frequency spectrum analysis using FFT.</li> <li>➤ Waveform addition and subtraction using MATH functions.</li> </ul> <p><b>Utility:</b></p> <ul style="list-style-type: none"> <li>➤ Supports advanced signal and waveform analysis.</li> <li>➤ Used in electrical, electronics, and communication laboratories.</li> <li>➤ Helpful in troubleshooting and frequency-domain studies.</li> <li>➤ Enhances understanding of modern oscilloscope functions.</li> </ul> |                                                                                                                                                                                                                                                                                  |            |                |
| <b>Experiment No. 11</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Study of various standards (IS/IEC) related to calibration process of various instruments and NABL accredited Test Laboratory visit. Such as ---- a. IS 13779 (Energy Meter) b. IS 12346 (Calibration Techniques) c. IEC 61010 (Safety) d. IEC 61557 (Electrical testing)</b> | <b>CO5</b> | <b>Hrs. 02</b> |
| <p><b>Objective:</b> To study IS/IEC standards related to calibration and testing of electrical instruments and observe calibration practices in a NABL accredited laboratory.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                  |            |                |


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**Task & Example:****Associated Tasks**

- Study IS 13779, IS 12346, IEC 61010, and IEC 61557 standards.
- Understand calibration and safety procedures.
- Observe testing and calibration methods in the laboratory.
- Analyze instrument testing practices and documentation.
- Prepare a report on laboratory observations.

**Exemplars**

- Study of energy meter calibration standards.
- Observation of electrical safety testing procedures.
- Analysis of calibration practices in NABL accredited laboratories.

**Utility:**

- Improves understanding of industrial standards and calibration techniques.
- Useful for quality control and instrument testing applications.
- Provides practical exposure to accredited laboratory practices.
- Supports industrial safety and measurement accuracy awareness.

|                          |                                                                                                      |            |                |
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| <b>Experiment No. 12</b> | <b>Performance Analysis of various Sensors used in Electrical and Electronic measurement systems</b> | <b>CO5</b> | <b>Hrs. 02</b> |
|--------------------------|------------------------------------------------------------------------------------------------------|------------|----------------|

**Objective:**

- To understand the operating principles of various sensors used in electrical and electronics measuring systems.
- To analyze the performance characteristics such as accuracy, sensitivity, linearity, repeatability, resolution, and response time of sensors.
- To compare different types of sensors based on performance, applications, and suitability.
- To study signal conditioning and interfacing techniques used with sensors.
- To develop practical knowledge for selection and implementation of sensors in industrial and automation systems.

**Task & Example:****Associated Tasks**

- Identification of different sensors used in measurement systems.
- Measurement of sensor characteristics and calibration.
- Comparison of sensor performance under varying conditions.
- Analysis of sensor output using measuring instruments.
- Study of signal conditioning circuits.

**Exemplars**

- Temperature Sensor Performance Analysis
- Hall Effect Current Sensor Analysis
- Light Sensor (LDR) Performance Analysis
- Pressure Sensor Performance Analysis
- Proximity Sensor Performance Analysis
- Humidity Sensor Performance Analysis
- Ultrasonic Sensor Performance Analysis

**Utility:**

- Used in industrial automation and control systems.

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- Important for electrical measurements and instrumentation.
- Useful in robotics, IoT, and embedded systems.
- Supports predictive maintenance and smart monitoring.
- Essential for modern electronic product development.

**Strength of CO-PO-PSO Mapping**

| CO   | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 3   | 2   | 2   | 1   | 3   | -   | -   | 1   | -   | 1    | 2    | 2    | 3    | 1    |
| CO2  | 3   | 3   | 2   | 2   | 2   | -   | -   | 1   | -   | -    | 2    | 2    | 2    | 1    |
| CO3  | 3   | 3   | 3   | 2   | 2   | -   | 1   | 1   | 1   | -    | 2    | 2    | 2    | 2    |
| CO4  | 2   | 2   | 2   | 3   | 3   | -   | -   | -   | -   | -    | 3    | 2    | 3    | 1    |
| CO5  | 1   | 2   | 1   | 2   | 2   | -   | 2   | 3   | -   | 2    | 3    | 2    | 3    | 1    |
| Avg. | 2.4 | 2.4 | 2   | 2   | 2.4 | -   | 1.5 | 1.5 | 1   | 1.5  | 2.4  | 2    | 2.6  | 1.2  |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**This course serves as a prerequisite for / maps with the following future courses:**

- Electrical Measurements and Instrumentation
- Industrial Automation
- Process Control
- Power System Protection
- Control Systems
- Embedded Systems
- Internet of Things (IoT)
- Smart Grid Technology
- Electrical Testing and Commissioning
- Sensor Technology and Applications

**Job Mapping:**

- Instrumentation Engineer
- Electrical Testing Engineer
- Calibration Engineer
- Maintenance Engineer
- Automation Engineer
- Control System Engineer
- Field Service Engineer
- Quality Assurance Engineer

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| <b>Program:</b>        | <b>S. Y. B. Tech (Electrical Engineering)</b> | <b>Semester:</b>    | <b>III</b>            |
| <b>Course:</b>         | <b>Analog and Digital Electronics Lab</b>     | <b>Course Code:</b> | <b>R25-EE-PCC-209</b> |
| <b>Teaching Scheme</b> |                                               |                     |                       |
| <b>Lecture</b>         | <b>Practical</b>                              | <b>Tutorial</b>     | <b>Credit</b>         |
| -                      | 02                                            | -                   | 01                    |

**Course Description:** Analog and Digital Electronics deals with electronic circuits used to process analog and digital signals. It covers semiconductor devices, logic gates, and basic circuits used in modern electronic systems and control applications.

**Course Relevance:** Analog and Digital Electronics is important because it provides the basic knowledge needed to understand and design modern electronic systems. It helps students learn circuit design, troubleshooting, and applications in computers, communication, automation, and control systems, forming a strong foundation for advanced engineering studies and careers.

**Prerequisite:**

3. Numbering system, Logic Gates and flip flops
4. Diode and BJT

**Bridge Content:**

4. Binary Addition and Subtraction
5. Internal Structure of IC741,
6. Basics of Diode

**Course Objectives:** This course aims to:

6. Use K map for Boolean algebra reduction and design digital circuit
7. Construct sequential and combinational circuits using flip flops and K map
8. Develop the concept of basics of operational Amplifier and its applications
9. Understand IC 555 timer and its applications
10. Design uncontrolled rectifier

**Course Outcomes:** After learning the course, students will be able to

| CO  | Course Outcome                                                                                                   | Bloom's Level |
|-----|------------------------------------------------------------------------------------------------------------------|---------------|
| CO1 | Simplify complex logic expression by using Boolean algebra and design combinational digital circuit using K-Map. | 3             |
| CO2 | Design logical, sequential digital circuit using K-Map.                                                          | 3             |
| CO3 | Apply and analyze applications of OPAMP in open and closed loop conditions.                                      | 4             |
| CO4 | Understand different analog circuits e.g. filters, IC555 and voltage regulators                                  | 2             |
| CO5 | Design uncontrolled rectifier with given specifications                                                          | 3             |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                     |            |               |
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| <b>Experiment No.1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Design of logical circuit for display of decimal number on seven segment display. (Hardware)</b> | <b>CO2</b> | <b>2 Hrs.</b> |
| <p><b>Objective:</b> To learn and understand the working of IC 7447 along with types of seven-segment display</p> <p><b>Associated Tasks:</b></p> <ol style="list-style-type: none"> <li>1. Study the construction and pin configuration of a seven-segment display.</li> <li>2. Identify common anode and common cathode types of seven-segment displays.</li> <li>3. Understand the truth table for displaying decimal digits (0–9).</li> <li>4. Determine the segment combinations required for each decimal number.</li> </ol> |                                                                                                     |            |               |

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5. Prepare Boolean expressions for each segment (a, b, c, d, e, f, g).
6. Simplify the Boolean expressions using K-map techniques.
7. Design the combinational logic circuit using basic logic gates.
8. Implement the circuit on breadboard/trainer kit using ICs and seven-segment display.
9. Verify the output for all decimal inputs from 0 to 9.
10. Observe and record the segment illumination pattern for each input combination.
11. Troubleshoot wiring and logic errors during hardware implementation.
12. Compare theoretical outputs with practical outputs.
13. Draw the complete circuit diagram and tabulate observations.
14. Conclude the working of seven-segment decoder/display logic circuit.

**Exemplars and Utility:**

1. Digital clocks and wrist watches for displaying time.
2. Calculator displays for showing numerical outputs.
3. Elevator floor indicators in buildings.
4. Digital measuring instruments such as voltmeters, ammeters, and multimeters.
5. Scoreboards used in sports stadiums.
6. Token number display systems in banks and hospitals.
7. Fuel dispensing machines and digital weighing machines.
8. Microwave ovens, washing machines, and home appliances with numeric displays.
9. Industrial control panels for process parameter indication.
10. Traffic signal countdown timers and public information systems.

| Experiment No.2 | Deign 3:8 decoder for binary to octal decoding. (Hardware) | CO2 | 2 Hrs. |
|-----------------|------------------------------------------------------------|-----|--------|
|-----------------|------------------------------------------------------------|-----|--------|

**Objective:**

1. To study the working principle of a 3:8 decoder.
2. To understand binary to octal decoding operation.
3. To design and implement a 3:8 decoder using logic gates/decoder IC.
4. To verify the truth table and output of the decoder circuit.
5. To develop practical knowledge of combinational logic circuits.

**Associated Tasks:**

1. Study the theory and operation of decoder circuits.
2. Understand the relationship between binary inputs and octal outputs.
3. Prepare the truth table for a 3:8 decoder.
4. Derive Boolean expressions for each output line.
5. Design the logic circuit using AND, NOT gates or decoder IC.
6. Identify input and output pins of the decoder IC.
7. Implement the circuit on breadboard/trainer kit.
8. Apply all possible binary input combinations (000 to 111).
9. Observe and verify corresponding octal output activation.
10. Record observations and compare theoretical and practical results.
11. Troubleshoot hardware connections and logic errors if any.
12. Draw the circuit diagram and tabulate outputs.
13. Conclude the operation and applications of decoder circuits.

**Exemplars and Utility:**

1. Memory address decoding in microprocessors and microcontrollers.
2. Chip select generation in digital systems.
3. Data routing and control applications.

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| 4. Instruction decoding in processors.<br>5. Display and LED selection circuits.<br>6. Digital communication systems.<br>7. Multiplexing and demultiplexing applications.<br>8. Control signal generation in automation systems.<br>9. Keyboard and input device encoding/decoding systems.<br>10. Industrial digital control circuits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                               |            |               |
| <b>Experiment No.3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Design three-bit full adder using any open-source software. (Software)</b> | <b>CO1</b> | <b>2 Hrs.</b> |
| <b>Objective:</b> <ol style="list-style-type: none"> <li>To study the working principle of a full adder circuit.</li> <li>To design a three-bit full adder using open-source simulation software.</li> <li>To understand binary addition and carry propagation concepts.</li> <li>To verify the sum and carry outputs for different binary inputs.</li> <li>To develop simulation and digital circuit design skills.</li> </ol> <b>Associated Tasks:</b> <ol style="list-style-type: none"> <li>Study the theory and operation of half adder and full adder circuits.</li> <li>Understand binary addition rules and carry generation.</li> <li>Prepare the truth table for a single-bit full adder.</li> <li>Design a one-bit full adder using logic gates.</li> <li>Extend the design to construct a three-bit full adder.</li> <li>Select suitable open-source simulation software (Logisim, CircuitVerse, etc.).</li> <li>Create the circuit diagram in the software environment.</li> <li>Provide binary inputs and simulate the circuit operation.</li> <li>Observe and verify sum and carry outputs.</li> <li>Test the circuit for different input combinations.</li> <li>Analyze carry propagation between stages.</li> <li>Record screenshots, observations, and simulation results.</li> <li>Compare theoretical calculations with simulated outputs.</li> <li>Troubleshoot logic or connection errors if present.</li> <li>Conclude the operation and advantages of full adder circuits.</li> </ol> <b>Exemplars and Utility:</b> <ol style="list-style-type: none"> <li>Arithmetic Logic Units (ALUs) in microprocessors.</li> <li>Digital calculators and computing devices.</li> <li>Binary addition operations in computers.</li> <li>Data processing systems and digital controllers.</li> <li>Embedded systems requiring arithmetic operations.</li> <li>Signal processing and communication systems.</li> <li>Digital counters and accumulators.</li> </ol> |                                                                               |            |               |
| <b>Experiment No.4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Design of comparator and Schmitt trigger. (Hardware)</b>                   | <b>CO3</b> | <b>2 Hrs.</b> |
| <b>Objective:</b> <ol style="list-style-type: none"> <li>To study the operation of comparator and Schmitt trigger circuits.</li> <li>To design and implement comparator and Schmitt trigger circuits using operational amplifiers.</li> <li>To understand the concept of threshold voltage and hysteresis.</li> <li>To observe the switching behavior of comparator circuits.</li> <li>To analyze waveform shaping using Schmitt trigger circuits.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                               |            |               |

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**Associated Tasks:**

1. Study the theory and characteristics of operational amplifiers.
2. Understand the working principle of comparator circuits.
3. Study the concept of positive feedback in Schmitt trigger circuits.
4. Calculate threshold voltages for comparator and Schmitt trigger.
5. Design the comparator circuit using op-amp and passive components.
6. Design the Schmitt trigger circuit using op-amp with feedback network.
7. Assemble the circuits on breadboard/trainer kit.
8. Apply varying analog input signals to the circuits.
9. Observe switching action and output waveforms using CRO/DSO.
10. Measure upper and lower threshold voltages.
11. Verify hysteresis behavior in the Schmitt trigger circuit.
12. Compare theoretical and practical observations.
13. Troubleshoot circuit connections and component issues.
14. Record waveforms, readings, and observations.
15. Conclude the performance and applications of comparator and Schmitt trigger circuits.

**Exemplars and Utility:**

1. Zero-crossing detectors in signal processing systems.
2. Voltage level detectors and monitoring circuits.
3. Pulse shaping and waveform conditioning circuits.
4. Noise reduction circuits using hysteresis action.
5. Switching circuits in automation and control systems.
6. Square wave generation from sinusoidal inputs.
7. Sensor interfacing and threshold detection applications.
8. Analog-to-digital converter input conditioning circuits.
9. Oscillator and timing circuits.
10. Industrial protection and alarm systems.

|                        |                                                                                           |            |               |
|------------------------|-------------------------------------------------------------------------------------------|------------|---------------|
| <b>Experiment No.5</b> | <b>Study of Instrumentation amplifier using three Op-amp, CMRR measurement (Hardware)</b> | <b>CO3</b> | <b>2 Hrs.</b> |
|------------------------|-------------------------------------------------------------------------------------------|------------|---------------|

**Objective:**

1. To study the working principle of an instrumentation amplifier using three operational amplifiers.
2. To design and implement an instrumentation amplifier circuit.
3. To understand differential gain and common mode gain concepts.
4. To measure the Common Mode Rejection Ratio (CMRR) of the instrumentation amplifier.
5. To analyze the performance of the amplifier for low-level signal amplification.

**Associated Tasks:**

1. Study the theory and characteristics of operational amplifiers.
2. Understand the configuration and operation of a three op-amp instrumentation amplifier.
3. Derive the expression for differential gain of the instrumentation amplifier.
4. Study the concept of common mode signal and CMRR.
5. Design the instrumentation amplifier circuit using suitable resistor values.
6. Assemble the circuit on breadboard/trainer kit.
7. Apply differential input signals and observe amplified output.
8. Apply common mode input signals to the circuit.
9. Measure differential gain and common mode gain.
10. Calculate the CMRR using measured values.

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11. Observe output waveforms using CRO/DSO.
12. Compare theoretical and practical values of gain and CMRR.
13. Troubleshoot circuit connections and component mismatches if present.
14. Record observations, calculations, and waveforms.
15. Conclude the performance and importance of instrumentation amplifiers.

**Exemplars and Utility:**

1. Biomedical instrumentation such as ECG and EEG signal amplification.
2. Sensor signal conditioning systems.
3. Industrial measurement and control systems.
4. Data acquisition systems.
5. Strain gauge and bridge circuit signal amplification.
6. Noise reduction in low-level signal processing applications.
7. Audio and communication signal amplification.
8. Precision measurement instruments.
9. Automation and process control systems.
10. Aerospace and defense electronic instrumentation systems.

|                            |                                                                   |            |               |
|----------------------------|-------------------------------------------------------------------|------------|---------------|
| <b>Experiment<br/>No.6</b> | <b>Design sine, and triangular wave generator.<br/>(Hardware)</b> | <b>CO3</b> | <b>2 Hrs.</b> |
|----------------------------|-------------------------------------------------------------------|------------|---------------|

**Objective:**

1. To study the generation of sine and triangular waveforms using electronic circuits.
2. To design and implement sine wave and triangular wave generator circuits.
3. To understand the operation of oscillators and waveform shaping circuits.
4. To observe and analyze generated waveforms using CRO/DSO.
5. To develop practical skills in analog waveform generation circuits.

**Associated Tasks:**

1. Study the theory of oscillators and waveform generators.
2. Understand the operation of op-amp based sine and triangular wave generators.
3. Select suitable components and calculate circuit parameters.
4. Design the triangular wave generator circuit.
5. Design the sine wave generator circuit.
6. Assemble the circuits on breadboard/trainer kit.
7. Apply power supply and verify circuit operation.
8. Observe generated waveforms using CRO/DSO.
9. Measure waveform parameters such as amplitude and frequency.
10. Compare generated waveforms with theoretical expectations.
11. Analyze frequency stability and waveform quality.
12. Troubleshoot hardware connections and component issues if present.
13. Record observations, waveforms, and readings.
14. Draw the complete circuit diagrams and tabulate results.
15. Conclude the performance and applications of waveform generator circuits.

**Exemplars and Utility:**

1. Function generators used in electronic laboratories.
2. Audio signal generation and testing systems.
3. Communication and modulation systems.
4. Signal testing and calibration equipment.
5. Pulse and waveform generation in digital electronics.
6. Industrial instrumentation and automation systems.

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                |            |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------------|---------------|
| 7. Biomedical electronic equipment testing.<br>8. Timing and synchronization circuits.<br>9. Control system signal generation applications.<br>10. Educational and research laboratory experiments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                |            |               |
| <b>Experiment No.7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Design first order high pass and low pass filter using OPAMP in any open-source software. (Software)</b>    | <b>CO4</b> | <b>2 Hrs.</b> |
| <b>Objective:</b> <ol style="list-style-type: none"> <li>To study the working principle of first-order active high pass and low pass filters.</li> <li>To design high pass and low pass filters using operational amplifiers.</li> <li>To understand the concept of cut-off frequency and frequency response.</li> <li>To simulate filter circuits using open-source software tools.</li> <li>To analyze the filtering characteristics of active filter circuits.</li> </ol> <b>Associated Tasks:</b> <ol style="list-style-type: none"> <li>Study the theory of active filters and operational amplifiers.</li> <li>Understand the operation of first-order low pass and high pass filters.</li> <li>Derive expressions for cut-off frequency of the filters.</li> <li>Select suitable resistor and capacitor values for desired cut-off frequency.</li> <li>Design the low pass filter circuit using OP-AMP.</li> <li>Design the high pass filter circuit using OP-AMP.</li> <li>Choose appropriate open-source simulation software (LTspice, CircuitVerse, QUCS, etc.).</li> <li>Implement the filter circuits in the software environment.</li> <li>Apply sinusoidal input signals of varying frequencies.</li> <li>Observe and analyze output waveforms and gain response.</li> <li>Plot or observe frequency response characteristics.</li> <li>Verify cut-off frequency and filter behavior.</li> <li>Compare theoretical and simulated results.</li> <li>Troubleshoot simulation or circuit design errors if any.</li> <li>Record screenshots, observations, and conclusions.</li> </ol> <b>Exemplars and Utility:</b> <ol style="list-style-type: none"> <li>Audio signal processing systems.</li> <li>Noise filtering and signal conditioning circuits.</li> <li>Communication systems for frequency selection.</li> <li>Biomedical signal processing applications.</li> <li>Sensor signal filtering in instrumentation systems.</li> <li>Radio and television receiver circuits.</li> <li>Data acquisition and measurement systems.</li> <li>Industrial automation and control applications.</li> <li>Embedded and analog electronic systems.</li> </ol> |                                                                                                                |            |               |
| <b>Experiment No.8</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Design of Monostable Multivibrator Using IC555 and Digital Circuit to Count Number of Pulses (Hardware)</b> | <b>CO4</b> | <b>2 Hrs.</b> |
| <b>Objective:</b> <ol style="list-style-type: none"> <li>To study the operation of IC555 timer in monostable mode.</li> <li>To design and implement a monostable multivibrator using IC555.</li> <li>To generate a single output pulse of fixed duration for each trigger input.</li> <li>To design and interface a digital pulse counting circuit.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                |            |               |

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- To observe and verify pulse generation and counting operation.

**Associated Tasks:**

- Study the internal block diagram and pin configuration of IC555 timer IC.
- Understand the working principle of monostable multivibrator circuits.
- Derive the pulse width equation for IC555 monostable operation.
- Pulse width relation:  $T=1.1RC$
- Select suitable resistor and capacitor values for the required pulse duration.
- Design the monostable multivibrator circuit using IC555.
- Study the operation of digital counters and display circuits.
- Design the pulse counting circuit using counter ICs and display units.
- Interface the monostable output with the digital counter circuit.
- Assemble the circuits on breadboard/trainer kit.
- Apply trigger pulses to the monostable circuit.
- Observe output pulses using CRO/DSO.
- Verify pulse width and triggering characteristics.
- Count the generated pulses using the digital counting circuit.
- Compare theoretical and practical pulse durations and counts.
- Troubleshoot hardware connections and component issues if present.
- Record observations, waveforms, and pulse counts.
- Draw the complete circuit diagram and tabulate results.
- Conclude the operation and applications of monostable multivibrator and pulse counting circuits.

**Exemplars and Utility:**

- Pulse generation and timing applications.
- Digital event and object counting systems.
- Traffic control and automatic timer circuits.
- Frequency and pulse measurement instruments.
- Industrial automation and process monitoring systems.
- Debouncing circuits for mechanical switches.
- Alarm, triggering, and security systems.
- Electronic instrumentation and testing equipment.
- Synchronization circuits in communication systems.
- Embedded system and microcontroller interfacing applications.

|                        |                                                              |            |               |
|------------------------|--------------------------------------------------------------|------------|---------------|
| <b>Experiment No.9</b> | <b>Design astable multivibrator using IC-555. (Hardware)</b> | <b>CO4</b> | <b>2 Hrs.</b> |
|------------------------|--------------------------------------------------------------|------------|---------------|

**Objective:**

- To study the operation of IC555 timer in astable mode.
- To design and implement an astable multivibrator using IC555 timer IC.
- To generate continuous square wave pulses without external triggering.
- To analyze the frequency and duty cycle of the output waveform.
- To observe the generated waveform using CRO/DSO.

**Associated Tasks:**

- Study the internal block diagram and pin configuration of IC555 timer.
- Understand the working principle of astable multivibrator circuits.
- Select suitable resistor and capacitor values for desired frequency.
- Design the astable multivibrator circuit using IC555.
- Assemble the circuit on breadboard/trainer kit.

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6. Apply power supply and verify circuit operation.
7. Observe output waveforms using CRO/DSO.
8. Measure output frequency and duty cycle.
9. Compare theoretical and practical values.
10. Analyze waveform characteristics and stability.
11. Troubleshoot hardware connections and component issues if present.
12. Record observations, readings, and waveforms.
13. Draw the complete circuit diagram and tabulate results.
14. Conclude the operation and applications of astable multivibrator circuits.

**Exemplars and Utility:**

1. Clock pulse generation in digital circuits.
2. LED flashing and blinking circuits.
3. Square wave signal generators.
4. Pulse generation in communication systems.
5. Tone and audio signal generation circuits.
6. Timing and delay applications.
7. Frequency generation in electronic systems.
8. Industrial automation and control circuits.
9. PWM signal generation applications.
10. Electronic toys, alarms, and warning systems.

| Experiment No.10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Design of regulated power supply (Hardware) | CO4 | 2 Hrs. |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-----|--------|
| <b>Objective:</b> <ol style="list-style-type: none"> <li>1. To study the working principle of a regulated power supply.</li> <li>2. To design and implement a DC regulated power supply circuit.</li> <li>3. To understand rectification, filtering, and voltage regulation processes.</li> <li>4. To obtain a stable DC output voltage from AC mains supply.</li> <li>5. To analyze the performance of the regulated power supply circuit.</li> </ol> <b>Associated Tasks:</b> <ol style="list-style-type: none"> <li>1. Study the basic blocks of a regulated power supply system.</li> <li>2. Understand the operation of transformer, rectifier, filter, and regulator circuits.</li> <li>3. Select suitable transformer, diode, capacitor, and voltage regulator components.</li> <li>4. Design the rectifier circuit (half-wave/full-wave/bridge rectifier).</li> <li>5. Design the filter circuit using capacitors.</li> <li>6. Design the voltage regulation stage using regulator ICs.</li> <li>7. Assemble the complete regulated power supply circuit on breadboard/trainer kit.</li> <li>8. Apply AC input supply through appropriate safety precautions.</li> <li>9. Measure rectified, filtered, and regulated output voltages.</li> <li>10. Observe ripple voltage using CRO/DSO.</li> <li>11. Compare input and regulated output characteristics.</li> <li>12. Verify voltage regulation under varying load conditions.</li> <li>13. Troubleshoot wiring, polarity, and component issues if present.</li> <li>14. Record observations, readings, and waveforms.</li> <li>15. Draw the complete circuit diagram and tabulate results.</li> <li>16. Conclude the operation and performance of the regulated power supply.</li> </ol> <b>Exemplars and Utility:</b> <ol style="list-style-type: none"> <li>1. Power supplies for electronic circuits and laboratory equipment.</li> </ol> |                                             |     |        |


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2. Mobile phone and battery charging systems.
3. Computer and embedded system power units.
4. Industrial automation and control systems.
5. Communication and instrumentation equipment.
6. Television, radio, and consumer electronic devices.
7. Microcontroller and digital circuit power applications.
8. Biomedical and measurement instruments.
9. LED lighting and display systems.
10. Renewable energy and backup power systems.

|                         |                                                                                                                  |            |               |
|-------------------------|------------------------------------------------------------------------------------------------------------------|------------|---------------|
| <b>Experiment No.11</b> | <b>Design of single-phase bridge rectifier with output voltage and specified ripple. (Software and Hardware)</b> | <b>CO5</b> | <b>2 Hrs.</b> |
|-------------------------|------------------------------------------------------------------------------------------------------------------|------------|---------------|

**Objective:**

1. To study the operation of a single-phase bridge rectifier circuit.
2. To design and implement a bridge rectifier with specified DC output voltage and ripple factor.
3. To understand rectification and filtering processes in AC to DC conversion.
4. To simulate and verify the rectifier circuit using software tools.
5. To analyze the performance of the rectifier under practical conditions.

**Associated Tasks:**

1. Study the theory and operation of bridge rectifier circuits.
2. Understand the concepts of ripple factor, rectification, and filtering.
3. Select suitable transformer, diode, and filter capacitor values.
4. Calculate required output voltage and ripple specifications.
5. Design the single-phase bridge rectifier circuit.
6. Design the filter circuit to achieve specified ripple.
7. Simulate the circuit using open-source software (LTspice, CircuitVerse, QUCS, etc.).
8. Observe input and output waveforms in simulation.
9. Assemble the hardware circuit on breadboard/trainer kit.
10. Apply AC input supply using proper safety precautions.
11. Measure rectified DC output voltage using multimeter/CRO.
12. Measure ripple voltage and verify specified ripple condition.
13. Compare simulated, theoretical, and practical results.
14. Analyze load regulation and filtering performance.
15. Troubleshoot hardware and simulation errors if present.
16. Record observations, calculations, waveforms, and screenshots.
17. Draw circuit diagrams and tabulate experimental results.
18. Conclude the operation and effectiveness of the bridge rectifier circuit.

**Exemplars and Utility:**

1. DC power supplies for electronic circuits.
2. Battery charging applications.
3. Power supplies in communication systems.
4. Consumer electronic devices and adapters.
5. Embedded and microcontroller-based systems.
6. Renewable energy conversion systems.
7. LED driver and lighting applications.
8. Instrumentation and laboratory power units.

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**Textbooks:**

1. Floyd and Jain, “Digital Fundamentals”, Pearson Education.
2. R. P. Jain, “Digital Electronics”, Tata McGraw Hill, New Delhi.
3. Gaikwad R., “Operational Amplifier”, PHI New Delhi.
4. Floyd, “Electronics Devices”, Pearson Education
5. Fundamental of digital circuits, 4th Edition, by A. Anand Kumar, PHI learning private limited publication.

**Reference Books:**

1. Tokheim, “Digital Electronics-Principles and Application”, 6th edition, Tata McGraw Hill, New Delhi.
2. A Jaico and Charles H. Roth, “Fundamentals of Logic Design” Jr. Fourth Edition.
3. James, “Operational Amplifier and Linear Integrated Circuits Theory and Application.”
4. P. S. Bimbhra, “Power Electronics”, Khanna Publications.
5. Foundations of Analog and Digital Electronic Circuits by Agarwal, Publisher

**MOOCs Links and additional reading material:**

1. NPTEL course on Digital Electronics Circuit, IIT, Kharagpur.  
<https://nptel.ac.in/courses/108105132/>
2. NPTEL course on Integrated circuit, MOSFET, OPAMP and their applications IISC Bangalore,  
<https://nptel.ac.in/courses/108/108/108108111/>
3. NPTEL course on power electronics by IIT Kharagpur.  
<https://nptel.ac.in/courses/108/105/108105066/>

**CO-PO-PSO Mapping**

| CO   | PO1 | PO2 | PO3  | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 2   | 2   | 1    | -   | 2   | -   | -   | -   | -   | -    | 2    | -    | 3    | 2    |
| CO2  | 2   | 2   | 3    | -   |     | -   | -   | -   | -   | -    | 2    | -    | 3    | 2    |
| CO3  | 2   | 2   | -    | -   | 2   | -   | -   | -   | -   | -    | 2    | -    | 1    | 2    |
| CO4  | 2   | 2   | -    | -   |     | -   | -   | -   | -   | -    | 2    | 2    | 3    | 2    |
| CO5  | 2   | 2   | 3    | -   | 2   | -   | -   | -   | -   | -    | 2    | 2    | 3    | 2    |
| Avg. | 2   | 2   | 2.33 | -   | 2   | -   | -   | -   | -   | -    | 2    | 2    | 2.6  | 2    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Assessment Pattern**

| BT Level | CCE based on ARCV |        |        |        |        |        |        |        |        |         |         |
|----------|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|
|          | Exp. 1            | Exp. 2 | Exp. 3 | Exp. 4 | Exp. 5 | Exp. 6 | Exp. 7 | Exp. 8 | Exp. 9 | Exp. 10 | Exp. 11 |
| CO       | CO2               | CO2    | CO1    | CO3    | CO3    | CO3    | CO4    | CO4    | CO4    | CO4     | CO5     |
| L1       | -                 | -      | -      | -      | -      | -      | -      | -      | -      | -       | -       |
| L2       | -                 | -      | -      | -      | -      | -      | -      | -      | -      | -       | -       |
| L3       | -                 | -      | ✓      | -      | -      | -      | ✓      | -      | -      | ✓       | -       |
| L4       | -                 | -      | -      | -      | ✓      | -      | -      | -      | -      | -       | -       |
| L5       | -                 | -      | -      | -      | -      | -      | -      | -      | -      | -       | -       |
| L6       | ✓                 | ✓      | -      | ✓      | -      | ✓      | -      | ✓      | ✓      | -       | ✓       |

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**This course serves as a prerequisite for / maps with the following future courses:**

1. Power Electronics,
2. Control System,
3. Advanced Electrical Drives and Control

**Job Mapping:**

Job opportunities that one can get after learning this course: Electrical Maintenance, Logic Circuit Designer, Electronics Repairing Workshop, etc.

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|                 |                                      |          |        |                    |              |    |                |  |
|-----------------|--------------------------------------|----------|--------|--------------------|--------------|----|----------------|--|
| Program:        | S. Y. B. Tech Electrical Engineering |          |        |                    | Semester:    |    | III            |  |
| Course:         | Energy Literacy & Electrical safety  |          |        |                    | Course Code: |    | R25-EE-PCC-208 |  |
| Teaching Scheme |                                      |          |        | Examination Scheme |              |    |                |  |
| Lecture         | Practical                            | Tutorial | Credit | CCE                | ESE          | TW | PR/ OR         |  |
| -               | 04                                   | -        | 01     | -                  | -            | 50 |                |  |

**Course Description:**

The Energy Literacy & Electrical Safety course is designed to provide foundational knowledge on energy generation, consumption, and environmental impact, while educating participants on safe electrical handling to prevent accidents. It focuses on fostering sustainable energy habits and understanding electrical hazards at home and in industrial settings

**Relevance:**

Energy literacy and electrical safety education are essential for fostering a sustainable, safe society. They empower individuals to make informed decisions about energy consumption, reducing environmental impact and improving energy efficiency. Education also prevents hazards by teaching safe handling, which helps prevent electrical accidents

**Prerequisite:**

Basic knowledge of energy, power, current, voltage, resistance, and circuits, General science

**Bridge Content:**

Revision of basic electrical Concept about Energy Conversion Utilization Steps

**Course Objectives:**

- 1 To provide the students an exposure to contemporary social reality.
- 2 To cultivate in the students the spirit of active involvement in the service to the community
- 3 Community awareness, suggesting practical, impactful devices or systems to address local needs in a community, while actively involving community members in the process through needs assessments, workshops, and feedback loops, potentially focusing on areas like energy efficiency, water conservation, waste management, or accessible technology development
- 4 To inculcate a sense of social responsibility in students

**Course Outcomes:** After learning the course, students will be able to

| CO  | Course Outcome                                                                                                                                             | Bloom's Level |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| CO1 | Improve access to essential services or technologies tailored to local needs understand the diverse perspectives and challenges faced by local populations | 3             |
| CO2 | Enhance the efficiency and sustainability of existing systems                                                                                              | 3             |
| CO3 | Mitigate the environmental concerns related to mechanical processes                                                                                        | 4             |
| CO4 | Increase community resilience through innovative solutions                                                                                                 | 3             |

|                         |                                                                                                                                |     |       |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----|-------|
| <b>Experiment No. 1</b> | <b>Write a report on workshops or campaigns to raise awareness about electrical safety in low-income or rural communities.</b> | CO1 | 2 Hrs |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----|-------|

**Objective:** To visit workshops or campaigns to raise awareness about electrical safety in low-income or rural communities.

**Associated Tasks:**

- 1) Conduct workshops or campaigns to raise awareness about electrical safety in low-income or rural communities.



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|                                                                                                                                                                                                    |                                                                                                                                                                                   |            |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------|
| 2) To educate the community on the dangers of poor electrical installations, safety measures, prevention of electric shocks and remedies and simple electrical troubleshooting                     |                                                                                                                                                                                   |            |              |
| <b>Exemplars :</b>                                                                                                                                                                                 |                                                                                                                                                                                   |            |              |
| 1) Campaigns to raise awareness in College , school, hospital, public rural Area                                                                                                                   |                                                                                                                                                                                   |            |              |
| <b>Utility:</b>                                                                                                                                                                                    |                                                                                                                                                                                   |            |              |
| 1) Used in industries, commercial , domestics area about safety precautions of supply.                                                                                                             |                                                                                                                                                                                   |            |              |
| <b>Experiment No. 2</b>                                                                                                                                                                            | <b>Write a detailed report on home upgradation which helps their electrical systems to be more energy-efficient</b>                                                               | <b>CO1</b> | <b>2Hrs</b>  |
| <b>Objective:</b> To Upgrade your home for Energy Conservation and Increase Energy Efficiency.                                                                                                     |                                                                                                                                                                                   |            |              |
| <b>Associated Tasks:</b>                                                                                                                                                                           |                                                                                                                                                                                   |            |              |
| Help community by upgrading their household electrical systems to be more energy-efficient, such as replacing incandescent bulbs with LED lights, installing smart plugs, and improving insulation |                                                                                                                                                                                   |            |              |
| <b>Exemplars:</b> 1) Used LED Lamp, smart plug                                                                                                                                                     |                                                                                                                                                                                   |            |              |
| <b>Utility:</b> Domestic ,Commercial and Industrial Area                                                                                                                                           |                                                                                                                                                                                   |            |              |
| <b>Experiment No. 3</b>                                                                                                                                                                            | <b>Write a report on survey of the electrical infrastructure in a community (e.g., wiring, circuit breakers, transformers) and propose and implement upgrades</b>                 | <b>C02</b> | <b>2Hrs</b>  |
| <b>Objective:</b>                                                                                                                                                                                  |                                                                                                                                                                                   |            |              |
| To survey of the electrical infrastructure in a community (e.g., wiring, circuit breakers, transformers) and propose and implement upgrades                                                        |                                                                                                                                                                                   |            |              |
| <b>Associated Tasks:</b>                                                                                                                                                                           |                                                                                                                                                                                   |            |              |
| Conduct a survey of the electrical infrastructure in a community (e.g., wiring, circuit breakers, transformers) and propose and implement upgrades                                                 |                                                                                                                                                                                   |            |              |
| <b>Utility:</b> Industrial Building installation, Commercial Area                                                                                                                                  |                                                                                                                                                                                   |            |              |
| <b>Experiment No. 4</b>                                                                                                                                                                            | <b>Perform energy audits for homes or small businesses in the community and provide recommendations for improving energy efficiency and write a complete energy audit report.</b> | <b>CO2</b> | <b>2Hrs</b>  |
| <b>Objective:</b> To Perform energy audits for homes or small businesses in the community and provide recommendations for improving energy efficiency and write a complete energy audit report..   |                                                                                                                                                                                   |            |              |
| <b>Associated Tasks:</b> Perform energy audits for homes or small businesses in the community and provide recommendations for improving energy efficiency.                                         |                                                                                                                                                                                   |            |              |
| <b>Exemplars</b> -Preparation of Report                                                                                                                                                            |                                                                                                                                                                                   |            |              |
| <b>Utility:</b> Industrial Building installation, Commercial Area                                                                                                                                  |                                                                                                                                                                                   |            |              |
| <b>Experiment No. 5</b>                                                                                                                                                                            | <b>Presentation on awareness of renewable energy</b>                                                                                                                              | <b>CO3</b> | <b>2 Hrs</b> |
| <b>Objective:</b> To create awareness on solar installation.                                                                                                                                       |                                                                                                                                                                                   |            |              |
| <b>Associated Tasks:</b> To raise awareness about renewable energy's cost-saving potential for businesses and household while promoting sustainability                                             |                                                                                                                                                                                   |            |              |
| <b>Exemplars:</b> School, College, Hospitals                                                                                                                                                       |                                                                                                                                                                                   |            |              |
| <b>Utility:</b>                                                                                                                                                                                    |                                                                                                                                                                                   |            |              |
| Maximum use of Renewable Energy Sources                                                                                                                                                            |                                                                                                                                                                                   |            |              |
| Useful for energy efficiency.                                                                                                                                                                      |                                                                                                                                                                                   |            |              |
| <b>Experiment No. 6</b>                                                                                                                                                                            | <b>Write report on the Conduction of an educational campaign to raise awareness about power theft.</b>                                                                            | <b>CO3</b> | <b>2Hrs</b>  |
| <b>Objective:</b> To raise awareness about power theft..                                                                                                                                           |                                                                                                                                                                                   |            |              |
| <b>Associated Tasks:</b>                                                                                                                                                                           |                                                                                                                                                                                   |            |              |
| 1) Understand About Power Theft                                                                                                                                                                    |                                                                                                                                                                                   |            |              |
| 2) Prepare Presentation                                                                                                                                                                            |                                                                                                                                                                                   |            |              |
| 3) Prepare Report.                                                                                                                                                                                 |                                                                                                                                                                                   |            |              |
| <b>Exemplars;</b>                                                                                                                                                                                  |                                                                                                                                                                                   |            |              |
| 1) Measurement of power, energy, time                                                                                                                                                              |                                                                                                                                                                                   |            |              |
| <b>Utility:</b>                                                                                                                                                                                    |                                                                                                                                                                                   |            |              |
| 1) Industrial ,Commercial,Domestic application                                                                                                                                                     |                                                                                                                                                                                   |            |              |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                               |            |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------|--------------|
| <b>Experiment No. 7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Write a report on workshop conducted (Workshop activities: repair and refurbish used electronics and small appliances)</b> | <b>CO4</b> | <b>2 Hrs</b> |
| <b>Objective:</b> To conduct workshop repair and refurbish used electronics and small appliances<br><b>Associated Tasks:</b><br>Diagnosing faults – identifying hardware or software problems.<br>Inspecting components – checking circuit boards, connectors, cables, batteries, and other parts.<br>Testing equipment – using multimeters, oscilloscopes, or diagnostic software.<br><b>Exemplars;</b><br>1 Diagnosed and repaired a smartphone that would not power on by replacing a faulty charging IC.<br>2 Troubleshoot and repaired a laptop with intermittent display issues by replacing a damaged display cable.<br>3 Replaced defective capacitors on a television power supply board to restore normal operation<br><b>Utility:</b><br>1) Restoring devices to proper working condition.<br>2) Extending the lifespan of electronic equipment.<br>3) Reducing replacement costs for users and organizations.<br>4) Minimizing electronic waste and supporting environmental sustainability.<br>5) Improving device performance, reliability, and safety. |                                                                                                                               |            |              |
| <b>Experiment No. 8</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Write a report on guest lecture delivered by an Energy Auditor.</b>                                                        | <b>CO4</b> | <b>2 Hrs</b> |
| <b>Objective:</b> Arrange Guest lecture of Energy Auditor<br><b>Task :</b><br>Prepare Report on Energy Audit<br><b>Exemplars:</b> College Audit, School Audit, Home Audit.<br><b>Utility:</b> College, school                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                               |            |              |
| <b>Experiment No. 9</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Write a report on the visit to an electrical appliances repair shop</b>                                                    | <b>CO4</b> | <b>2Hrs</b>  |
| <b>Objective:</b> To repair and study organize a workshop to repair and refurbish used electronics and small appliances.<br><b>Associated Task</b><br>1)Visit to electrical appliances workshop<br>2)Measure all parameters.<br><b>Exemplars</b><br>1)Repaire fan.motor.<br>2)Testing of small appliance<br><b>Utility:</b><br>1)Used in electrical and electronics laboratories.<br>2)Helpful in troubleshooting of Domestic and Industrial Appliances.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                               |            |              |

**Strength of CO-PO-PSO Mapping**

| CO   | PO1 | PO2 | PO3  | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 3   | 2   | 2    | 1   | 3   | 3   | 3   | 1   | 2   | 1    | 2    | 2    | 3    | 1    |
| CO2  | 3   | 3   | 2    | 2   | 2   | 3   | 3   | 1   | 2   | 1    | 2    | 2    | 2    | 1    |
| CO3  | 3   | 3   | 3    | 2   | 2   | 3   | 3   | 1   | 2   | 1    | 2    | 2    | 2    | 2    |
| CO4  | 2   | 2   | 2    | 3   | 3   | 2   | 2   | -   | 2   | 1    | 3    | 2    | 3    | 1    |
| Avg. | 2.8 | 2.5 | 2.25 | 2   | 2.5 | 2.8 | 2.8 | 1   | 2   | 1    | 2.25 | 2    | 2.5  | 1.25 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Assessment Pattern-**

| BT Level | CCE |     |             |                |                             |                          | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
|          | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. |     |

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|    |   |   |   |   |   |   |   |
|----|---|---|---|---|---|---|---|
| K1 | - | - | - | - | - | - | - |
| K2 | - | - | - | - | - | - | - |
| K3 | - | - | - | - | - | - | - |
| K4 | - | - | - | - | - | - | - |
| K5 | - | - | - | - | - | - | - |
| K6 | - | - | - | - | - | - | - |

**Assessment Table:**

| EXAM                                | Particular                  | CO1 | CO2 | CO3 | CO4 | CO5 |
|-------------------------------------|-----------------------------|-----|-----|-----|-----|-----|
| Knowledge and Attitude Profile (WK) |                             | -   | -   | -   | -   | -   |
| CCE                                 | CT1                         | -   | -   | -   | -   | -   |
|                                     | CT2                         | -   | -   | -   | -   | -   |
|                                     | Assignments                 | -   | -   | -   | -   | -   |
|                                     | Course Project              | -   | -   | -   | -   | -   |
|                                     | Field Activity / Case Study | -   | -   | -   | -   | -   |
|                                     | Quiz / presentation etc.    | -   | -   | -   | -   | -   |
| ESE                                 |                             | -   | -   | -   | -   | -   |
| Total                               |                             | -   | -   | -   | -   | -   |

**Unit-wise Weightage:**

| Exam  | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|-------|-------|-------|-------|-------|-------|
| CT1   | -     | -     | -     | -     | -     |
| CT2   | -     | -     | -     | -     | -     |
| ESE   | -     | -     | -     | -     | -     |
| Total | -     | -     | -     | -     | -     |

**This course serves as a prerequisite for / maps with the following future courses:**

**The Energy Literacy & Electrical Safety Education**

Energy Auditor, Energy Conservation, Power theft, Energy Consultancy, Testing Electrical Installation, Power Quality Solar Instalation, Electrical Testing and Commissioning

**Job Mapping:**

Energy Auditor, Electrical Testing, Instalation, Power quality, Maintenance Engineer, Automation Engineer  
Electrical Vehicle, Field Service Engineer, Quality Assurance Engineer


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**SECOND YEAR ENGINEERING**

**SEMESTER-IV**

**ELECTRICAL ENGINEERING**





| CO  | Course Outcome                                                                                                         | Bloom's Level |
|-----|------------------------------------------------------------------------------------------------------------------------|---------------|
| CO1 | <b>Compute</b> the voltage regulation and efficiency of a given 1-phase transformer at a specified power factor & load | 03            |
| CO2 | <b>Understand</b> the standard connections and parallel operation of 1-phase and 3-phase transformers.                 | 02            |
| CO3 | <b>Calculate</b> the efficiency of a given DC motor                                                                    | 03            |
| CO4 | <b>Compute</b> the losses and efficiency of a given three-phase induction motor                                        | 04            |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                           |                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Evaluate</b> the equivalent circuit parameters by conducting a no-load and blocked rotor test & performance parameters by drawing a circle diagram for a given 3-Phase Induction motor | 05                |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                           |                   |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Single Phase Transformer &amp; Testing</b>                                                                                                                                             | <b>9 Hrs. CO1</b> |
| Single-phase Transformer: Concept of an ideal transformer. Useful and leakage flux, its effects. Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency. Exact and approximate equivalent circuits referred to L.V. and H.V. sides of the transformer, losses, efficiency, and conditions for maximum efficiency. Concept of all-day efficiency. Auto transformers and their applications, Polarity test, conditions of parallel operations, Parallel operation of single-phase transformers and load sharing. |                                                                                                                                                                                           |                   |
| Exemplars / Practical Applications and usage: Single-phase transformers are widely used in residential areas to step down distribution voltage to usable household voltage levels.                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                           |                   |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Three-Phase Transformer</b>                                                                                                                                                            | <b>9 Hrs. CO2</b> |
| Three Phase Transformers: Standard connections of three-phase transformers and their suitability for various applications, voltage Phasor diagrams and vector groups. Descriptive treatment of the parallel operation of three-phase transformers, Scott connection, and V-V connections. Three winding (tertiary windings) transformers.                                                                                                                                                                                                                                                |                                                                                                                                                                                           |                   |
| Exemplars / Practical Applications and usage: 11 kV / 230 V distribution transformer, 11 kV to 132 kV transformer                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                           |                   |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Basics of DC Machines</b>                                                                                                                                                              | <b>9 Hrs. CO3</b> |
| Construction and Working of DC machine, Types of DC motors, significance of back E.M.F torque equation, working at no-load and on-load. Losses, power flow diagram and efficiency. Starting of DC motors and types of starters, characteristics and speed control of DC shunt and series motor, Armature reaction and commutation: Concept of magnetizing, demagnetizing & cross magnetizing armature reaction, compensating winding, concept of commutation, value of reactance voltage, methods of improving commutation.                                                              |                                                                                                                                                                                           |                   |
| Exemplars / Practical Applications and usage: DC machines are widely used in electric vehicles, cranes, rolling mills, robotics, conveyor systems, battery charging, welding, and industrial automation because of their high starting torque, smooth speed control, and reliable performance.                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                           |                   |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Fundamentals of Three-Phase Induction Motor</b>                                                                                                                                        | <b>9 Hrs. CO4</b> |
| Construction and types of induction motor, working principle, concept of rotating magnetic field, slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. Production of torque, torque equation, torque-slip characteristics, effect of rotor resistance on torque-slip characteristics, and condition for maximum torque. Relation between starting torque, full load torque and maximum torque, Necessity & types of starters for 3-phase induction motors, Introduction to Induction Generators.                      |                                                                                                                                                                                           |                   |
| Exemplars / Practical Applications and usage: Three-phase induction motors are extensively used in industries, water pumping systems, HVAC systems, machine tools, conveyors, cranes, refrigeration plants, and automation systems because of their rugged construction, high efficiency, low maintenance, and reliable performance.                                                                                                                                                                                                                                                     |                                                                                                                                                                                           |                   |
| <b>Unit 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Performance Analysis of a Three-Phase Induction Motor</b>                                                                                                                              | <b>9 Hrs. CO5</b> |
| Losses in a three-phase induction motor, power flow diagram, relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency, Induction motor as a generalized transformer; phasor diagram. Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent                                                                                                                                                                                                                                                     |                                                                                                                                                                                           |                   |

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circuit parameters, and plotting the circle diagram.

Exemplars / Practical Applications and usage: Three-phase induction motors are uniquely used in MAGLEV transportation, space research facilities, nuclear reactor cooling systems, robotic warehouses, underwater exploration vehicles, and advanced amusement ride systems due to their robustness, reliability, and high-performance capability.

#### Textbooks:

- [T1]. Edward Hughes, “Electrical Technology”, ELBS, Pearson Education.
- [T2]. Ashfaq Husain, “Electrical Machines”, Dhanpat Rai & Sons.
- [T3]. S. K. Bhattacharya, “Electrical Machine”, Tata McGraw-Hill Publishing Co. Ltd, 2nd Edition.
- [T4]. Nagrath & Kothari, “Electrical Machines”, Tata McGraw-Hill.
- [T5]. Bhag S Guru, Husein R. Hiziroglu, “Electrical Machines”, Oxford University Press.
- [T6]. K Krishna Reddy, “Electrical Machines- I and II”, SCITECH Publications (India) Pvt. Ltd. Chennai.

#### Reference Books:

- [R1]. A.E. Clayton and N. N. Hancock, “Performance and Design of Direct Current Machines”, CBS Publishers, Third Edition.
- [R2]. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, “Electrical Machines”, Tata McGraw-Hill Publication Ltd., Fifth Edition.
- [R3]. A.S. Langsdorf, “Theory and performance of DC machines”, Tata McGraw-Hill.
- [R4]. M.G. Say, “Performance and Design of AC. Machines”, CBS Publishers and Distributors.
- [R5]. Smarajit Ghosh, “Electrical Machines”, Pearson Education, New Delhi.
- [R6]. Charles I Hubert, “Electrical Machines Theory, Application, & Control”, Pearson Education, New Delhi, Second Edition.
- [R7]. Direct Current Machines, R K Rajput, Laxmi Publications
- [R8]. AC Machines, R K Rajput, Laxmi Publications

#### MOOCs Links and additional reading material:

1. NPTEL Course on Electrical Machines – IIT Kharagpur- <https://nptel.ac.in/courses/108105155>
2. NPTEL Course on Electrical Machines – IIT Delhi- <https://nptel.ac.in/courses/108102146>
3. Springer eBook: Electrical Machines by Slobodan N. Vukosavic-  
<https://link.springer.com/book/10.1007/978-1-4614-0400-2>

#### Strength of CO-PO-PSO Mapping

| CO   | PO1  | PO2  | PO3  | PO4  | PO5  | PO6  | PO7  | PO8  | PO9  | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| CO1  | 3    | 3    | 1    | 3    | 3    | -    | -    | 1    | 2    | -    | 2    | 3    | 3    | 2    |
| CO2  | 3    | 3    | 1    | 2    | 3    | -    | -    | -    | -    | -    | 2    | 2    | 3    | 2    |
| CO3  | 2    | 3    | 1    | 3    | 3    | -    | -    | -    | 3    | -    | 3    | 3    | 3    | 2    |
| CO4  | 3    | 3    | 1    | 3    | 3    | -    | -    | -    | 3    | -    | 3    | 3    | 3    | 2    |
| CO5  | 3    | 3    | 1    | 3    | 3    | -    | -    | -    | 3    | -    | 2    | 3    | 3    | 2    |
| Avg. | 2.83 | 3.00 | 1.00 | 2.67 | 3.00 | 0.00 | 0.00 | 1.00 | 2.80 | -    | 2.50 | 2.83 | 3.00 | 2.00 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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**Unit wise Weightage:**

| Exam  | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|-------|-------|-------|-------|-------|-------|
| CCE 1 | 8     | 8     | -     | -     | -     |
| CCE 2 | -     | -     | 8     | 8     | --    |
| CCE 3 | -     | -     | -     | -     | 8     |
| ESE   | 12    | 12    | 12    | 12    | 12    |
| Total | 20    | 20    | 20    | 20    | 20    |

**Assessment Pattern**

| BT Level | CCE |     |     |     |     | ESE |     |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          | CO1 | CO2 | CO3 | CO4 | CO5 | CO1 | CO2 | CO3 | CO4 | CO5 |
|          | 8   | 8   | 8   | 8   | 8   | 12  | 12  | 12  | 12  | 12  |
| L1       | √   | √   | √   | √   | √   | √   | √   | √   | √   | √   |
| L2       | √   | √   | √   | √   | √   | √   | √   | √   | √   | √   |
| L3       | √   | -   | √   | √   | √   | √   | -   | √   | √   | √   |
| L4       | -   | -   | -   | √   | √   | -   | -   | -   | √   | √   |
| L5       | -   | -   | -   | -   | √   | -   | -   | -   | -   | √   |
| L6       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

This course serves as a prerequisite for / maps with the following future courses:

Job Mapping:

Job opportunities that one can get after learning this course:

After learning this course, students can work in electrical maintenance, power systems, machine testing, electrical design, manufacturing industries and automation sectors.

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| Program:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | S. Y. B. Tech (Electrical Engineering)                                                                                                         |          |        | Semester:          |     | III            |    |
| Course:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Network Analysis                                                                                                                               |          |        | Course Code:       |     | R25-EE-PCC-212 |    |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                |          |        | Examination Scheme |     |                |    |
| Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Practical                                                                                                                                      | Tutorial | Credit | CCE                | ESE | TW             | PR |
| 03                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -                                                                                                                                              | -        | 03     | 40                 | 60  | -              | -  |
| <b>Course Description:</b> This course introduces the fundamental principles, mathematical techniques, and analytical methods used to study electrical networks and circuits. It develops the ability to analyse DC and AC electrical circuits using classical methods, network theorems, transient analysis, Laplace transforms, and network function concepts.                                                                                                                                                                        |                                                                                                                                                |          |        |                    |     |                |    |
| <b>Course Relevance:</b> The course forms the foundation for advanced subjects in: Electrical Engineering, Electronics Engineering, Power Systems, Control Systems, Communication Engineering, Embedded Systems, Signal Processing. Students learn how electrical circuits behave under steady-state and transient conditions, how energy is transferred and stored in electrical components, and how practical engineering systems are modelled and analysed mathematically.                                                           |                                                                                                                                                |          |        |                    |     |                |    |
| <b>Prerequisite:</b><br><div><div></div><div>1. Terminology of electrical networks,</div><div>2. Series and parallel combinations of resistance,</div><div>3. Laplace transforms,</div><div>4. Linear differential equations</div></div>                                                                                                                                                                                                                                                                                                |                                                                                                                                                |          |        |                    |     |                |    |
| <b>Bridge Content:</b><br><div><div></div><div>1. Basic Laws and Circuit Elements, Series-Parallel Networks and Dividers</div><div>2. AC Fundamentals and Phasors, Mathematical Tools for Network Analysis</div><div>3. Differential Equations and Time Constants</div><div>4. Introduction to Laplace and Stability Concepts</div></div>                                                                                                                                                                                               |                                                                                                                                                |          |        |                    |     |                |    |
| <b>Course Objectives:</b> This course aims to:<br><div><div></div><div>1. <b>Develop</b> the strong foundation for Electrical Networks.</div><div>2. <b>Develop</b> analytical qualities in Electrical circuits by application of various theorems.</div><div>3. <b>Understand</b> the behaviour of circuits by analysing the transient response using classical methods and Laplace Transform approach.</div><div>4. <b>Develop</b> understating of basics of Network Functions and design of other circuits like filters.</div></div> |                                                                                                                                                |          |        |                    |     |                |    |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |          |        |                    |     |                |    |
| CO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Course Outcome                                                                                                                                 |          |        |                    |     | Bloom's Level  |    |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Calculate current/voltage in electrical circuits using simplification techniques, Mesh, Nodal analysis.                                        |          |        |                    |     | 3              |    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Solve the given network by applying Superposition, Thevenin's, Norton, Reciprocity, Maximum power transfer and Millman's theorems.             |          |        |                    |     | 3              |    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Analyze the response of RLC circuit in transient and steady state condition.                                                                   |          |        |                    |     | 4              |    |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply Laplace transform to analyze behavior of an electrical circuit.                                                                          |          |        |                    |     | 3              |    |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply the knowledge of network theory to find transfer function, poles and zeroes location to perform stability analysis and Design of filters |          |        |                    |     | 4              |    |


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| Course Content                                                                                                                                                                                                                                                                                                                                           |                                                                      |               |            |
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| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                            | <b>Types of Networks, Mesh and Nodal analysis</b>                    | <b>9 Hrs.</b> | <b>CO1</b> |
| Independent and Dependent (controlled) voltage and current sources. Concept of voltage and current divider, Source transformation. Network equations on Loop basis and Node basis, Concept of super node and super mesh. Dot convention for coupled circuits (series only).                                                                              |                                                                      |               |            |
| <b>Exemplars / Practical Applications and usage:</b><br>Smartphone Battery Gauges & Charging Circuits, Analog Voltmeter & Sensor Interfacing, Audio Equipment & Guitar Amplifiers, Power Grid Substation Modelling, Wireless EV Charging & Smartphone Charging Pads                                                                                      |                                                                      |               |            |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                            | <b>Network Theorems</b>                                              | <b>9 Hrs.</b> | <b>CO2</b> |
| Superposition Theorem, Thevenin Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem, Millman Theorems applied to electrical DC and AC networks with independent sources.                                                                                                                                                      |                                                                      |               |            |
| <b>Exemplars / Practical Applications and usage:</b><br>Smartphone Fast Charging & Wireless EV Chargers, Electronic Sensor Interfacing & Signal Conditioning, Power Grid Substation Analysis & Solar Grid Integration, Multimeter Design & High-Current Industrial Panels, Telecommunication Transmitters & Antenna Matching                             |                                                                      |               |            |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                            | <b>Transient Analysis in RLC circuit-Time domain approach</b>        | <b>9 Hrs.</b> | <b>CO3</b> |
| Initial and Final Conditions in Network Elements, Forced and free response, Basic concept of time constants of RL and RC circuit, Steady-state and transient state response. Solutions of differential equations using classical method for R-L, R-C and R-L-C circuits (series and parallel).                                                           |                                                                      |               |            |
| <b>Exemplars / Practical Applications and usage:</b><br>Automotive Engine Ignition Systems, Camera Flash Units & Defibrillators, Surge Protection & Debouncing in Industrial Switches, Airbag Deployment Systems in Vehicles, Radio Tuning & Wireless Receiver Stages                                                                                    |                                                                      |               |            |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                            | <b>Transient Analysis in RLC circuit: Laplace Transform approach</b> | <b>9 Hrs.</b> | <b>CO4</b> |
| Laplace Transform of Basic R, L and C components, Solutions of differential equations and network equations using Laplace transform method for RL, R-C and R-L-C circuits (series and parallel), Inverse Laplace transforms, transformed networks with initial conditions.                                                                               |                                                                      |               |            |
| <b>Exemplars / Practical Applications and usage:</b><br>Anti-Lock Braking Systems (ABS) & Active Suspensions, Telecommunication Filters & DSL Broadband Modems, Lightning Strike Protection in Power Substation Transformers, Cardiac Pacemaker Circuit Design                                                                                           |                                                                      |               |            |
| <b>Unit 5</b>                                                                                                                                                                                                                                                                                                                                            | <b>Network Functions and Filters</b>                                 | <b>9 Hrs.</b> | <b>CO4</b> |
| Network functions for the one port and two port networks, calculation of network functions. Plotting of Poles and zeros of networks functions, Restrictions on poles and zeros locations for transfer functions and driving point function. Stability of active networks. Descriptive treatment to passive filters, low pass filters, high pass filters. |                                                                      |               |            |
| <b>Exemplars / Practical Applications and usage:</b><br>Audio Equalizers & Speaker Crossover Networks, 5G Smart Antenna Arrays & RF Front-Ends, Aircraft Autopilot & Industrial Control Stability, Biomedical Sensors & Pacemaker Pulse Shaping, Active Noise-Cancelling (ANC) Headphones                                                                |                                                                      |               |            |



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**Comprehensive Continuous Evaluation (CCE) components for the course:**

1. **Class Tests / Unit Tests:** Unit-1 and Unit-2: (16 Marks)
2. **Assignments:** Unit-3 and Unit-4: (16 Marks)
3. **Quiz / MCQ Tests:** Unit-5 (8 Marks)

**Textbooks:**

1. Network Analysis Third Edition by M. E. Van Valkenburg, Prentice Hall of India Private Limited.
2. Network Analysis & Synthesis by G. K. Mittal, Khanna Publication.
3. Network Analysis and Synthesis by Ravish R Singh, McGraw Hill.
4. Introduction to Electric Circuits by Alexander & Sadiku, McGraw Hill.
5. Introduction to Electric Circuits by S. Charkarboorty, Dhanpat Rai & Co.
6. Fundamentals of Electrical Networks by B.R.Gupta & Vandana Singhal- S.Chand Publications
7. Electrical Circuit Analysis 2nd Edition by P. Ramesh babu, Scitech Publication India Pvt Ltd.

**Reference Books:**

1. Network Analysis by Cramer, McGraw Hill Publication.
2. Engineering Circuit Analysis by William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication
3. Schaum's Outline of Electric Circuits, McGraw-Hill Education; 7 edition
4. Joseph A. Edminister, Mahmood Maqvi, "Theory and Problems of Electric Circuits", Mc Graw hill
5. A Course in Electrical Circuits and Analysis, M. L. Soni, J. C. Gupta, Dhanpat rai and sons
6. 3000 solved problems in Electrical circuits, Syed A. Nasar, Mc Graw hill

**MOOCs Links and additional reading material:**

1. Network Analysis, IIT Kharagpur. [https://onlinecourses.nptel.ac.in/noc20\\_ee46/preview](https://onlinecourses.nptel.ac.in/noc20_ee46/preview)
2. Network Analysis, IIT Kharagpur. <https://nptel.ac.in/courses/108105159>

**CO-PO-PSO Mapping**

| CO   | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 3   | 3   | 2   | 2   | 2   | 1   | --  | --  | --  | --   | --   |      |      |      |
| CO2  | 2   | 3   | 3   | 2   | 2   | 1   | --  | --  | --  | --   | --   | 3    | 3    | —    |
| CO3  | 3   | 3   | 2   | 2   | 2   | 1   | --  | --  | --  | --   | --   | 3    | —    | —    |
| CO4  | 3   | 2   | 3   | 2   | 2   | 1   | --  | --  | --  | --   | --   | —    | 3    | —    |
| CO5  | 3   | 3   | 2   | 2   | 2   | 1   | --  | --  | --  | --   | --   | 3    | —    | 3    |
| Avg. | 2.8 | 2.8 | 2.4 | 2   | 2   | 1   | --  | --  | --  | --   | --   | 3    | 3    | 3    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam       | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|------------|-------|-------|-------|-------|-------|
| CCE        |       |       |       |       |       |
| CT1        | 8     | 8     |       |       |       |
| Assignment |       |       | 8     | 8     |       |
| Quiz       |       |       |       |       | 8     |
| ESE        | 12    | 12    | 12    | 12    | 12    |
| Total      | 20    | 20    | 20    | 20    | 20    |

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**Assessment Pattern**

| BT Level  | CCE |     |     |     |     | ESE |     |     |     |     |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|           | CO1 | CO2 | CO3 | CO4 | CO5 | CO1 | CO2 | CO3 | CO4 | CO5 |
|           | 8   | 8   | 8   | 8   | 8   | 12  | 12  | 12  | 12  | 12  |
| <b>L1</b> | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| <b>L2</b> | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| <b>L3</b> | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| <b>L4</b> | -   | -   | ✓   | -   | ✓   | -   | -   | ✓   | -   | ✓   |
| <b>L5</b> | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| <b>L6</b> | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

**This course serves as a prerequisite for / maps with the following future courses:**

1. Control Systems
2. Electronic Circuit Design
3. Electrical Machines & Power Systems
4. Analog & Digital Filter Design (Advanced Signal Processing)

**Job Mapping:**

Hardware / Analog Circuit Designer, RF & Telecommunications Engineer, EV Powertrain & Battery Engineer, Power Systems / Grid Engineer



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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------|---------------|---------------------------|---------------------|---------------|-----------------------|--|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>S. Y. B. Tech (Electrical Engineering)</b>                                             |                 |               |                           | <b>Semester:</b>    |               | <b>IV</b>             |  |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Numerical Methods and Computer Programming</b>                                         |                 |               |                           | <b>Course Code:</b> |               | <b>R25-EE-PCC-213</b> |  |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                           |                 |               | <b>Examination Scheme</b> |                     |               |                       |  |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Practical</b>                                                                          | <b>Tutorial</b> | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>          | <b>TW</b>     | <b>PR</b>             |  |
| 02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | --                                                                                        | --              | 02            | 40                        | 60                  | --            | --                    |  |
| <b>Course Description:</b><br>Numerical Methods and Computer Programming focus on solving mathematical and engineering problems using numerical techniques and computer programs. It helps students learn methods like solving equations, interpolation, integration, and programming skills (such as Python) to solve complex problems accurately and efficiently.                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>Course Relevance:</b><br>Numerical Methods and Computer Programming is important because it helps solve real-world engineering and scientific problems using computational methods. It develops problem-solving and programming skills that are useful in data analysis, simulation, research, and various industry applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>Prerequisite:</b><br>1. Basic Calculus, Linear Algebra<br>2. Basic Programming Skills<br>3. Basic Electrical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>Bridge Content:</b><br>Basic Programming language C, C++                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>Course Objectives:</b><br>1. To promote computational thinking and problem-solving using numerical methods.<br>2. To develop multidisciplinary analytical skills through the use of Python in engineering applications.<br>3. To enable experiential learning through hands-on projects, simulations, and coding.<br>4. To nurture lifelong learning habits through use of open-source tools and online platforms                                                                                                                                                                                                                                                                                                                                                                             |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Course Outcome</b>                                                                     |                 |               |                           |                     |               | <b>Bloom's Level</b>  |  |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Identify the suitable numerical techniques for solving engineering problems.              |                 |               |                           |                     |               | 2                     |  |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Apply root-finding methods and least squares curve fitting to solve engineering problems. |                 |               |                           |                     |               | 3                     |  |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Apply problem-solving skills in electrical signals & systems and machines.                |                 |               |                           |                     |               | 3                     |  |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Analyze the results and errors for various computational methods.                         |                 |               |                           |                     |               | 4                     |  |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Introduction to Python and Numerical Methods</b>                                       |                 |               |                           |                     | <b>7 Hrs.</b> | <b>CO1</b>            |  |
| <b>Python Basics:</b> Data types, control statements, loops, functions, modules, file handling. Libraries: Introduction to NumPy, Matplotlib, SymPy and SciPy for scientific computation.<br><b>Errors in Computation:</b> Round-off and truncation errors and error sources.<br><b>Overview of Numerical Methods:</b> Need and scope of numerical methods in multidisciplinary domains. Importance in electrical engineering applications (circuit analysis, control systems, electromagnetics, etc.)<br>Exemplars / Practical Applications and usage:<br>Smart Metering Systems: Impact of Computational Precision<br>Study how small computational errors can affect energy billing over long durations.<br>Implement simple billing logic in Python and demonstrate the effect of round-off. |                                                                                           |                 |               |                           |                     |               |                       |  |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Solution of Transcendental and polynomial equation and Curve Fitting</b>               |                 |               |                           |                     | <b>7 Hrs.</b> | <b>CO2</b>            |  |
| Bisection Method, False Position (Regula Falsi) Method, Newton-Raphson Method (for one variable), Rate of Convergence and limitations of methods.<br><b>Curve Fitting:</b> Least Squares Method (Linear and 2nd Order).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                           |                 |               |                           |                     |               |                       |  |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------|------------|
| Exemplars / Practical Applications and usage:<br>Solving nonlinear equations in electrical circuits (e.g., diode IV characteristics, motor speed equations)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                  |               |            |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Systems of Linear Algebraic Equations and Ordinary Differential Equations</b> | <b>8 Hrs.</b> | <b>CO3</b> |
| <b>Direct Methods:</b> Gauss Elimination, Partial Pivoting, Gauss-Jordan method.<br><b>Iterative Methods:</b> Jacobi Method, Gauss-Seidel Method.<br><b>Solution of First Order ODEs:</b> Euler's Method, Runge-Kutta Methods (2nd & 4th order)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                  |               |            |
| Exemplars / Practical Applications and usage:<br>Power system equations, network analysis: Solving node-voltage and mesh- current equations in electric circuits.<br>Solving Mesh Equations in a Resistive Circuit - Convert mesh or nodal analysis of a 3-loop circuit into $Ax = b$ and solve using Gauss Jordan or LU.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                  |               |            |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Interpolation, Numerical Differentiation, and Integration</b>                 | <b>8 Hrs.</b> | <b>CO4</b> |
| <b>Interpolation:</b> Newton's Forward and Backward Difference, Lagrange Interpolation.<br><b>Numerical Differentiation:</b> Using finite differences for equally spaced points.<br><b>Numerical Integration:</b> Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule (for single & double integration (Descriptive treatment only)).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                  |               |            |
| Exemplars / Practical Applications and usage:<br>Applications: Area under waveforms, energy calculations in electrical signals.<br>Given sampled data from an oscilloscope, use Simpson's Rule to compute the RMS voltage or energy.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                  |               |            |
| <b>Course Projects:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |               |            |
| ---                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                  |               |            |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                  |               |            |
| 1. S. S. Sastry – Introductory Methods of Numerical Analysis, PHI<br>2. S Kalavathy, M Joice Punitha- Numerical Methods second Edition, Mc Graw-hill Education Pvt. Ltd<br>3. B. S. Grewal - Numerical Methods in Engineering and Science, Khanna Publishers<br>4. Jaan Kiusalaas – Numerical Methods in Engineering with Python, Cambridge University Press<br>5. Steven C. Chapra – Applied Numerical Methods with Python for Engineers and Scientists, McGraw-Hill<br>6. Reema Thareja - Python Programming: Using Problem Solving Approach, Oxford University Press                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |               |            |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                  |               |            |
| 1. Steven C. Chapra, Raymond P. Canale - Numerical Methods for Engineers, McGraw-Hill<br>2. Amos Gilat, Vish Subramaniam - Numerical Methods for Engineers and Scientists, Wiley<br>3. Ruben R. Gonzalez - A First Course in Scientific Computing: Symbolic, Graphic, and Numeric Modeling Using MATLAB, Princeton University Press<br>4. Claude Gomez - Numerical Computation Using Python, Wiley (Scientific Computing series)<br>5. Rakesh Nayak - Python for Engineers and Scientists, BPB Publications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                  |               |            |
| <b>MOOCs Links and additional reading material:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                  |               |            |
| 1. Numerical Methods for Engineers by Prof. Niket Kaisare, IIT Madras:<br><a href="https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ge20/">https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ge20/</a><br>2. Computational Science and Engineering Using Python by Prof. Mahendra Verma, IIT Kanpur:<br><a href="https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-ph02/">https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-ph02/</a><br>3. Numerical Methods and Simulation Techniques for Scientists and Engineers by Prof. Saurabh Basu, IIT Guwahati: <a href="https://onlinecourses.nptel.ac.in/noc22_ph42/preview?utm_source=chatgpt.com">https://onlinecourses.nptel.ac.in/noc22_ph42/preview?utm_source=chatgpt.com</a><br>4. Numerical Analysis and Methods by Ahmad Bazzi: <a href="https://youtube.com/playlist?list=PL-DDW8QIRjNOxxzJLhxrenUXH5G-pjUC&amp;si=B9ua1-4bEwa15BSr">https://youtube.com/playlist?list=PL-DDW8QIRjNOxxzJLhxrenUXH5G-pjUC&amp;si=B9ua1-4bEwa15BSr</a><br>Numerical Methods and Computer Programming by John T. Foster<br><a href="https://www.youtube.com/playlist?list=PLCnJOMhMC0PW7IUv312SgQauEujq1HdU">https://www.youtube.com/playlist?list=PLCnJOMhMC0PW7IUv312SgQauEujq1HdU</a> |                                                                                  |               |            |

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**Strength of CO-PO-PSO Mapping**

| CO   | PO1         | PO2         | PO3      | PO4         | PO5      | PO6 | PO7 | PO8 | PO9 | PO10 | PO11     | PSO1     | PSO2     | PSO3     |
|------|-------------|-------------|----------|-------------|----------|-----|-----|-----|-----|------|----------|----------|----------|----------|
| CO1  | 1           | 3           | -        | -           | 3        | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| CO2  | 1           | -           | -        | 2           | 3        | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| CO3  | 2           | 2           | 1        | 1           | 1        | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| CO4  | -           | 3           | 1        | 1           | 1        | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| Avg. | <b>1.66</b> | <b>2.66</b> | <b>1</b> | <b>1.33</b> | <b>2</b> | -   | -   | -   | -   | -    | <b>1</b> | <b>1</b> | <b>2</b> | <b>2</b> |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam       | Unit1 | Unit2 | Unit3 | Unit4 |
|------------|-------|-------|-------|-------|
| CCE        |       |       |       |       |
| CT1        | 10    | 10    |       |       |
| Assignment |       |       | 10    | 10    |
| Quiz       |       |       |       |       |
| ESE        | 15    | 15    | 15    | 15    |
| Total      | 25    | 25    | 25    | 25    |

**Assessment Pattern**

| BT Level  | CCE |     |     |     | ESE |     |     |     |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|
|           | CO1 | CO2 | CO3 | CO4 | CO1 | CO2 | CO3 | CO4 |
|           | 10  | 10  | 10  | 10  | 15  | 15  | 15  | 15  |
| <b>L1</b> | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| <b>L2</b> | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| <b>L3</b> | -   | ✓   | ✓   | ✓   | -   | ✓   | ✓   | ✓   |
| <b>L4</b> | -   | -   | -   | ✓   | -   | -   | -   | ✓   |
| <b>L5</b> | -   | -   | -   | -   | -   | -   | -   | -   |
| <b>L6</b> | -   | -   | -   | -   | -   | -   | -   | -   |

**This course serves as a prerequisite for / maps with the following future courses:** Control Systems, Power System Analysis, Machine Learning, Signal Processing, and Simulation & Modeling.

**Job Mapping:**

Job opportunities that one can get after learning this course: Software Developer, Data Analyst, Simulation Engineer

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                 |                                                        |               |                           |                     |           |                |                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|---------------|---------------------------|---------------------|-----------|----------------|----------------------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                 | <b>S. Y. B. Tech (Electrical Engineering)</b>          |               |                           | <b>Semester:</b>    |           | 4              |                      |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                 | <b>Principles of Data Science and Machine Learning</b> |               |                           | <b>Course Code:</b> |           | R25-EE-MDM-215 |                      |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                 |                                                        |               | <b>Examination Scheme</b> |                     |           |                |                      |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Practical</b>                                                                                                                                | <b>Tutorial</b>                                        | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>          | <b>TW</b> | <b>PR</b>      |                      |
| 02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | --                                                                                                                                              |                                                        | 02            | 40                        | 60                  | --        | --             |                      |
| <b>Course Description and Relevance:</b><br>The Fundamentals of Data Science and Machine Learning course introduces the basic concepts of data analysis, data preprocessing, statistical methods, and machine learning techniques. It helps students understand how data is collected, processed, and used to develop intelligent systems for prediction, classification, and decision-making in real-world applications.<br>This subject is important because data science and machine learning are widely used in industries such as healthcare, finance, agriculture, business, and technology for data-driven decision making and automation. The course develops analytical thinking, problem-solving abilities, and programming skills, preparing students for emerging career opportunities in artificial intelligence, data analytics, and intelligent system development. |                                                                                                                                                 |                                                        |               |                           |                     |           |                |                      |
| <b>Prerequisite:</b><br><div><div>1.</div><div>Basic knowledge of mathematics and statistics.</div></div> <div><div>2.</div><div>Understanding of computer fundamentals and programming concepts.</div></div> <div><div>3.</div><div>Familiarity with Python programming and logical problem-solving.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                 |                                                        |               |                           |                     |           |                |                      |
| <b>Bridge Content:</b><br><div><div>1.</div><div>Fundamentals of Statistics and Data Handling.</div></div> <div><div>2.</div><div>Basic Concepts of Data Analysis and Visualization.</div></div> <div><div>3.</div><div>Introduction to Machine Learning Terminologies and Applications.</div></div> <div><div>4.</div><div>Problem-Solving and Logical Thinking Techniques.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                 |                                                        |               |                           |                     |           |                |                      |
| <b>Course Objectives:</b><br><div><div>1.</div><div>To understand core data science concepts, tools, and applications in electrical engineering.</div></div> <div><div>2.</div><div>To develop skills in data collection, preprocessing, visualization, and basic statistics for engineering decisions.</div></div> <div><div>3.</div><div>To introduce machine learning types, workflows, and applications in electrical engineering using standard tools.</div></div> <div><div>4.</div><div>To apply supervised and unsupervised ML techniques and evaluation metrics using scikit-learn in engineering tasks.</div></div>                                                                                                                                                                                                                                                      |                                                                                                                                                 |                                                        |               |                           |                     |           |                |                      |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                 |                                                        |               |                           |                     |           |                |                      |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Course Outcome</b>                                                                                                                           |                                                        |               |                           |                     |           |                | <b>Bloom's Level</b> |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Process</b> data using NumPy and Pandas; Apply descriptive statistics and identify data science roles and tools for electrical engineering,. |                                                        |               |                           |                     |           |                | <b>3</b>             |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Differentiate</b> structured and unstructured data; collect, clean, visualize electrical data and understand hypothesis testing concepts.    |                                                        |               |                           |                     |           |                | <b>4</b>             |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Differentiate</b> AI, ML, DL, describe ML workflow, apply in electrical systems .                                                            |                                                        |               |                           |                     |           |                | <b>4</b>             |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Apply</b> Linear Regression, K-Nearest Neighbors, K-Means Clustering to electrical data, evaluate models, implement using scikit-learn.      |                                                        |               |                           |                     |           |                | <b>3</b>             |

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| Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                          |               |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|---------------|------------|
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Fundamentals of Data Science and Applications in Electrical Engg.</b> | <b>6 Hrs.</b> | <b>CO1</b> |
| <p>Data Science: Concept, Key components and lifecycle, Introduction to NumPy, Pandas., Descriptive statistics: mean, median, mode, std deviation, Applications in Electrical Engineering: Load forecasting using curve fitting method, Smart grids for next monthly electric bill (energy consumption) prediction, Fault prediction etc., Roles in data science: Analyst, Engineer, Scientist. (Limited to Self-Study) ,Overview of tools: Python, R, Jupyter, Excel (Limited to Self-Study).</p> <p><b>Exemplars / Practical Applications and usage:</b><br/>Analysis of electrical system data for performance monitoring and fault detection. Load forecasting and energy consumption prediction using data analysis techniques. Predictive maintenance of electrical equipment using machine learning methods. Data visualization for power system parameters and electrical measurements. Smart grid and automation applications using data-driven decision-making.</p>     |                                                                          |               |            |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Data Acquisition, Visualization, and Hypothesis Testing</b>           | <b>6 Hrs.</b> | <b>CO2</b> |
| <p>Data sources: SCADA, IoT sensors, meters (Limited to Data Extraction), Structured vs unstructured data, time-series in electrical systems, Data preprocessing: handling missing values, outliers, duplicates. Visualization tools: matplotlib, seaborn: Line plot, histogram, boxplot, scatter plot. Hypothesis testing: Null and alternate hypotheses, p-value, significance level, type I/II errors, t-test and z-test (conceptual introduction). Test case: Load comparison before and after processing.</p> <p><b>Exemplars / Practical Applications and usage:</b><br/>Collecting and processing real-world data from sensors, surveys, and databases. Visualizing data using graphs, charts, and dashboards for better analysis. Identifying trends and patterns through data exploration techniques. Applying hypothesis testing to validate assumptions and make data-driven decisions. Using statistical analysis for quality control and performance evaluation.</p> |                                                                          |               |            |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Introduction to Machine Learning (ML)</b>                             | <b>6 Hrs.</b> | <b>CO3</b> |
| <p>Machine Learning (ML): Concept, scope of ML, Differences between Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) ,ML Types: Supervised, Unsupervised Learning and Reinforcement learning (Examples identification of ML Types) ML pipeline: Data → Train → Predict → Evaluate, Electrical Applications: Predictive maintenance, Load and outage forecasting, Fault classification etc.</p> <p><b>Exemplars / Practical Applications and usage:</b><br/>Developing prediction models for sales, weather, and energy forecasting. Classification of data such as spam detection and disease prediction. Pattern recognition in images, speech, and text data. Recommendation systems used in e-commerce and online platforms. Automation of decision-making processes using machine learning algorithms.</p>                                                                                                                                         |                                                                          |               |            |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Basic ML Algorithms and Model Evaluation</b>                          | <b>CO4</b>    |            |
| <p>Introduction to scikit-learn and model-building steps. Supervised Learning: Linear Regression (for load forecasting), K-Nearest Neighbors (for fault classification) Unsupervised Learning: K-Means Clustering (load profile segmentation), Model Evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-Score, Cross-validation basics Simple Python implementation using scikit-learn.</p> <p><b>Exemplars / Practical Applications and usage:</b><br/>Applying regression algorithms for prediction and forecasting tasks. Using classification algorithms for spam filtering and fraud detection. Clustering data for customer segmentation and pattern analysis. Evaluating model performance using accuracy, precision, recall, and F1-score. Comparing machine learning models to select the best-performing solution for real-world applications.</p>                                                                                                           |                                                                          |               |            |
| <b>Comprehensive Continuous Evaluation (CCE) components for the course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                          |               |            |
| <p><b>1. Course Projects (Mini/Micro Project):</b><br/>-Student Performance Prediction System using Machine Learning. Electricity Consumption Analysis and Forecasting using Data Science Techniques. Weather Prediction using Basic Machine Learning Algorithms.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                          |               |            |

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Spam Email Detection using Classification Algorithms. Sales Data Analysis and Visualization using Python Libraries. Smart Attendance Analysis System using Data Analytics. House Price Prediction using Regression Techniques. Health Data Analysis and Disease Prediction System. Customer Segmentation using Clustering Algorithms. Power System Fault Detection using Machine Learning Techniques.

## 2. Class Tests / Unit Tests: Unit ..... and Unit....(any two units)

The teacher can suggest the most appropriate and relevant components for CCE evaluation from the following (shall cover all the remaining units)

Open ended Assignments, Quiz / MCQ Tests, Case Study Analysis, Seminar / Presentation, Group Discussion / Team Activity, Industry Visit / Field Visit Report, Poster Presentation etc.

### Textbooks:

[T1]. VanderPlas, Jake. Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media, 2016.

[T2]. Raschka, Sebastian & Mir Jalili, Vahid. Python Machine Learning. Packet Publishing, 3rd Edition, 2019.

[T3]. McKinney, Wes. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I Python. O'Reilly Media, 2nd Edition, 2017.

[T4]. Alladin, Ethem. Introduction to Machine Learning. MIT Press, 4th Edition, 2020.

### Reference Books:

[R1]. Saxena, Atulya K. Data Science and Machine Learning Applications in Engineering. CRC Press, 2021.

[R2]. James, Gareth et al. An Introduction to Statistical Learning with Applications in R. Springer, 2nd Edition, 2021.

[R3]. IEEE papers and case studies on Smart Grids, Load Forecasting, and Predictive Maintenance

### MOOCs Links and additional reading material:

[E1]. <https://colab.research.google.com> – Google Collab environment

[E2]. <https://scikit-learn.org> – Machine Learning Library Documentation

[E3]. <https://matplotlib.org>, <https://seaborn.pydata.org> – Visualization libraries

[E4]. Kaggle Datasets – Sample datasets for electrical applications

1. Data Science for Engineers - Course
2. The Joy of Computing using Python - Course
3. Python For Data Science - Course
4. Introduction to Machine Learning - Course
5. Introduction to Machine Learning - IITKGP - Course

## CO-PO-PSO Mapping

| CO   | PO1 | PO2  | PO3 | PO4 | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|------|-----|-----|------|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 3   | 2    | -   | -   | 2    | -   | -   | -   | -   | -    | -    | 2    | 1    | -    |
| CO2  | 3   | 3    | 1   | 1   | 3    | -   | -   | -   | -   | -    | -    | 3    | 2    | -    |
| CO3  | 2   | 3    | 2   | 2   | 3    | -   | -   | -   | 1   | -    | -    | 3    | 2    | 1    |
| CO4  | 2   | 3    | 3   | 3   | 3    | -   | -   | -   | 2   | 1    | -    | 3    | 3    | 2    |
| Avg. | 2.5 | 2.75 | 2   | 2   | 2.75 | -   | -   | -   | 1.5 | 1    | 1    | 2.75 | 2    | 1.5  |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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**Unit wise Weightage:**

| Exam  | Unit1 | Unit2 | Unit3 | Unit4 |
|-------|-------|-------|-------|-------|
| CCE 1 | 10    | 10    | -     | -     |
| CCE 2 | -     | -     | 10    | -     |
| CCE 3 | -     | -     | -     | 10    |
| ESE   | 15    | 15    | 15    | 15    |
| Total | 25    | 25    | 25    | 25    |

| Assessment Pattern |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| BT Level           | CCE |     |     |     | ESE |     |     |     |
|                    | CO1 | CO2 | CO3 | CO4 | CO1 | CO2 | CO3 | CO4 |
|                    | 8   | 8   | 8   | 8   | 12  | 12  | 12  | 12  |
| L1                 | √   | √   | √   | √   | √   | √   | √   | √   |
| L2                 | √   | √   | √   | √   | √   | √   | √   | √   |
| L3                 | √   | √   | √   | √   | √   | √   | √   | √   |
| L4                 | –   | √   | √   | -   | –   | √   | √   | -   |
| L5                 | –   | –   | –   | –   | –   | –   | –   | –   |
| L6                 | –   | –   | –   | –   | –   | –   | –   | –   |

This course serves as a prerequisite for / maps with the following future courses:

**Job Mapping:**

Job opportunities that one can get after learning this course:

Data Analyst ,Machine Learning Engineer,Data Science Associate, Python Developer, Business Intelligence Analyst ,AI and ML Engineer ,Research Assistant in Data Analytics ,Software Developer for Intelligent Systems Predictive Analytics Specialist ,Data Visualization Engineer.



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                        |                                                        |               |                           |                     |           |                        |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|--------------------------------------------------------|---------------|---------------------------|---------------------|-----------|------------------------|--|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                        | <b>S. Y. B. Tech (Electrical Engineering)</b>          |               |                           | <b>Semester:</b>    |           | <b>IV</b>              |  |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                        | <b>Electrical Workshop &amp; Engineering Materials</b> |               |                           | <b>Course Code:</b> |           | <b>R25-EE-VSEC-216</b> |  |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                        |                                                        |               | <b>Examination Scheme</b> |                     |           |                        |  |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Practical</b>                                                                       | <b>Tutorial</b>                                        | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>          | <b>TW</b> | <b>OR</b>              |  |
| 01                                                                                                                                                                                                                                                                                                                                                                                                                                                       | --                                                                                     |                                                        | 01            | --                        | --                  | 25        | 25                     |  |
| <b>Course Description and Relevance:</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Description:</b> This course provides hands-on training in basic electrical workshop practices and introduces students to the properties and applications of engineering materials used in electrical systems. It bridges theoretical knowledge with practical skills, preparing students for real-world engineering challenges.                                                                                                                      |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Relevance:</b> This course is foundational for electrical engineers, as it combines practical workshop skills with material science knowledge, both essential for professional practice. Ability to wire, assemble, and test electrical systems safely, understanding which materials suit specific electrical applications. Prepare students for lab work, internships, and industrial projects, Ensures compliance with electrical safety standards |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Prerequisite:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 1. Basic knowledge of Electrical connections and operations                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 2. Basic knowledge of semiconductor devices                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Bridge Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 1. Tools & Materials Relationship                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 2. Wiring & Material Selection                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 3. Safety & Reliability                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 4. Innovation & Sustainability                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 1. Develop Practical Electrical Skills.                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 2. Understand Engineering Materials.                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 3. Integrate Materials with Electrical Applications.                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| 4. Promote Safety and Industry Readiness.                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                              |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Course Outcome</b>                                                                  |                                                        |               |                           |                     |           | <b>Bloom's Level</b>   |  |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Apply</b> basic electrical workshop practices                                       |                                                        |               |                           |                     |           | <b>3</b>               |  |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Explain</b> the properties and applications of engineering materials                |                                                        |               |                           |                     |           | <b>2</b>               |  |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Analyze</b> material suitability for electrical systems                             |                                                        |               |                           |                     |           | <b>4</b>               |  |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Integrate</b> safety standards and sustainable practices in electrical applications |                                                        |               |                           |                     |           | <b>3</b>               |  |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Electrical Workshop Fundamentals</b>                                                |                                                        |               |                           | <b>4 Hrs.</b>       |           | <b>CO1</b>             |  |
| Introduction to electrical tools and instruments (pliers, screwdrivers, testers, multimeters, soldering iron). Types of wiring systems: house wiring, industrial wiring, and their layouts. Safety measures: earthing, fuses, circuit breakers, and protective devices. Practical exercises: simple circuit assembly, lamp control, and troubleshooting                                                                                                  |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Conducting and Insulating Materials</b>                                             |                                                        |               |                           | <b>4 Hrs.</b>       |           | <b>CO2</b>             |  |
| Classification of engineering materials: conductors, insulators, semiconductors. Properties of conducting materials: copper, aluminum, silver. Properties of insulating materials: Ceramics, Plastics, Glass, Rubber. Applications in cables, transformers, motors, and switchgear.                                                                                                                                                                      |                                                                                        |                                                        |               |                           |                     |           |                        |  |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Magnetic Materials</b>                                                              |                                                        |               |                           | <b>4 Hrs.</b>       |           | <b>CO3</b>             |  |
| Magnetic materials: Soft and Hard magnetic materials, Hysteresis, and its applications in electrical machines.                                                                                                                                                                                                                                                                                                                                           |                                                                                        |                                                        |               |                           |                     |           |                        |  |



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Differences between Magnetic and semiconductor material.

|                                                                                                                                                                                                                                                                                                                                                                                            |                                |               |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------|------------|
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                              | <b>Semiconductor Materials</b> | <b>3 Hrs.</b> | <b>CO4</b> |
| Introduction to Semiconductors, Definition and classification of Semiconductor materials (intrinsic vs. extrinsic semiconductors) Explain Silicon, Germanium, and Compound Semiconductors. Superconducting materials and their applications in power systems.                                                                                                                              |                                |               |            |
| <b>Comprehensive Continuous Evaluation (CCE) components for the course:</b>                                                                                                                                                                                                                                                                                                                |                                |               |            |
| ----                                                                                                                                                                                                                                                                                                                                                                                       |                                |               |            |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                          |                                |               |            |
| 1. Electrical Engineering Materials – R.K. Rajput S. Chand & Company Ltd. (New Delhi, India)<br>2. Basic Electrical Engineering – D.P. Kothari & I.J. Nagrath Tata McGraw-Hill Education Pvt. Ltd. (India)<br>3. A Textbook of Electrical Technology (Vol. 1: Basic Electrical Engineering) – B.L. Theraja & A. K. Theraja<br>4. Electrical Materials and Wiring Practices – B.H. Deshmukh |                                |               |            |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                    |                                |               |            |
| 1. Electrical Installation and Workshop Practices by John F. Whitfield – for Unit 1 (tools, wiring, safety).<br>2. Handbook of Automotive Power Electronics and Motor Drives by Ali Emadi<br>3. Electrical Engineering Materials and Applications by J.B. Gupta                                                                                                                            |                                |               |            |
| <b>MOOCs Links and additional reading material:</b>                                                                                                                                                                                                                                                                                                                                        |                                |               |            |
| 1. <b>A Basic Course on Electric and Magnetic Circuits</b> By Prof. Ashok Kumar Pradhan IIT Kharagpur<br><a href="#">Preview: A Basic Course on Electric and Magnetic Circuits   SWAYAM</a>                                                                                                                                                                                                |                                |               |            |

**CO-PO-PSO Mapping**

| CO   | PO1  | PO2  | PO3  | PO4 | PO5  | PO6 | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|------|------|------|-----|------|-----|-----|-----|------|------|------|------|------|------|
| CO1  | 2    | 1    | 1    | 1   | 1    | 2   | 2   | 1   | 2    | 1    | 2    | -    | -    | -    |
| CO2  | 2    | 2    | 1    | 2   | 1    | 3   | 2   | 1   | 2    | 1    | 2    | -    | -    | -    |
| CO3  | 1    | 1    | 1    | 1   | 1    | 2   | 2   | 1   | 1    | 1    | 2    | -    | -    | -    |
| CO4  | 2    | 2    | 2    | 2   | 2    | 3   | 2   | 1   | 2    | 1    | 3    | -    | -    | -    |
| Avg. | 1.75 | 1.50 | 1.25 | 1.5 | 1.25 | 2.5 | 2   | 1   | 1.75 | 1    | 2.22 | -    | -    | -    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Assessment Pattern**

| BT Level | CCE |     |             |                |                             |                          | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
|          | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. |     |
| K1       | -   | -   | -           | -              | -                           | -                        | -   |
| K2       | -   | -   | -           | -              | -                           | -                        | -   |
| K3       | -   | -   | -           | -              | -                           | -                        | -   |
| K4       | -   | -   | -           | -              | -                           | -                        | -   |
| K5       | -   | -   | -           | -              | -                           | -                        | -   |
| K6       | -   | -   | -           | -              | -                           | -                        | -   |

**Assessment Table:**

| EXAM                                | Particular | CO1 | CO2 | CO3 | CO4 | CO5 |
|-------------------------------------|------------|-----|-----|-----|-----|-----|
| Knowledge and Attitude Profile (WK) |            | -   | -   | -   | -   | -   |

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|       |                             |   |   |   |   |   |
|-------|-----------------------------|---|---|---|---|---|
| CCE   | CT1                         | - | - | - | - | - |
|       | CT2                         | - | - | - | - | - |
|       | Assignments                 | - | - | - | - | - |
|       | Course Project              | - | - | - | - | - |
|       | Field Activity / Case Study | - | - | - | - | - |
|       | Quiz / presentation etc.    | - | - | - | - | - |
| ESE   |                             | - | - | - | - | - |
| Total |                             | - | - | - | - | - |

**Unit-wise Weightage:**

| Exam  | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|-------|-------|-------|-------|-------|-------|
| CT1   | -     | -     | -     | -     | -     |
| CT2   | -     | -     | -     | -     | -     |
| ESE   | -     | -     | -     | -     | -     |
| Total | -     | -     | -     | -     | -     |

This course serves as a prerequisite for / maps with the following future courses:

**Job Mapping:**

Job opportunities that one can get after learning this course:

After completing this course, students can explore career opportunities in industries and organizations focused on environmental sustainability, energy management, and green technologies.



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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------|---------------------------|------------|------------------------|----------------------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                  | <b>S. Y. B. Tech</b>                                                            |               | <b>Semester:</b>          |            | <b>IV</b>              |                      |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                  | <b>Electrical Workshop &amp; Engineering Materials (Electrical Engineering)</b> |               | <b>Course Code:</b>       |            | <b>R25-EE-VSEC-216</b> |                      |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                  |                                                                                 |               | <b>Examination Scheme</b> |            |                        |                      |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Practical</b>                                                 | <b>Tutorial</b>                                                                 | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b> | <b>TW</b>              | <b>OR</b>            |
| --                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 02                                                               | -                                                                               | 01            | -                         | -          | 25                     | 25                   |
| <b>Course Description and Relevance:</b><br>This course bridges theoretical circuit analysis and physical application, providing second-year students with hands-on experience in domestic and industrial wiring, power distribution, and machine diagnostics. By mastering assembly techniques and safety protocols, such as grounding and insulation testing, students translate mathematical models into functional systems. This practicum is essential for developing the technical proficiency and regulatory literacy required for modern power systems and infrastructure maintenance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                  |                                                                                 |               |                           |            |                        |                      |
| <b>Prerequisite:</b><br>Basic knowledge of Passive component (R,L,C), Knowledge of Circuit barker, Knowledge of market survey for component, Basic knowledge Electrical safety equipment, Knowledge of working of different electrical domestic and industrial appliances                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                  |                                                                                 |               |                           |            |                        |                      |
| <b>Bridge Content:</b><br>Revision of basic concepts of current, voltage, resistance, and power, Types of household equipment, Wiring type (1phase and 3phase) Basic idea of AC vs. DC supply. Recap of safety precautions while handling electrical equipment, Introduction to basic computer usage and online software environment for simple debugging of program.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                  |                                                                                 |               |                           |            |                        |                      |
| <b>Course Objectives:</b><br>1. <b>Develop</b> hardware skills such as soldering and winding etc<br>2. <b>Explore</b> debugging skills.<br>3. <b>Analysis</b> and test Electrical circuits.<br>4. <b>Market Survey</b> of available Components to prepare demo model.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                  |                                                                                 |               |                           |            |                        |                      |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                  |                                                                                 |               |                           |            |                        |                      |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Course Outcome</b>                                            |                                                                                 |               |                           |            |                        | <b>Bloom's Level</b> |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Sketch/Design/draw the electrical circuit for given application. |                                                                                 |               |                           |            |                        | 3                    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Understand data Manual/data sheet for a specified application.   |                                                                                 |               |                           |            |                        | 2                    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Repair and Test electrical appliances/circuits.                  |                                                                                 |               |                           |            |                        | 4                    |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Acquire Hardware skills to fabricate designed Circuits.          |                                                                                 |               |                           |            |                        | 3                    |
| <b>List of Practical:</b><br><b>Group A (Electrical Components) (Minimum 3 Exercises from this group)</b><br>1. Demonstrative model of domestic wiring to control one fan and two lamps through switch board.<br>2. Distribution box wiring for components like MCB, MCCB, ELCB, RCCB<br>3. Repairing of Ceiling / Table fan/ Mixer/Grinder / Electric Iron<br>4. Wiring and realization of contactor-based Star Delta starter.<br>5. Design and fabrication of reactor for various inductance values.<br><br><b>Group B (Electronic Circuits) (Minimum 2 Exercises from this group)</b><br>This group consist of Electronic Circuits that must be assembled on general purpose PCB.<br>1. Design and Development of combined Dual 12 volt and Dual 5 volt regulated power supply.<br>2. Design and Development of PWM generator for various values of PWM.<br>3. Design and Development of Object counter circuit.<br>4. Design and Development of Electronic Fan speed regulator<br>5. Design of Traffic light control using time delay circuits.<br><br><b>Group C (Arduino based applications) (Minimum 3 Exercises from this group)</b><br>(All interfacing circuits for Arduino boards must be assembled on general purpose PCB's/ Bread board)<br>1. Switch based Relay control using Arduino board. |                                                                  |                                                                                 |               |                           |            |                        |                      |

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| <b>2. DC motor speed control using Arduino board.</b><br><b>3. String of character display on 16 X 2 LCD display using Arduino board.</b><br><b>4. Measurement and display of Temperature using Arduino board.</b><br><b>5. Distance measurement using Arduino board.</b><br><b>6. Generate Square and Triangular wave using Arduino board.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                      |
| <b>Experiment No. 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Demonstrative model of domestic wiring to control one fan and two lamps through switch board.</b> |
| <p><b>Objective:</b> To construct a functional domestic wiring circuit that demonstrates the parallel control of a ceiling fan and two lamps using a centralized switchboard.</p> <p><b>Associated Tasks:</b><br/>           Circuit Mapping: Designing the layout for phase, neutral, and earth connections.<br/>           Component Mounting: Installing two-way/one-way switches, a fan regulator, and lamp holders onto a switchboard.<br/>           Wiring &amp; Termination: Stripping and securing conductors to terminals according to standard color codes.<br/>           Safety Testing: Conducting continuity and polarity checks before energizing the circuit.</p> <p><b>Exemplars and Utility:</b> This model serves as a primary blueprint for residential electrification, enabling students to master practical load distribution and the integration of control devices like regulators and switches.</p>                                          |                                                                                                      |
| <b>Experiment No. 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Distribution box wiring for components like MCB, MCCB, ELCB, RCCB</b>                             |
| <p><b>Objective:</b> To assemble a distribution panel that safeguards circuits and personnel through automated fault detection and isolation.</p> <p><b>Associated Tasks:</b><br/>           Mounting: Securing the MCCB, RCCB, and MCBs onto a DIN rail.<br/>           Wiring: Connecting the incoming supply to protective devices using busbars or jumpers.<br/>           Earthing: Terminating neutral and ground wires to their respective busbar links.<br/>           Validation: Testing for proper trip coordination and insulation resistance.</p> <p><b>Exemplars and Utility:</b> This system acts as the primary safety interface for electrical installations, preventing fires from overloads and protecting users from lethal electric shocks.</p>                                                                                                                                                                                                    |                                                                                                      |
| <b>Experiment No. 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Repairing of Ceiling/ Table fan/ Mixer/ Grinder/ Electric Iron</b>                                |
| <p><b>Objective:</b><br/>           To learn the basic principles, common faults, and repair/maintenance procedures of domestic electrical appliances.</p> <p><b>Associated Tasks:</b><br/>           Identify different home appliances and their working principles.<br/>           Study the internal parts and wiring of selected appliances.<br/>           Learn the use of basic tools (screwdriver, plier, tester, multimeter, soldering iron).<br/>           Diagnose common faults such as loose connections, blown fuse, damaged wire, or heating element failure.<br/>           Carry out minor repairs (e.g., rewiring, fuse replacement, cleaning, and lubrication of fan bearings).<br/>           Test the repaired appliance for safe and proper working.<br/>           Record safety precautions and preventive maintenance tips</p> <p><b>Exemplars and Utility:</b><br/>           Reduces cost of maintenance and dependency on technicians</p> |                                                                                                      |
| <b>Experiment No. 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Wiring and realization of contactor-based Star Delta starter.</b>                                 |
| <p><b>Objective:</b> To wire a control and power circuit that minimizes starting current surge by transitioning a three-phase motor from star to delta configuration.</p> <p><b>Associated Tasks:</b><br/>           Wiring: Connecting three contactors, an OLR, and a timer for automatic transition.<br/>           Interlocking: Implementing electrical locks to prevent simultaneous star-delta engagement.</p> <p><b>Exemplars and Utility:</b> This is the standard industrial method for starting large motors in pumps and conveyors to protect the power grid and motor windings from excessive thermal stress.</p>                                                                                                                                                                                                                                                                                                                                          |                                                                                                      |
| <b>Experiment No. 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Design and fabrication of reactor for various inductance values.</b>                              |
| <p><b>Objective:</b> To design and construct an inductor (reactor) that achieves specific inductance values by calculating and winding a designated number of turns on a core.</p> <p><b>Associated Tasks:</b><br/>           Design: Calculating turns and wire gauge based on required L and current ratings.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                      |



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| <p>Fabrication: Winding conductors onto a former and assembling the magnetic core.</p> <p>Measurement: Verifying inductance values using an LCR meter.</p> <p><b>Exemplars and Utility:</b></p> <p>This process is fundamental for creating custom filters and chokes used in power electronics to smooth current ripples and mitigate harmonic distortion.</p>                                                                                                                                                                                                                                                             |                                                                                               |
| <b>Experiment No. 6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Design and Development of combined Dual 12 volt and Dual 5 volt regulated power supply</b> |
| <p><b>Objective:</b> To construct a multi-rail DC power supply providing stable 12V and 5V outputs from an AC source.</p> <p><b>Associated Tasks:</b></p> <p>Integration: Wiring a step-down transformer, bridge rectifier, and smoothing capacitors.</p> <p>Regulation: Utilizing 78xx and 79xx series ICs to maintain constant voltage levels.</p> <p>Verification: Testing output precision and thermal stability under load.</p> <p><b>Exemplars and Utility:</b></p> <p>This circuit acts as an essential benchtop tool, simultaneously powering digital logic and analog components during electronic prototyping</p> |                                                                                               |
| <b>Experiment No. 7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Design and Development of PWM generator for various values of PWM</b>                      |
| <p><b>Objective:</b> To build a circuit that produces a variable duty cycle signal for precise control over power delivery to electrical loads.</p> <p><b>Associated Tasks:</b></p> <p>Assembly: Configuring a 555 timer or microcontroller circuit with a potentiometer for pulse adjustment.</p> <p>Analysis: Using an oscilloscope to verify duty cycle range and signal frequency.</p> <p><b>Exemplars and Utility:</b> This device is the standard controller for DC motor speed and LED brightness, enabling high-efficiency power management with minimal heat loss.</p>                                             |                                                                                               |
| <b>Experiment No. 8</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Design and Development of Object counter circuit.</b>                                      |
| <p><b>Objective:</b> To automate the detection and tallying of physical items using electronic sensors to ensure accuracy and efficiency in data collection.</p> <p><b>Task &amp; Example:</b> The system uses an IR sensor pair to detect a "break" in a light beam; for example, as a product moves down a conveyor belt, each interruption sends a signal to a microcontroller that updates a digital display.</p> <p><b>Exemplars and Utility:</b> It provides high-speed, error-free monitoring of production volumes and foot traffic in industrial or commercial settings.</p>                                       |                                                                                               |
| <b>Experiment No. 9</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Design and Development of Electronic Fan speed regulator</b>                               |
| <p><b>Objective:</b> To achieve precise, energy-efficient control of fan speed by modulating the electrical power delivered to the motor.</p> <p><b>Task &amp; Example:</b> A <b>potentiometer</b> adjusts the firing angle of a <b>TRIAC</b> to slice the AC waveform; for instance, turning the knob increases resistance, which reduces the voltage sent to the fan, effectively slowing it down.</p> <p><b>Utility:</b> It enables step-less speed adjustment and reduces power consumption compared to traditional resistive regulators.</p>                                                                           |                                                                                               |
| <b>Experiment No. 10</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Switch based Relay control using Arduino board..</b>                                       |
| <p><b>Objective:</b> To safely control a high-power device using a low-power Arduino signal triggered by a manual switch.</p> <p><b>Task &amp; Example:</b> The Arduino detects a button press and triggers a Relay Module to close a high-voltage circuit; for example, pressing a small tactile switch to turn a 120V/230V light bulb on or off.</p> <p><b>Utility:</b> It provides electrical isolation, allowing a microcontroller to manage heavy-duty appliances like motors, heaters, or home lighting systems safely.</p>                                                                                           |                                                                                               |
| <b>Experiment No. 11</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>DC motor speed control using Arduino board</b>                                             |
| <p><b>Objective:</b> To regulate the rotational speed of a DC motor by using <b>Pulse Width Modulation (PWM)</b> to vary the average voltage delivered to the motor.</p> <p><b>Task &amp; Example:</b> The Arduino outputs a PWM signal to a Motor Driver (e.g., L293D) based on an input; for instance, turning a potentiometer scales the signal from 0 to 255, causing a small robot wheel to spin faster or slower.</p> <p><b>Utility:</b> Essential for precision motion in robotics, conveyor systems, and variable-speed cooling fans</p>                                                                            |                                                                                               |
| <b>Experiment No. 12</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>String of character display on 16 X 2 LCD display using Arduino board.</b>                 |



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**Objective:** To visualize alphanumeric text and system data by interfacing an Arduino with a 16x2 LCD module.

**Task & Example:** The **Arduino** communicates via the `LiquidCrystal` library to control the LCD's pixels; for instance, executing `lcd.print("Temp: 25C")` sends character codes that render the specific text on the display's liquid crystal grid.

**Utility:** Provides a simple, low-power visual interface for displaying sensor outputs, error messages, or user instructions in electronic devices

#### Experiment No. 13 Measurement and display of Temperature using Arduino board.

**Objective:** To electronically sense ambient thermal energy and convert it into human-readable digital data.

**Task & Example:** An **Arduino** processes voltage from a **temperature sensor** (like LM35) using mathematical calibration; for instance, converting a 250mV input into a **25°C** text output on a display.

**Utility:** Enables automated thermal management for industrial safety, food storage, and smart climate control.

#### Experiment No. 14 Distance measurement using Arduino board.

**Objective:** To measure the distance of an object using an ultrasonic sensor interfaced with an Arduino board.

**Procedure:** Connect the HC-SR04 sensor to the Arduino, write and upload a code to trigger the sensor, read echo time, and calculate distance using the formula  $Distance = (Time \times Speed\ of\ Sound)/2$ .

**Exemplar:** The Arduino displays the measured distance (in cm) of an obstacle on the Serial Monitor or LCD screen.

#### Experiment No. 15 Generate Square and Triangular wave using Arduino board.

**Objective:** To generate square and triangular wave using with an Arduino board.

Connect the Arduino board to the computer using a USB cable.

Open the Arduino IDE from Arduino Official Website.

Write a program to generate a square wave by toggling a digital output pin HIGH and LOW with delay intervals.

Upload the square wave program to the Arduino board.

Observe the square wave output on an oscilloscope or CRO from the selected output pin.

Write a program to generate a triangular wave using PWM and incremental duty cycle variation.

Connect an RC low-pass filter at the PWM output pin to smooth the waveform.

Upload the triangular wave program to the Arduino board.

Observe the triangular waveform on the oscilloscope or CRO.

**Exemplar:** The Arduino displays the measured distance (in cm) of an obstacle on the Serial Monitor or LCD screen.

#### Strength of CO-PO-PSO Mapping

| CO   | PO1  | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| CO1  | 3    | 2   | 2   | 3   | 2   | 2   | 1   | 3   | 2    | 3    | 2    | 1    | 2    | 2    |
| CO2  | 2    | 1   | 3   | 2   | 2   | 1   | 1   | 1   | 2    | 2    | 2    | 2    | 1    | 2    |
| CO3  | 3    | 3   | 2   | 3   | 2   | 2   | -   | 2   | 1    | 3    | 2    | 1    | 1    | 1    |
| CO4  | 3    | 2   | 3   | 2   | 2   | 1   | -   | 2   | 2    | 3    | 3    | 1    | 2    | 2    |
| Avg. | 2.75 | 2   | 2.5 | 2.5 | 2   | 1.5 | 1   | 2   | 1.75 | 2.75 | 2.25 | 1.25 | 1.5  | 1.75 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

#### Assessment Pattern

| BT Level | CCE |     |             |                |                             |                          | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
|          | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. |     |
| K1       | -   | -   | -           | -              | -                           | -                        | -   |
| K2       | -   | -   | -           | -              | -                           | -                        | -   |
| K3       | -   | -   | -           | -              | -                           | -                        | -   |
| K4       | -   | -   | -           | -              | -                           | -                        | -   |



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|    |   |   |   |   |   |   |   |
|----|---|---|---|---|---|---|---|
| K5 | - | - | - | - | - | - | - |
| K6 | - | - | - | - | - | - | - |

**Assessment Table:**

| EXAM                                | Particular                  | CO1 | CO2 | CO3 | CO4 | CO5 |
|-------------------------------------|-----------------------------|-----|-----|-----|-----|-----|
| Knowledge and Attitude Profile (WK) |                             | -   | -   | -   | -   | -   |
| CCE                                 | CT1                         | -   | -   | -   | -   | -   |
|                                     | CT2                         | -   | -   | -   | -   | -   |
|                                     | Assignments                 | -   | -   | -   | -   | -   |
|                                     | Course Project              | -   | -   | -   | -   | -   |
|                                     | Field Activity / Case Study | -   | -   | -   | -   | -   |
|                                     | Quiz / presentation etc.    | -   | -   | -   | -   | -   |
| ESE                                 |                             | -   | -   | -   | -   | -   |
| Total                               |                             | -   | -   | -   | -   | -   |

**Unit-wise Weightage:**

| Exam  | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|-------|-------|-------|-------|-------|-------|
| CT1   | -     | -     | -     | -     | -     |
| CT2   | -     | -     | -     | -     | -     |
| ESE   | -     | -     | -     | -     | -     |
| Total | -     | -     | -     | -     | -     |

**This course serves as a prerequisite for / maps with the following future courses:**

The Electrical Workshop Practice practical course serves as a foundation and prerequisite for several future courses such as Basic Electrical Engineering, Electrical Machines, Power Electronics, Control Systems, Industrial Wiring and Installation, Microcontroller and Embedded Systems, Electrical Maintenance and Safety, and Automation and PLC, as it provides essential practical knowledge of tools, wiring, safety procedures, circuit connections, and electrical equipment handling required for advanced electrical and electronics engineering studies.

**Job Mapping:**

Electrical Technician / Wiring Supervisor, Maintenance Engineer, Junior Design/Simulation Engineer

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                       |                                              |        |                    |     |                |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--------|--------------------|-----|----------------|---------------|
| Program:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                       | S. Y. B. Tech                                |        | Semester:          |     | IV             |               |
| Course:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                       | Modern Indian Language and Technical Writing |        | Course Code:       |     | R25-EE-MDM-217 |               |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                       |                                              |        | Examination Scheme |     |                |               |
| Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Practical                                                                                                                                             | Tutorial                                     | Credit | CCE                | ESE | TW             | PR            |
| --                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2 Hrs/Week                                                                                                                                            | 1Hrs/Week                                    | --     | --                 | --  | 50             | --            |
| Course Description and Relevance:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                       |                                              |        |                    |     |                |               |
| <p>मराठी अभ्यासक्रम उच्च शिक्षण स्तरावर भारताच्या भाषिक वारशाचे जतन व प्रसार करण्याचे उद्दिष्ट पूर्ण करतो. भारतीय ज्ञान प्रणाली (IKS) या अभ्यासक्रमात अभ्यासल्या जाणाऱ्या वारकरी, भक्ती आणि लोकसाहित्य परंपरा NEP च्या भारतीय ज्ञान वारसा आधुनिक अभ्यासक्रमात एकत्रित करण्याच्या भूमिकेशी थेट सुसंगत आहेत. बहुभाषिकता व सांस्कृतिक बांधिलकी NEP २०२० त्रिभाषिक व बहुभाषिक शिक्षणाचे समर्थन करते. MIL मराठी अभ्यासक्रम मातृभाषा व प्रादेशिक भाषा साक्षरतेला बळ देतो आणि राष्ट्रीय एकात्मतेसोबतच प्रादेशिक अस्मितेचा अभिमान जोपासतो.</p>                                                                                                                                                                      |                                                                                                                                                       |                                              |        |                    |     |                |               |
| <p>आधुनिक भारतीय भाषा (MIL) मराठी अभ्यासक्रम विद्यार्थ्यांना भारतातील सर्वात प्राचीन आणि समृद्ध साहित्य परंपरांपैकी एकाशी परिचित करून देतो. या अभ्यासक्रमात अभिजात व समकालीन मराठी गद्य, पद्य, नाटक आणि लोकसाहित्य यांचा समावेश असून, त्याद्वारे विद्यार्थ्यांमध्ये भाषिक प्रावीण्य, समालोचनात्मक विचारशक्ती आणि सांस्कृतिक जागरूकता विकसित केली जाते. विविध विद्याशाखांमधील विद्यार्थी — जे मराठीला द्वितीय भाषा किंवा अतिरिक्त भाषा म्हणून शिकू इच्छितात — त्यांच्यासाठी हा अभ्यासक्रम विशेषतः उपयुक्त आहे.</p>                                                                                                                                                                                           |                                                                                                                                                       |                                              |        |                    |     |                |               |
| Prerequisite:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                       |                                              |        |                    |     |                |               |
| <p>1. देवनागरी लिपीची मूलभूत ओळख (वाचन व लेखन) उपयुक्त आहे, परंतु प्रारंभिक स्तरावर ती अनिवार्य नाही.</p> <p>2. ज्या विद्यार्थ्यांची मातृभाषा किंवा प्रादेशिक भाषा मराठी आहे, त्यांना या अभ्यासक्रमात विशेष सोय होते.</p> <p>3. भारतीय भाषांमध्ये रुची असणाऱ्या अमराठी भाषिक विद्यार्थ्यांचेही या अभ्यासक्रमात समान स्वागत आहे.</p>                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                       |                                              |        |                    |     |                |               |
| Bridge Content:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                       |                                              |        |                    |     |                |               |
| <p>1. देवनागरी लिपी ओळख</p> <p>2. मूलभूत मराठी व्याकरण</p> <p>3. दैनंदिन संभाषण</p> <p>4. मराठी साहित्य व संस्कृतीची प्राथमिक ओळख.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                       |                                              |        |                    |     |                |               |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                       |                                              |        |                    |     |                |               |
| <p>1. मराठी भाषेतील वाचन, लेखन, श्रवण आणि संभाषण या चारही कौशल्यांचा सर्वांगीण विकास करणे.</p> <p>2. अभिजात व समकालीन मराठी गद्य, पद्य, नाटक आणि लोकसाहित्य यांचा अभ्यास करून विद्यार्थ्यांमध्ये साहित्यिक जाणीव व समालोचनात्मक विचारशक्ती विकसित करणे.</p> <p>3. वारकरी, भक्ती, साहित्य आणि सामाजिक सुधारणा लेखन यांच्या माध्यमातून महाराष्ट्राच्या सांस्कृतिक, ऐतिहासिक व सामाजिक वारशाची ओळख करून देणे.</p> <p>4. विविध विद्याशाखांमधील विद्यार्थ्यांमध्ये भारतीय भाषांबद्दल आदर, बहुभाषिक दृष्टिकोन आणि आंतरसांस्कृतिक संवेदनशीलता निर्माण करणे.</p> <p>5. राष्ट्रीय शिक्षण धोरण २०२० च्या अनुषंगाने विद्यार्थ्यांमध्ये भारतीय ज्ञान प्रणाली, संविधानिक मूल्ये आणि नैतिक नागरिकत्वाची जाणीव रुजवणे.</p> |                                                                                                                                                       |                                              |        |                    |     |                |               |
| Course Outcomes: After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                       |                                              |        |                    |     |                |               |
| CO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Course Outcome                                                                                                                                        |                                              |        |                    |     |                | Bloom's Level |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | स्मरण व आकलन (Remember & Understand) मराठी भाषेतील देवनागरी लिपी, मूलभूत व्याकरण नियम आणि साहित्यप्रकारांची माहिती सांगणे व त्यांचा अर्थ स्पष्ट करणे. |                                              |        |                    |     |                | 1,2           |

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|     |                                                                                                                                                            |   |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| CO2 | <b>उपयोजन (Apply)</b> दैनंदिन जीवनातील विविध परिस्थितींमध्ये मराठी भाषेचा वाचन, लेखन व संभाषणासाठी योग्य प्रकारे उपयोग करणे.                               | 3 |
| CO3 | <b>विश्लेषण (Analyse)</b> अभिजात व समकालीन मराठी गद्य, पद्य आणि नाटक यांचे साहित्यिक, सामाजिक व सांस्कृतिक संदर्भांच्या आधारे विश्लेषण करणे.               | 4 |
| CO4 | <b>मूल्यमापन (Evaluate)</b> वारकरी, भक्ती, साहित्य आणि सामाजिक सुधारणा लेखन यांच्या सामाजिक प्रासंगिकतेचे व साहित्यिक मूल्याचे समीक्षात्मक मूल्यमापन करणे. | 5 |
| CO5 | <b>निर्मिती (Create)</b> मराठी भाषेतील सर्जनशील लेखन, प्रकल्प अहवाल व तोंडी सादरीकरणाद्वारे स्वतंत्र विचार व्यक्त करण्याची क्षमता निर्माण करणे.            | 4 |

**Course Content****Syllabus****Unit I & II (07 Hrs & 08 Hrs)**

| घटक | तपशील                                                                                                                                                    |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| १   | १. भाषा आणि व्यक्तिमत्त्व विकास : सहसंबंध<br>२. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे                                                                 |
| २   | प्रसारमाध्यमांसाठी लेखन<br>१ वृत्तपत्रासाठी बातमीलेखन आणि मुद्रितशोधन<br>२ नभोवाणीसाठी भाषणाची संहितालेखन<br>३ दूरचित्रवाणीसाठी माहितीपटासाठी संहितालेखन |

**Unit III & IV (07 Hrs & 08 Hrs)**

|   |                                                                                                                                                                                             |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| १ | १. भाषा, जीवन व्यवहार आणि नवमाध्यमे, समाजमाध्यमे<br>२. नवमाध्यमे आणि समाजमाध्यमांचे प्रकार : ब्लॉग, फेसबुक, ट्विटर.<br>३. नवमाध्यमे आणि समाजमाध्यमांविषयक साक्षरता, दक्षता, वापर आणि परिणाम |
| २ | १. वेबसाईट आणि ब्लॉग, ट्विटरसाठी लेखन<br>२. व्यावसायिक पत्रव्यवहार                                                                                                                          |

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**Suggested List of Assignments**

1. Read a specific column (Sports, political, finance, editorial, education, international news etc) in the daily Marathi newspapers, summarize and present in the practical. A summary should be added as part of the journal.

दैनिक मराठी वर्तमानपत्रामध्ये विशिष्ट कॉलम (क्रिडा, राजकीय, वित्त, संपादकीय, शिक्षण, आंतरराष्ट्रीय बातम्या इ.) वाचा, सारांश द्या आणि सादरीकरण करा. त्या संदर्भातला सगळा सारांश जर्नलमध्ये जमा करावा.

2. Write blogs and posts on social media up to 200 words on recent development in their field of study.

सोशल मीडियावर त्याच्या अभ्यासाच्या क्षेत्रातील अलीकडील विकासावर 200 शब्दांच्या ब्लॉग लिहावा आणि पोस्ट करावा

3. Professional letter / report writing. (व्यावसायिक पत्र / अहवाल लेखन)

- a. Write a letter to the principal about organizing an NSS camp in a nearby village. Preparation of the budget, permission letters and report submission in the University.

जवळच्या गावात एन एस एस शिबिर आयोजित करण्यासाठी मुख्याध्यापकांना पत्र लिहा. विद्यापीठात बजेट, परवानगी पत्रे आणि अहवाल सादर करणे.

- b. Write a letter for internship sponsorship to any organization.

कोणत्याही संस्थेला इंटर्नशिप प्रायोजकत्वासाठी पत्र लिहा.

4. Book Review – Students are expected to read any novel, fiction or literature book of their choice and write a review on post it on social media of their choice.

पुस्तक पुनरावलोकन- विद्यार्थ्यांनी त्याच्या आवडीचे कोणतेही कादंबरी, काल्पनिक कथा किंवा साहित्य पुस्तक वाचावे आणि त्यावर पुनरावलोकन लिहून ते त्यांच्या आवडीच्या सोशल मीडियावर पोस्ट करावे अशी अपेक्षा आहे

5. Participation in Competitions (in college/outside the college) debate, declamation, elocution – A Report should be submitted

स्पर्धामध्ये (महाविद्यालयात / महाविद्यालयाबाहेर) सहभाग, वादविवाद, भाषणे, वक्तृत्व- अहवाल सादर करावा.

6. Group Activity: Road show, skit play, one-act play

गट, क्रियाकलाप: रोड शो, स्किट प्ले, एकांकिका

7. Participation in Purushottam Karandak, Firodia Karandak, Dajikaka Gadgil Karandak and Shreetej Karandak.

पुरुषोत्तम करंडक, फिरोदिया करंडक, दाजीकाका गाडगीळ करंडक आणि श्रीतेज करंडक या स्पर्धामध्ये सहभाग नोंदवावा.

8. Marathi film Review – Social Marathi movie available and write a review on post it on social media of their choice.

मराठी चित्रपट पुनरावलोकन सामाजिक आशय वर आधारित मराठी चित्रपट उपलब्ध आहे आणि त्या चित्रपटाची समीक्षा करून त्यावर सारांश लिहावा व तो वर्तमानपत्रे किंवा पसंतीच्या सोशल मीडियावर पोस्ट करावा.

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**Textbooks:**

सायबर संस्कृती, डॉ. रमेश वरखेडे  
 उपयोजित मराठी, संपादक डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई  
 ओळख माहिती तंत्रज्ञानाची, टिमोथी जे. ओ लिअरी  
 संगणक, अच्युत गोडबोले, मौज प्रकाशन, मुंबई.  
 इंटरनेट, डॉ. प्रबोध चोबे, मनोरमा प्रकाशन, मुंबई.

**Reference Books:**

व्यावहारिक मराठी, डॉ. ल. रा. नसिराबादकर, फडके प्रकाशन, कोल्हापूर.  
 आधुनिक माहिती तंत्रज्ञानाच्या विश्वात, शिक्रापूरकर दीपक, मराठे उज्ज्वल, उत्कर्ष प्रकाशन, पुणे.

**Virtual Lab, related open source/ subscription based software, Links or websites for lab conduction, animation, simulation etc., e-learning.**

**Not Applicable.**

\*Add additional rows as per requirement

**CO-PO-PSO Mapping**

| CO   | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1  | 3   | 2   | -   | -   | 2   | -   | -   | -   | -   | -    | -    | 2    | 1    | -    |
| CO2  | 3   | 3   | 1   | 1   | 3   | -   | -   | -   | -   | -    | -    | 3    | 2    | -    |
| CO3  | 2   | 3   | 2   | 2   | 3   | -   | -   | -   | 1   | -    | -    | 3    | 2    | 1    |
| CO4  | 2   | 3   | 3   | 3   | 3   | -   | -   | -   | 2   | 1    | -    | 3    | 3    | 2    |
| CO5  | 2   | 3   | 3   | 3   | 3   | -   | -   | -   | 2   | 2    | 1    | 3    | 3    | 2    |
| Avg. | 2   | 3   | 2   | 2   | 3   | -   | -   | -   | 1   | 1    | 1    | 3    | 2    | 1    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

This course serves as a prerequisite for / maps with the following future courses:

**Job Mapping:**

Job opportunities that one can get after learning this course: Students completing this course can develop strong communication, documentation, translation, and technical writing skills that are useful in both industry and academia. The course prepares learners for roles such as:

- Technical Writer – preparing user manuals, reports, SOPs, and technical documentation.
- Documentation Engineer – maintaining project and product documentation in engineering organizations.

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------|---------------------------|---------------|-------------------------|----------------------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                     | <b>S. Y. B. Tech (Electrical Engineering)</b> |               | <b>Semester:</b>          |               | <b>II</b>               |                      |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                     | Industrial Organization and Management        |               | <b>Course Code:</b>       |               | R25-EE-HSSM-218         |                      |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                     |                                               |               | <b>Examination Scheme</b> |               |                         |                      |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Practical</b>                                                                                                                                                    | <b>Tutorial</b>                               | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>    | <b>TW</b>               | <b>PR</b>            |
| 02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | --                                                                                                                                                                  |                                               | 02            | 50                        | --            | --                      | --                   |
| <b>Course Description and Relevance:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>Description:</b> This subject provides a comprehensive understanding of management principles, leadership qualities, teamwork, industrial economics, quality management, technology management, and human resource management. It also introduces the concepts of Intellectual Property Rights (IPR), including patents, copyrights, and trademarks, along with the fundamentals of marketing management, financial management, business organizations, and entrepreneurship. The course develops managerial, analytical, and decision-making skills required to understand business operations, organizational behavior, and modern industrial practices. |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>Relevance :</b> This subject is important because it helps students develop professional, managerial, and entrepreneurial skills that are essential in today's competitive industrial and business environment. Understanding management, quality systems, finance, marketing, and IPR enables students to improve productivity, innovation, leadership, and organizational efficiency. The knowledge gained through this subject supports career growth in industries, startups, and corporate sectors while also encouraging entrepreneurship, teamwork, ethical practices, and effective decision-making in real-world situations.                      |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>Prerequisite:</b> -----                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>Bridge Content:</b> Provides understanding of how industries function and how organizations are structured, Builds foundation for managerial decision-making, improves professional interaction in industries, helps to understand workforce management, Develops safe and ethical industrial practices, Creates awareness about maintaining product standards and quality.                                                                                                                                                                                                                                                                                |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>Course Objectives:</b> This course aims to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| 1. <b>Understand</b> the basic concepts, management quality of good leadership and teamwork, leadership skill, and industrial economics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| 2. <b>Explore</b> the fundamentals of Industrial economics and Management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| 3. <b>Understand</b> the basic concepts of Technology management and Quality management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| 4. <b>Analyze</b> and <b>differentiate</b> between marketing management and financial management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| 5. <b>Identify</b> the importance of Intellectual property rights and understand the concept of patents, copy rights and trademarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Course Outcome</b>                                                                                                                                               |                                               |               |                           |               |                         | <b>Bloom's Level</b> |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Discuss</b> the fundamentals of management, quality of good leadership and teamwork, leadership skill, and industrial economics.                                 |                                               |               |                           |               |                         | <b>2</b>             |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Explain</b> the importance of quality, technology management and quality management.                                                                             |                                               |               |                           |               |                         | <b>2</b>             |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Identify</b> the importance of Intellectual property rights and understand the concept of patents, copy rights and trademarks. role of Human Resource Management |                                               |               |                           |               |                         | <b>2</b>             |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Analyze</b> and <b>differentiate</b> between marketing management and financial management                                                                       |                                               |               |                           |               |                         | <b>4</b>             |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Differentiate</b> between different types of business organizations, business ownership and road map to Entrepreneurship                                         |                                               |               |                           |               |                         | <b>4</b>             |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                     |                                               |               |                           |               |                         |                      |
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Introduction to Management, Industrial Economics and Leadership</b>                                                                                              |                                               |               |                           | <b>6 Hrs.</b> | <b>COs Mapped - CO1</b> |                      |

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Management: Meaning, scope, function, and importance of management. Difference between administration and management.

Leadership: Importance, Types: Autocratic, Democratic and Laissez-Faire Leadership, qualities of good Leader. Industrial Economics: Definition, Demand and Supply concept, Law of demand and supply

**Exemplars / Practical Applications and usage:**

Administration & management difference, Qualities of Good Leadership

|               |                                                     |               |                       |
|---------------|-----------------------------------------------------|---------------|-----------------------|
| <b>Unit 2</b> | <b>Technology Management and Quality Management</b> | <b>6 Hrs.</b> | <b>COs Mapped-CO2</b> |
|---------------|-----------------------------------------------------|---------------|-----------------------|

Technology Management & Its Classification: Definition, application and its scope. Classification its importance on National Economy, Quality Management: Definition Types, Quality of design, Seven QC Tools, Poka Yoke (Mistake Proofing), Quality circles, Kaizen. TQM, 5S (Case study of Toyota, descriptive treatment). Six-Sigma.

**Exemplars / Practical Applications and usage:**

Kaizen. Use of 5S in implementation of Kaizen.

|               |                                                                                 |               |                       |
|---------------|---------------------------------------------------------------------------------|---------------|-----------------------|
| <b>Unit 3</b> | <b>Intellectual Property Rights (IPR) &amp; Human Resource Management (HRM)</b> | <b>6 Hrs.</b> | <b>COs Mapped-CO3</b> |
|---------------|---------------------------------------------------------------------------------|---------------|-----------------------|

Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Types, Different forms of IPR, Patents, Copy rights and trademark (Descriptive treatment only). Human Resource Management: Introduction, importance, scope, HR planning, Recruitment, selection, training and development

**Exemplars / Practical Applications and usage:**

Patent types, Copy rights and trademark.

|               |                                           |               |                       |
|---------------|-------------------------------------------|---------------|-----------------------|
| <b>Unit 4</b> | <b>Marketing and Financial Management</b> | <b>6 Hrs.</b> | <b>COs Mapped-CO4</b> |
|---------------|-------------------------------------------|---------------|-----------------------|

Marketing Management: Meaning of Market, Marketing strategy, motives, types-Perfect Competition, Monopoly, Monopolistic completion and Oligopoly. Online Marketing (Digital Marketing). Financial Management: Definition, Types of costs (Fixed, Variable, average, marginal, and total cost) and methods of costing price, capital. Debit, credit, Profit and loss statement, Balance sheet

**Exemplars / Practical Applications and usage:**

Online Marketing, Debit, credit, Profit and loss statement, Balance sheet

|               |                                                                |               |                       |
|---------------|----------------------------------------------------------------|---------------|-----------------------|
| <b>Unit 5</b> | <b>Business Organization, Business Ownership and its Types</b> | <b>6 Hrs.</b> | <b>COs Mapped-CO5</b> |
|---------------|----------------------------------------------------------------|---------------|-----------------------|

Business Organizations: Line organization, Staff organization and Functional Organization, Business Ownership and its Types: One person company Types of ownership, Sole proprietorship, Partnership (Act 1934), LLP (Limited Liability Partnership) (Act 2008)., Entrepreneurship: Importance and limitations of rational decision making, Decision making under certainty, uncertainty and risk

**Exemplars / Practical Applications and usage:**

Entrepreneurship, Case study on small scale industries in India.

**Comprehensive Continuous Evaluation (CCE) components for the course:**

**1. Course Projects (Mini/Micro Project):**

Unit 1 and 2: Unit Test: 20 Marks

Unit 3 and 4: Assignments: 20 marks

Unit 5: MCQ Test: 10 Marks

Total CCE Marks: 50

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**2. Class Tests / Unit Tests: Unit ..... and Unit....(any two units)**

NA

**Textbooks:**

1. Khanna, industrial engineering and management, Dhanpat Rai and sons, New Delhi.
2. E. H. McGraw, S. J. Basic managerial skills for all.
3. Tarek Khalil, Management of Technology Tata McGraw Hill Publication Pvt. Ltd.
4. Prabuddha Ganguli Intellectual Property rights Tata McGraw Hill Publication Company
5. Management Accounting and financial management by M. Y. Khan and P.K. Jain, Tata McGraw Hill-Tata

**Reference Books:**

1. C. B. Marmoria and V. S. P. Rao- Personnel Management, Himalaya Publishing House, 30th Edition 2014.
2. Harold Koonlz and OD'onnel-Management. Tata McGraw Hill Publication 1980.
3. Philip Kotler-Marketing Management. Pearson Edition 2008.
4. Robert Heller, Managing Teams, Dorling Kindersley, London.
5. Kelly John M, Total Quality Management, InfoTech Standard, Delhi.
6. Joseph M. Juran, Juran's Quality Handbook TATA McGraw-Hill.
7. Dale H. Bester field and Carol Bester field Total Quality Management Prentice Hall of India Pvt. Ltd.
8. Shiv Sahai Singh [Editor] The Law of Intellectual Property rights.
9. N. R. Subbaram, What Everyone Should Know About Patents, Pharma Book Syndicate, Hyderabad.
10. Principles and Practices of Management –Dr. P.C. Shejwalkar, Dr. Anjali Ghanekar, Deepak Bhivpathki.
11. Financial Management by I. M. Pandey, Vikas Publishing House Pvt. Ltd., Delhi Philip Kotler-Marketing Management.

**MOOCs Links and additional reading material:**

1. <https://youtu.be/w-wxvJFfKEw>
  2. <https://youtu.be/SoUjQpIO3YY>
  3. <https://youtu.be/NWsw9tKhRg8>
  4. <https://youtu.be/5fvpsqPWZac> [M5]. [https://youtu.be/HX8\\_Udlwy58](https://youtu.be/HX8_Udlwy58)
- YouTube/Video Links
- [1]. <https://youtu.be/uB-j2koAPwk?si=kZwiVs9oT72tAuB>
  - [2]. [https://youtu.be/4G9CJLwR3SM?si=8ajLh3SfexP71\\_rx](https://youtu.be/4G9CJLwR3SM?si=8ajLh3SfexP71_rx)
  - [3]. <https://youtu.be/usrfNII7oqM?si=gQ7On7rS2g4fivM>
  - [4]. <https://youtu.be/aINJsQ3UT74?si=pD0gEOKvZFh9T2PD>
  - [5]. <https://youtu.be/0Zt7xTyELNc?si=vJOVeRXPmk-t56cx>
  - [6]. <https://youtu.be/zHpi7mnGdg0?si=IsnhSjvMU5iKwbyR>
  - [7]. <https://www.youtube.com/live/XJW5fHuZ-qo?si=IQMmOs6XgN2zvHDr>
  - [8]. [https://youtu.be/zkWJAvG6\\_ME?si=pjmtv0tpdfHliF9y](https://youtu.be/zkWJAvG6_ME?si=pjmtv0tpdfHliF9y)
  - [9]. <https://youtu.be/XQ8tRdcr0xQ?si=cJfJueH4HcoeQpJf>
  - [10]. <https://youtu.be/zAy6xT8Rvag?si=J7LHr6fUplxTijMY>
  - [11]. <https://youtu.be/fWG-bwTKVXk?si=HipFDDZNcW8CDWxZ>
  - [12]. <https://youtu.be/jyyh4krZQKQ?si=w3V0AbfXjTkkq7Oo>
  - [13]. [https://youtu.be/adC-vnd9abM?si=dN1sKN\\_C1DNZoTzM](https://youtu.be/adC-vnd9abM?si=dN1sKN_C1DNZoTzM)
  - [14]. <https://youtu.be/bQrk8yE2m3I?si=3n5NCQ5wgWg1gQlr>
  - [15]. <https://youtu.be/vw6xWV7Jqi8?si=UWLM8TrCvBZFP1e7>
  - [16]. [https://youtu.be/xuSaHf6SsvE?si=7eftQHw7RU\\_n\\_L0Vy](https://youtu.be/xuSaHf6SsvE?si=7eftQHw7RU_n_L0Vy)
  - [17]. <https://youtu.be/CPOS7w7SsHk?si=FUF6fby77hTQYyBb>
  - [18]. <https://youtu.be/4T1WdgrfDms?si=z-jA53VsJLzxTsQ9>

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**CO-PO-PSO Mapping**

| CO   | PO1  | PO2 | PO3 | PO4  | PO5 | PO6 | PO7  | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|------|-----|-----|------|-----|-----|------|-----|------|------|------|------|------|------|
| CO1  | 2    | 1   | -   | -    | -   | 1   | 2    | -   | 2    | 3    | 2    | 0    | 0    | 0    |
| CO2  | 2    | -   | 1   | 2    | 1   | 1   | 2    | 1   | 2    | 3    | 2    | 0    | 0    | 0    |
| CO3  | 2    | 2   | -   | 3    | 1   | 2   | -    | -   | 2    | 3    | 2    | 0    | 0    | 0    |
| CO4  | 1    | 3   | 1   | 2    | -   | 2   | 3    | -   | -    | 2    | 1    | 0    | 0    | 0    |
| CO5  | -    | -   | 1   | 4    | 2   | 1   | -    | -   | 3    | 2    | -    | 0    | 0    | 0    |
| Avg. | 1.75 | 2   | 1   | 2.25 | 1   | 1.4 | 2.33 | 1   | 2.25 | 2.6  | 1.75 | 0    | 0    | 0    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam       | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 |
|------------|-------|-------|-------|-------|-------|
| CCE        |       |       |       |       |       |
| CT1        | 10    | 10    |       |       |       |
| Assignment |       |       | 10    | 10    |       |
| MCQ Test   |       |       |       |       | 10    |
| ESE        | NA    |       |       |       |       |
| Total      | 10    | 10    | 10    | 10    | 10    |

**Assessment Pattern**

| BT Level | CCE |     |     |     |     | ESE |     |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|          | CO1 | CO2 | CO3 | CO4 | CO5 | CO1 | CO2 | CO3 | CO4 | CO5 |
|          | 8   | 8   | 8   | 8   | 8   | —   | —   | —   | —   | —   |
| L1       | √   | √   | √   | √   | √   | —   | —   | —   | —   | —   |
| L2       | √   | √   | √   | √   | √   | —   | —   | —   | —   | —   |
| L3       | —   | -   | —   | √   | √   | —   | —   | —   | —   | —   |
| L4       | —   | —   | —   | √   | √   | —   | —   | —   | —   | —   |
| L5       | —   | —   | —   | —   | —   | —   | —   | —   | —   | —   |
| L6       | —   | —   | —   | —   | —   | —   | —   | —   | —   | —   |

This course serves as a prerequisite for / maps with the following future courses:

**Job Mapping:**

Job opportunities that one can get after learning this course:

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                    |                        |        |                    |              |    |               |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------|--------|--------------------|--------------|----|---------------|--|
| Program:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                    | S. Y. B. Tech          |        |                    | Semester:    |    | IV            |  |
| Course:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                    | AC & DC Machines - Lab |        |                    | Course Code: |    | PCC-254-ELE   |  |
| Teaching Scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                    |                        |        | Examination Scheme |              |    |               |  |
| Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Practical                                                          | Tutorial               | Credit | CCE                | ESE          | TW | PR            |  |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 02                                                                 | -                      | 01     | -                  | -            | -  | 25            |  |
| <b>Course Description:</b><br>The Basics of AC & DC Machines - Lab Laboratory is designed to provide practical exposure to the construction, operation, testing and performance analysis of electrical machines such as transformers, DC machines and induction motors. The laboratory enables students to verify theoretical concepts through hands-on experiments, including open circuit and short circuit tests on transformers, speed control of DC motors, load testing, efficiency measurement and starting methods of induction motors. Students gain practical knowledge of electrical measuring instruments, machine characteristics, wiring practices, safety procedures and troubleshooting techniques. The laboratory also develops skills in conducting experiments, analyzing results and preparing technical reports related to electromechanical energy conversion systems. |                                                                    |                        |        |                    |              |    |               |  |
| <b>Relevance:</b><br>The Basics of AC & DC Machines - Lab Laboratory is highly relevant for understanding the practical behaviour and industrial applications of electrical machines used in power systems, manufacturing industries, automation and electric drives. The course bridges the gap between theoretical concepts and real-world implementation by providing hands-on experience with electrical equipment and testing procedures. It helps students develop technical competency in operation, maintenance and performance evaluation of electrical machines, which are essential skills for careers in electrical engineering, industrial automation, renewable energy systems and power generation sectors. The laboratory also enhances problem-solving ability, teamwork and adherence to electrical safety standards required in professional engineering practice.        |                                                                    |                        |        |                    |              |    |               |  |
| <b>Prerequisite:</b><br><div><div></div><div><div>1. Basic knowledge of DC and AC electrical circuits</div><div>2. Understanding of Ohm’s Law, Kirchhoff’s Laws and power calculations</div><div>3. Fundamentals of magnetic circuits and electromagnetic induction</div><div>4. Knowledge of single-phase and three-phase systems</div><div>5. Basic understanding of electrical measuring instruments</div><div>6. Familiarity with circuit connections and wiring practices</div><div>7. Understanding of voltage, current, power factor and efficiency concepts</div><div>8. Basic knowledge of transformers and electromechanical energy conversion</div><div>9. Awareness of laboratory safety rules and electrical precautions</div><div>10. Ability to read circuit diagrams and machine nameplate details</div></div></div>                                                         |                                                                    |                        |        |                    |              |    |               |  |
| <b>Bridge Content:</b><br><div><div></div><div><div>1. Understanding of electrical measuring instruments and testing methods</div><div>2. Fundamentals of electrical safety, earthing and laboratory precautions</div><div>3. Reading and interpretation of electrical circuit diagrams and machine nameplates</div><div>4. Basic wiring practices and connection techniques</div><div>5. Overview of industrial applications of transformers, DC machines and induction motors</div></div></div>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                    |                        |        |                    |              |    |               |  |
| <b>Course Objectives:</b> This course aims to<br><div><div></div><div><div>1. <b>Conduct</b> the OC/SC test on a single-phase transformer.</div><div>2. <b>Conduct</b> the polarity test on a single-phase and three-phase transformer.</div><div>3. <b>Test</b> the performance of the DC Shunt motor by various methods.</div><div>4. <b>Perform</b> a load test on a three-phase induction machine</div><div>5. <b>Find</b> the performance characteristics of a 3-phase induction motor by conducting the No Load and Blocked Rotor test</div></div></div>                                                                                                                                                                                                                                                                                                                               |                                                                    |                        |        |                    |              |    |               |  |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                    |                        |        |                    |              |    |               |  |
| CO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Course Outcome                                                     |                        |        |                    |              |    | Bloom’s Level |  |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Determine the equivalent circuit parameter, voltage regulation and |                        |        |                    |              |    | 3             |  |

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|     |                                                                                                                                                                                    |   |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|     | efficiency of a given 1-phase transformer.                                                                                                                                         |   |
| CO2 | <b>Find</b> the polarity of single-phase and three-phase transformers.                                                                                                             | 3 |
| CO3 | <b>Calculate</b> the torque, speed and efficiency of a given DC shunt motor by conducting the brake test, Hopkinson's Test & Swinburn Test.                                        | 4 |
| CO4 | <b>Calculate</b> the torque, speed and efficiency of a three-phase induction motor by the direct/indirect loading method                                                           | 3 |
| CO5 | <b>Plot</b> the circle diagram & compute slip, pf, torque, rotor & stator losses & efficiency by conducting No Load & Blocked Rotor test on the given three-phase induction motor. | 4 |

#### Course Content

**Any eight experiments shall be carried out as compulsory laboratory work.**

#### List of Practical:

|                        |                                                                                                                                                                                        |            |               |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------|
| <b>Experiment No.1</b> | <b>O.C. and S.C. test on single-phase transformer</b><br>a. Determination of equivalent circuit parameters from the test data<br>b. Determination of voltage regulation and efficiency | <b>CO1</b> | <b>Hrs.02</b> |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------|

#### Objective

To perform Open Circuit (O.C.) and Short Circuit (S.C.) tests on a single-phase transformer for determining equivalent circuit parameters, voltage regulation and efficiency of the transformer.

#### Associated Tasks

1. Study the nameplate details and ratings of the transformer.
2. Connect the circuit for the Open Circuit test and record voltmeter, ammeter and wattmeter readings.
3. Determine core loss, no-load current and shunt parameters from O.C. test data.
4. Connect the circuit for the Short Circuit test and record the required readings.
5. Determine copper loss and equivalent resistance and reactance from S.C. test data.

#### Exemplars and Utility

The O.C. and S.C. tests are widely used in electrical industries, transformer manufacturing units and power system laboratories for evaluating transformer performance without actual full-load testing. The experiment helps in predicting efficiency, voltage regulation and losses of transformers used in power distribution systems, substations, industrial plants and renewable energy applications. Understanding these tests is essential for transformer selection, condition assessment, maintenance and energy-efficient operation in practical power engineering applications.

|                        |                                                                                                                                                       |            |                |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------|
| <b>Experiment No.2</b> | <b>Parallel operation of two single-phase transformers and study of their load sharing under various conditions of voltage ratios and impedances.</b> | <b>CO2</b> | <b>Hrs. 02</b> |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------|

#### Objective

To study the parallel operation of two single-phase transformers and analyze load sharing under different conditions of voltage ratios and leakage impedances.

#### Associated Tasks

1. Study the nameplate details and ratings of both transformers.
2. Verify polarity, voltage ratio and phase sequence before parallel operation.
3. Connect two single-phase transformers in parallel according to the circuit diagram.
4. Measure no-load secondary voltages and check circulating current conditions.
5. Apply load gradually and record load sharing between transformers.

#### Exemplars and Utility

Parallel operation of transformers is extensively used in substations, industries and power distribution systems to increase system capacity, improve reliability and ensure continuity of power supply. This experiment helps students understand practical conditions required for successful transformer paralleling such as equal voltage ratio, polarity and impedance matching. The knowledge gained is useful in power system expansion, load management, maintenance scheduling and efficient utilization of transformers in industrial and utility

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                  |            |                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|------------|----------------|
| applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                  |            |                |
| <b>Experiment No.3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Polarity test on a single-phase, three-phase transformer.</b> | <b>CO3</b> | <b>Hrs.02</b>  |
| <p><b>Objective</b><br/>To perform a polarity test on single-phase and three-phase transformers for identifying the relative polarity of transformer windings and ensuring correct connections during operation.</p> <p><b>Associated Tasks</b></p> <ol style="list-style-type: none"> <li>1. Study the constructional details and nameplate ratings of the transformers.</li> <li>2. Identify primary and secondary terminals of the transformer windings.</li> <li>3. Connect the circuit for polarity testing as per the standard procedure.</li> <li>4. Apply rated voltage carefully to the transformer winding.</li> <li>5. Measure voltages across different terminal combinations using suitable instruments.</li> </ol> <p><b>Exemplars and Utility</b><br/>Polarity testing is essential in transformer installation, maintenance and commissioning processes to ensure correct winding connections and avoid short circuits or circulating currents. The experiment is highly useful in parallel operation of transformers, three-phase transformer connections and power distribution systems. Knowledge of transformer polarity is important for electrical utilities, substations, industrial power systems and transformer manufacturing industries to ensure safe and reliable operation.</p> |                                                                  |            |                |
| <b>Experiment No.4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Speed control of D.C. Shunt motor and study of starters.</b>  | <b>CO4</b> | <b>Hrs. 02</b> |
| <p><b>Objective</b><br/>To study the speed control methods of a D.C. shunt motor and understand the operation and necessity of motor starters.</p> <p><b>Associated Tasks</b></p> <ol style="list-style-type: none"> <li>1. Study the constructional details and nameplate ratings of the D.C. shunt motor.</li> <li>2. Connect the motor circuit with an appropriate starter arrangement.</li> <li>3. Observe the operation and protective functions of a three-point and four-point starter.</li> <li>4. Perform speed control of the D.C. shunt motor using the field control method.</li> <li>5. Perform speed control using the armature voltage control method.</li> </ol> <p><b>Exemplars and Utility</b><br/>D.C. shunt motor speed control is widely used in industrial drives requiring precise and smooth speed variation such as conveyors, rolling mills, cranes, elevators and machine tools. The study of starters is important for protecting motors from excessive starting current and ensuring safe operation. This experiment provides practical understanding of motor control techniques used in automation systems, electric traction and industrial process control applications.</p>                                                                                                 |                                                                  |            |                |
| <b>Experiment No.5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Brake Test on D.C. Shunt Motor</b>                            | <b>CO4</b> | <b>Hrs.02</b>  |
| <p><b>Objective</b><br/>To perform a brake test on a D.C. shunt motor and determine its performance characteristics, such as output power, torque and efficiency under different loading conditions.</p> <p><b>Associated Tasks</b></p> <ol style="list-style-type: none"> <li>1. Study the nameplate details and ratings of the D.C. shunt motor.</li> <li>2. Connect the motor with a suitable starter and brake drum arrangement.</li> <li>3. Start the motor safely using the appropriate starter.</li> <li>4. Apply mechanical load gradually using the brake mechanism.</li> <li>5. Measure speed, voltage, current and spring balance readings at different loads.</li> </ol> <p><b>Exemplars and Utility</b><br/>Brake testing of D.C. shunt motors is widely used in electrical machine laboratories, maintenance departments and industrial testing applications for evaluating motor performance under actual load conditions. The experiment helps in understanding torque production, efficiency and speed characteristics of D.C. motors used</p>                                                                                                                                                                                                                                               |                                                                  |            |                |

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in cranes, elevators, conveyors, rolling mills and machine tools. The knowledge gained is useful for motor selection, condition monitoring, industrial drive analysis and efficient operation of electrical machines in practical engineering applications.

|                        |                                                   |            |               |
|------------------------|---------------------------------------------------|------------|---------------|
| <b>Experiment No.6</b> | <b>Load characteristics of D.C. series motor.</b> | <b>CO4</b> | <b>Hrs.02</b> |
|------------------------|---------------------------------------------------|------------|---------------|

#### Objective

To study the load characteristics of a D.C. series motor by observing the variation of speed, current, torque and efficiency with a change in load.

#### Associated Tasks

1. Study the constructional details and nameplate ratings of the D.C. series motor.
2. Connect the motor circuit with the appropriate starter and loading arrangement.
3. Start the motor safely under no-load or minimum load conditions.
4. Apply load gradually and record voltage, current, speed and load readings.
5. Calculate output power, torque and efficiency at different load conditions.

#### Exemplars and Utility

D.C. series motors are widely used in applications requiring high starting torque, such as electric traction systems, cranes, hoists, elevators and rolling mills. The study of load characteristics helps in understanding the performance behaviour of the motor under varying mechanical loads. This experiment is useful for industrial drive applications, motor performance analysis, maintenance activities and selection of suitable motors for heavy-duty operations.

|                        |                                                |            |                |
|------------------------|------------------------------------------------|------------|----------------|
| <b>Experiment No.7</b> | <b>Load test on a 3-phase induction motor.</b> | <b>CO5</b> | <b>Hrs. 02</b> |
|------------------------|------------------------------------------------|------------|----------------|

#### Objective

To perform a load test on a three-phase induction motor and determine its performance characteristics such as efficiency, slip, power factor and speed regulation under varying load conditions.

#### Associated Tasks

1. Study the nameplate details and ratings of the three-phase induction motor.
2. Connect the induction motor with an appropriate starting arrangement and loading setup.
3. Start the motor safely and observe no-load operating conditions.
4. Apply load gradually and record voltage, current, power, speed and load readings.
5. Calculate input power, output power, slip and efficiency at different load conditions.

#### Exemplars and Utility

Three-phase induction motors are extensively used in industries for pumps, compressors, conveyors, fans, blowers and machine tools due to their rugged construction and reliable performance. The load test helps in evaluating motor efficiency, speed regulation and operating characteristics under practical conditions. The experiment is highly useful for motor selection, industrial maintenance, energy management and performance assessment in electrical drives and automation systems.

|                        |                                                                                                                                                                                                                            |            |                |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------|
| <b>Experiment No.8</b> | <b>No load &amp; blocked-rotor test on 3-phase induction motor:</b><br>a. Determination of parameters of equivalent circuit.<br>b. Plotting of circle diagram.<br>c. Calculation of motor performance from (a) & (b) above | <b>CO5</b> | <b>Hrs. 02</b> |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------|

#### Objective

To perform no-load and blocked-rotor tests on a three-phase induction motor for determining equivalent circuit parameters, plotting the circle diagram and evaluating motor performance characteristics.

#### Associated Tasks

1. Study the nameplate details and ratings of the three-phase induction motor.
2. Connect the circuit for no-load test and record voltage, current and power readings.
3. Determine no-load parameters and losses from test observations.
4. Conduct a blocked-rotor test by applying reduced voltage under safe operating conditions.
5. Record blocked-rotor voltage, current and power readings.

#### Exemplars and Utility



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No-load and blocked-rotor tests are standard industrial methods used for performance evaluation and parameter estimation of induction motors without full-load testing. The experiment helps in understanding motor behaviour, efficiency, torque characteristics and power factor under different operating conditions. Circle diagram analysis is widely used in electrical machine design, testing laboratories, industrial maintenance and power system studies for predicting motor performance accurately and efficiently.

|                        |                                                                       |            |               |
|------------------------|-----------------------------------------------------------------------|------------|---------------|
| <b>Experiment No.9</b> | <b>Experimental Investigation of Self-Excited Induction Generator</b> | <b>CO5</b> | <b>Hrs.02</b> |
|------------------------|-----------------------------------------------------------------------|------------|---------------|

#### Objective

To experimentally investigate the performance characteristics of a Self-Excited Induction Generator (SEIG) under different operating conditions and determine the effect of excitation capacitance, speed and loading on voltage build-up, frequency and output performance.

#### Associated Tasks

1. Study the nameplate details and ratings of the three-phase induction machine used as a self-excited induction generator.
2. Identify and connect the excitation capacitors required for self-excitation of the induction generator.
3. Connect the experimental setup with prime mover, capacitors, load and measuring instruments.
4. Operate the induction machine above synchronous speed using a suitable prime mover.
5. Observe and record the voltage build-up characteristics of the self-excited induction generator.

#### Exemplars and Utility

Self-Excited Induction Generators are widely used in standalone renewable energy systems such as wind energy conversion systems, micro-hydel plants and rural electrification applications due to their simple construction, ruggedness and low maintenance requirements. The experiment helps in understanding the voltage build-up mechanism, excitation requirements and load behaviour of induction generators under isolated operating conditions. Performance analysis of SEIGs is important in renewable energy integration, distributed generation systems, industrial backup power applications and research related to sustainable electrical energy systems.

|                         |                                         |            |               |
|-------------------------|-----------------------------------------|------------|---------------|
| <b>Experiment No.10</b> | <b>Speed Control of Induction Motor</b> | <b>CO5</b> | <b>Hrs.02</b> |
|-------------------------|-----------------------------------------|------------|---------------|

#### Objective

To study and experimentally investigate different methods of speed control of a three-phase induction motor and analyze the effect of speed variation on motor performance characteristics.

#### Associated Tasks

1. Study the nameplate details and ratings of the three-phase induction motor.
2. Identify the components and control devices used for speed control of induction motors.
3. Connect the experimental setup for speed control using suitable control methods.
4. Measure the motor speed under no-load and loaded operating conditions.
5. Perform speed control using the stator voltage control method and record observations.

#### Exemplars and Utility

Speed control of induction motors is widely used in industrial automation, electric drives, conveyors, pumps, fans, compressors and machine tools where variable speed operation is required. The experiment helps in understanding the principles of motor speed variation, torque-speed characteristics and energy-efficient motor control techniques. Modern Variable Frequency Drive (VFD) based speed control systems are extensively used in industries for precise speed regulation, reduced energy consumption and improved process control. Knowledge of induction motor speed control is essential in industrial automation, electric vehicle drives, robotics and smart manufacturing systems.

#### Textbooks:

- [T1]. Edward Hughes “Electrical Technology”, ELBS, Pearson Education.  
[T2]. Ashfaq Husain, “Electrical Machines”, Dhanpat Rai & Sons.



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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [T3]. S. K. Bhattacharya, “Electrical Machine”, Tata McGraw Hill publishing Co. Ltd, 2nd Edition.                                                                                                                                               |
| [T4]. Nagrath & Kothari, “Electrical Machines”, Tata McGraw Hill.                                                                                                                                                                               |
| [T5]. Bhag S Guru, Husein R. Hiziroglu, “Electrical Machines”, Oxford University Press.                                                                                                                                                         |
| [T6]. K Krishna Reddy, “Electrical Machines- I and II”, SCITECH Publications (India) Pvt. Ltd. Chennai.                                                                                                                                         |
| <b>Reference Books:</b>                                                                                                                                                                                                                         |
| [R1]. A.E. Clayton and N. N. Hancock, “Performance and Design of Direct Current Machines”, CBS Publishers, Third Edition.                                                                                                                       |
| [R2]. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, “Electrical Machines”, Tata McGraw Hill Publication Ltd., Second Year Engineering – 2024 Pattern - Faculty of Science and Technology Electrical Engineering Page   50 Fifth Edition. |
| [R3]. A.S. Langsdorf, “Theory and performance of DC machines”, Tata McGraw Hill.                                                                                                                                                                |
| [R4]. M.G. Say, “Performance and Design of AC. Machines”, CBS Publishers and Distributors.                                                                                                                                                      |
| [R5]. Smarajit Ghosh, “Electrical Machines”, Pearson Education, New Delhi.                                                                                                                                                                      |
| [R6]. Charles I Hubert, “Electrical Machines Theory, Application, & Control”, Pearson Education, New Delhi, Second Edition.                                                                                                                     |
| [R7]. Direct Current Machines, R K Rajput, Laxmi Publications                                                                                                                                                                                   |
| [R8]. AC Machines, R K Rajput, Laxmi Publications                                                                                                                                                                                               |
| <b>Virtual Lab, related open source/subscription-based software, Links or websites for lab conduction, animation, simulation, etc., e-learning.</b>                                                                                             |
| 1. Virtual Lab                                                                                                                                                                                                                                  |
| 2. Matlab                                                                                                                                                                                                                                       |

\*Add additional rows as per requirement

### CO-PO-PSO Mapping

| CO   | PO1         | PO2         | PO3         | PO4         | PO5         | PO6         | PO7         | PO8         | PO9         | PO10     | PO11        | PSO1 | PSO2        | PSO3        |
|------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|----------|-------------|------|-------------|-------------|
| CO1  | 3           | 3           | 1           | 3           | 3           | -           | 1           | 1           | 2           | -        | 2           |      | 3           | 3           |
| CO2  | 3           | 3           | 1           | 2           | 3           | -           | -           | -           | -           | -        | 2           |      | 2           | 3           |
| CO3  | 2           | 3           | 1           | 3           | 3           | -           | -           | -           | 3           | -        | 3           |      | 3           | 3           |
| CO4  | 3           | 3           | 1           | 3           | 3           | -           | -           | -           | 3           | -        | 3           |      | 3           | 3           |
| CO5  | 3           | 3           | 1           | 3           | 3           | -           | -           | -           | 3           | -        | 2           |      | 3           | 3           |
| Avg. | <b>2.83</b> | <b>3.00</b> | <b>1.00</b> | <b>2.67</b> | <b>3.00</b> | <b>0.00</b> | <b>1.00</b> | <b>1.00</b> | <b>2.80</b> | <b>-</b> | <b>2.50</b> |      | <b>2.83</b> | <b>3.00</b> |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

|                                                                                    |
|------------------------------------------------------------------------------------|
| This course serves as a prerequisite for / maps with the following future courses: |
| Job Mapping:                                                                       |
| Job opportunities that one can get after learning this course:                     |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------|---------------------------|---------------------|------------|-----------------------|----------------------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                               | <b>S. Y. B. Tech (Electrical Engineering)</b>                                     |               |                           | <b>Semester:</b>    |            | <b>IV</b>             |                      |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                               | <b>Numerical Methods and Computer Programming Lab</b>                             |               |                           | <b>Course Code:</b> |            | <b>R25-EE-PCC-220</b> |                      |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                               |                                                                                   |               | <b>Examination Scheme</b> |                     |            |                       |                      |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Practical</b>                                                              | <b>Tutorial</b>                                                                   | <b>Credit</b> | <b>CCE</b>                |                     | <b>ESE</b> | <b>TW</b>             | <b>PR</b>            |
| --                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 02                                                                            | --                                                                                | 01            | --                        |                     | --         | --                    | 25                   |
| <b>Course Description:</b><br>Numerical Methods and Computer Programming focus on solving mathematical and engineering problems using numerical techniques and computer programs. It helps students learn methods like solving equations, interpolation, integration, and programming skills (such as Python) to solve complex problems accurately and efficiently.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Course Relevance:</b><br>Numerical Methods and Computer Programming is important because it helps solve real-world engineering and scientific problems using computational methods. It develops problem-solving and programming skills that are useful in data analysis, simulation, research, and various industry applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Prerequisite:</b><br>1. Basic Calculus, Linear Algebra<br>2. Basic Programming Skills<br>3. Basic Electrical Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Bridge Content:</b><br>Basic Programming language C, C++                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Course Objectives:</b><br>1. To promote computational thinking and problem-solving using numerical methods.<br>2. To develop multidisciplinary analytical skills through the use of Python in engineering applications.<br>3. To enable experiential learning through hands-on projects, simulations, and coding.<br>4. To nurture lifelong learning habits through use of open-source tools and online platforms.                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Course Outcome</b>                                                         |                                                                                   |               |                           |                     |            |                       | <b>Bloom's Level</b> |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Identify the suitable numerical techniques for solving engineering problems.  |                                                                                   |               |                           |                     |            |                       | 2                    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Write Python programs to implement numerical methods for real-time scenarios. |                                                                                   |               |                           |                     |            |                       | 3                    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Apply problem-solving skills in electrical signals & systems and machines.    |                                                                                   |               |                           |                     |            |                       | 4                    |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Analyze the results and errors for various computational methods.             |                                                                                   |               |                           |                     |            |                       | 4                    |
| <b>Course Content</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Experiment No.1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                               | <b>Write a Python program to compute and plot truncation and round-off error.</b> |               |                           |                     |            | <b>CO-1</b>           | <b>2 Hrs.</b>        |
| <b>Objective:</b><br>To develop a Python program that computes and plots <b>truncation error</b> and <b>round-off error</b> , helping students understand how numerical errors occur in computations and how they affect the accuracy of results.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Associated Tasks:</b><br>1. Study the concepts of truncation error and round-off error in numerical computations.<br>2. Choose a suitable function (e.g., $e^x$ , $\sin(x)$ , or polynomial functions) for error analysis.<br>3. Write Python code to approximate the function using numerical methods (such as Taylor series) and compute the truncation error.<br>4. Simulate limited precision arithmetic and calculate the difference between exact and rounded values.<br>5. Utilize libraries such as NumPy for calculations and Matplotlib for visualization.<br>6. Compute error values for different approximation levels or precision settings.<br>7. Create plots showing how truncation and round-off errors vary with changing parameters.<br>8. Analyze and compare the trends of both errors to understand their impact on numerical accuracy. |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |
| <b>Exemplars and Utility:</b><br>1. Compute the truncation error by comparing the approximation with the exact value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                               |                                                                                   |               |                           |                     |            |                       |                      |

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2. Compute the round-off error as the difference between exact and rounded values.
3. Analyze both truncation and round-off errors as step size changes.
4. Observe how total error changes and identify optimal computation parameters.
5. Essential in simulations, data analysis, and solving mathematical models where precision matters.

Develops the ability to interpret error plots and evaluate the reliability of numerical results.

|                        |                                                                      |             |               |
|------------------------|----------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.2</b> | <b>Implement root-finding methods and compare their performance.</b> | <b>CO-2</b> | <b>2 Hrs.</b> |
|------------------------|----------------------------------------------------------------------|-------------|---------------|

**Objective:**

To implement various root-finding methods (such as Bisection Method, Newton-Raphson Method and False Position Method) in Python and compare their performance in terms of accuracy, convergence speed, and computational efficiency for solving nonlinear equations.

**Associated Tasks:**

1. Study numerical methods used to solve nonlinear equations and identify roots of functions.
2. Select mathematical functions (polynomial, exponential, logarithmic, or trigonometric) for root analysis.
3. Develop a Python program to find roots using interval halving.
4. Implement Newton-Raphson Method: Write code using derivatives to estimate roots iteratively.
5. Implement False Position Method: Develop a program using linear interpolation to locate roots within an interval.
6. Define stopping conditions such as tolerance level and maximum number of iterations.
7. Calculate the estimated roots for each method.
8. Compare obtained roots with exact or expected values and determine approximation errors.
9. Record and compare the number of iterations required by each method.
10. Measure execution time and overall algorithm performance.
11. Plot convergence graphs or error-versus-iteration charts using Python libraries like NumPy and Matplotlib.
12. Analyze advantages and limitations of each root-finding technique.
13. Summarize findings and identify the most effective method for different problem types.

**Exemplars and Utility:**

1. Find roots of equations such as  $x^3 - x - 2 = 0$ ,  $\sin(x) - \frac{x}{2} = 0$  or  $e^{-x} - x = 0$  using Bisection, Newton-Raphson and False Position methods. Compare the number of iterations and accuracy of each method.
2. Plot error versus iteration for each root-finding method, Analyze convergence speed and stability graphically.
3. Enables comparison of numerical techniques to choose the most suitable method for a given problem
4. Provides practical understanding of iterative methods and their real-world significance in applied mathematics.

|                        |                                                                               |             |               |
|------------------------|-------------------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.3</b> | <b>Solve a system of linear equations derived from mesh or node analysis.</b> | <b>CO-3</b> | <b>2 Hrs.</b> |
|------------------------|-------------------------------------------------------------------------------|-------------|---------------|

**Objective:**

To determine the unknown electrical quantities (such as currents or voltages) in an electrical circuit by applying circuit laws and solving the resulting simultaneous equations.

**Associated Tasks:**

1. Use Kirchhoff's Voltage Law to write loop equations (mesh analysis).
2. Use Kirchhoff's Current Law to write node equations (node analysis).
3. Include Ohm's Law to relate voltages and currents.
4. Rearrange equations into standard linear form:  $Ax = b$   
Build the coefficient matrix  $A$ , unknown vector  $x$ , and constant vector  $b$ .
5. Common methods include:  
Gauss elimination, Gauss Jordan, Gauss Jacobi and Gauss-Seidel method
6. After finding unknown currents or voltages:  
Calculate branch currents

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Determine voltage drops

**Exemplars and Utility:**

1. Mesh analysis solves for loop currents using Kirchhoff's Voltage Law.
2. Node analysis solves for node voltages using Kirchhoff's Current Law
3. Post-Solution Power Analysis

|                             |                                                                        |             |               |
|-----------------------------|------------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.<br/>4</b> | <b>Interpolate values from a lookup table using Lagrange's method.</b> | <b>CO-3</b> | <b>2 Hrs.</b> |
|-----------------------------|------------------------------------------------------------------------|-------------|---------------|

**Objective:**

To estimate an unknown function value at a given point using known discrete data points from a lookup table by constructing an interpolating polynomial.

**Associated Tasks:**

1. Identify the known data points from the table:  
 $(x_0, y_0), (x_1, y_1), \dots, (x_n, y_n)$   
 Ensure the x-values are distinct (required for Lagrange interpolation).
2. Determine the target value  $x$  where the function needs to be estimated:

$$x = x^*$$

3. For each data point, compute the basis polynomial:

$$L_i(x) = \prod_{j \neq i} \frac{x - x_j}{x_i - x_j}$$

Calculate each denominator  $(x_i - x_j)$

Evaluate numerator terms  $(x - x_j)$

Multiply terms to obtain each  $L_i(x)$

4. Combine basis polynomials with table values:

$$P(x) = \sum_{i=0}^n y_i L_i(x)$$

Multiply each  $y_i$  by corresponding  $L_i(x)$

Sum all terms to obtain interpolated value

5. Substitute the desired  $x$ -value into the polynomial and Compute:

$$P(x^*)$$

**Exemplars and Utility:**

1. Predict function values between measured or tabulated data points.
2. Produces a polynomial passing through all known points.
3. Estimate values mathematically instead of collecting additional measurements.

|                        |                                                                                      |             |               |
|------------------------|--------------------------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.5</b> | <b>Interpolate values from a lookup table using Newton forward difference method</b> | <b>CO-3</b> | <b>2 Hrs.</b> |
|------------------------|--------------------------------------------------------------------------------------|-------------|---------------|

**Objective:**

To estimate an unknown function value at a desired point using equally spaced tabulated data by constructing an interpolation polynomial based on forward differences.

**Associated Tasks:**

1. Ensure the lookup table has uniformly spaced independent-variable values:

$$x_0, x_1, x_2, \dots, x_n$$

Check that:

$$h = x_{i+1} - x_i$$

where  $h$  is constant.

2. List known data points:



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 $(x_0, y_0), (x_1, y_1), (x_2, y_2), \dots$ 

Identify:

Initial value  $x_0$ Corresponding function values  $y_i$ 

3. Construct the Forward Difference Table
4. Compute the Normalized Parameter  $p$
5. Construct the Newton Forward Interpolation Polynomial
6. Evaluate the Polynomial

Calculate:  $f(x)$ **Exemplars and Utility:**

1. Basic Numerical Interpolation
2. Capacitor voltage calculation
3. Thermodynamic Property Table
4. Thermodynamic/property tables
5. Sensor calibration
6. Experimental data analysis
7. Population/statistical estimation
8. Signal processing

|                                   |                                                                            |             |               |
|-----------------------------------|----------------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.</b><br><b>6</b> | <b>Calculate current/voltage waveform area using Simpson's 1/3rd rule.</b> | <b>CO-3</b> | <b>2 Hrs.</b> |
|-----------------------------------|----------------------------------------------------------------------------|-------------|---------------|

**Objective:**

To calculate the area under current or voltage waveforms from sampled data using Simpson's 1/3<sup>rd</sup> rule, so that average value, charge, energy, and other electrical quantities can be determined accurately.

**Associated Tasks:**

1. Record current or voltage values at equally spaced time intervals.
2. Ensure all data points have equal spacing ( $h$ ).
3. Verify that the number of intervals is even (required for Simpson's rule).
4. Arrange data in tabular form  
List time values and corresponding current/voltage values.
5. Apply Simpson's 1/3rd formula
6. Area =  $\frac{h}{3} [y_0 + y_n + 4(\text{odd terms}) + 2(\text{even terms})]$   
Calculate the waveform area  
Compute the approximate integral (area under the curve).
7. Determine required electrical quantity  
Use the area to calculate:
8. Average value
9. Charge ( $Q = \int i \, dt$ )
10. Energy or power-related values

**Exemplars and Utility:**

1. Calculate Area Under Current Waveform
2. Find Average Voltage
3. Oscilloscope Data Analysis
4. Determine electric charge

$$Q = \int i(t) \, dt$$

5. Compute energy or power-related quantities
6. Analyze waveform data from experiments, simulations, or oscilloscopes

|                                   |                                                                                       |             |               |
|-----------------------------------|---------------------------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.</b><br><b>7</b> | <b>Calculate current/voltage waveform area using Simpson's 3/8<sup>th</sup> rule.</b> | <b>CO-3</b> | <b>2 Hrs.</b> |
|-----------------------------------|---------------------------------------------------------------------------------------|-------------|---------------|

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To calculate the area under current or voltage waveforms from sampled data using Simpson's  $3/8^{\text{th}}$  rule, so that average value, charge, energy, and other electrical quantities can be determined accurately.

**Associated Tasks:**

1. Record current or voltage values at equally spaced time intervals.
2. Ensure all data points have equal spacing (h).
3. Verify that the number of intervals is even (required for Simpson's rule).
4. Arrange data in tabular form  
List time values and corresponding current/voltage values.
5. Apply Simpson's  $3/8^{\text{th}}$  formula
6.  $\text{Area} = 3h/8[y_0 + y_n + 3(\text{sum of non-multiple-of-3 terms}) + 2(\text{sum of multiple-of-3 terms})]$   
Calculate the waveform area  
Compute the approximate integral (area under the curve).
7. Determine required electrical quantity  
Use the area to calculate:
8. Average value
9. Charge ( $Q = \int i \, dt$ )
10. Energy or power-related values

**Exemplars and Utility:**

1. Calculate Area Under Current Waveform
  2. Find Average Voltage
  3. Oscilloscope Data Analysis
  4. Determine electric charge
- $$Q = \int i(t) \, dt$$
5. Compute energy or power-related quantities
  6. Analyze waveform data from experiments, simulations, or oscilloscopes

|                            |                                                                      |             |               |
|----------------------------|----------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.</b><br>8 | <b>Simulate an RL circuit's transient response using RK4 method.</b> | <b>CO-4</b> | <b>2 Hrs.</b> |
|----------------------------|----------------------------------------------------------------------|-------------|---------------|

**Objective:**

To accurately compute the time-varying current or voltage of an RL circuit during transient conditions using the RK4 numerical method.

**Associated Tasks:**

1. Define circuit parameters  
Specify: Resistance (R)  
Inductance (L)  
Source voltage (V)  
Initial current  $i(0)$
2. Form the RL circuit differential equation  
Using Kirchhoff's Voltage Law:

$$L \frac{di}{dt} + Ri = V$$

Rearrange into standard form:

$$\frac{di}{dt} = \frac{V - Ri}{L}$$

3. Choose simulation settings  
Select time step (h)  
Define total simulation time
4. Apply the Runge-Kutta methods 4th-order (RK4) method  
Compute:  
 $k_1, k_2, k_3, k_4$



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- Update current using RK4 formula.
- 5. Iterate over time steps  
Calculate current at each time interval until the final simulation time.
- 6. Compute related circuit quantities  
Inductor voltage  
Resistor voltage  
Time constant behavior
- 7. Plot transient response  
Display current vs. time and/or voltage vs. time graphs.
- 8. Verify results  
Compare with expected RL exponential response for accuracy.

**Exemplars and Utility:**

- 1. Calculate current rise and decay during switching
- 2. Determine inductor and resistor voltages
- 3. Analyze time constant behavior
- 4. RL Circuit Current Decay (Switch OFF)
- 5. RL Circuit Current Growth (Switch ON)

|                                   |                                                                            |             |               |
|-----------------------------------|----------------------------------------------------------------------------|-------------|---------------|
| <b>Experiment No.</b><br><b>9</b> | <b>Fit a curve to noisy voltage-time data and analyze goodness of fit.</b> | <b>CO-4</b> | <b>2 Hrs.</b> |
|-----------------------------------|----------------------------------------------------------------------------|-------------|---------------|

**Objective:**

Fit a curve to noisy voltage–time data and check how well the curve matches the data using goodness-of-fit measures like  $R^2$  and RMSE.

**Associated Tasks:**

- 1. Collect voltage–time data.
- 2. Plot the noisy data.
- 3. Choose a suitable fitting curve (linear/exponential/polynomial).
- 4. Fit the curve to the data.
- 5. Calculate goodness of fit ( $R^2$ , RMSE).
- 6. Analyze residual errors.
- 7. Interpret and report the results.

**Exemplars:**

- 1. Fitting an RC circuit discharge voltage curve.
- 2. Modeling battery voltage decay over time.
- 3. Analyzing sensor voltage signals with noise.
- 4. Fitting oscilloscope waveform data.

**Utility:**

- 1. Helps identify the underlying voltage trend.
- 2. Reduces the effect of measurement noise.
- 3. Evaluates model accuracy using  $R^2$  and RMSE.
- 4. Supports prediction and system performance analysis.

|                                    |                                                                                                                    |                       |               |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|
| <b>Experiment No.</b><br><b>10</b> | <b>Mini project: Create a Python GUI (Tkinter or Streamlit) for solving numerical problems in electrical engg.</b> | <b>CO-1,CO-2,CO-3</b> | <b>2 Hrs.</b> |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|

**Objective:**

Create a Python GUI using Tkinter or Streamlit to solve and visualize numerical problems in Electrical Engineering easily and interactively.

**Associated Tasks:**

- 1. Design the GUI layout (input/output fields, buttons).
- 2. Implement numerical problem-solving algorithms.
- 3. Add user input validation.
- 4. Display calculated results clearly.
- 5. Include plots/graphs for visualization (if needed).

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6. Test the application with sample electrical engineering problems.
7. Improve usability and finalize the project.

**Exemplars:**

1. Circuit calculator (Ohm's law, power, resistance).
2. AC/DC analysis tool for voltage and current calculations.
3. Filter design calculator.
4. Transformer parameter solver.

**Utility:**

1. Makes electrical calculations faster and easier.
2. Provides a user-friendly interface for problem solving.
3. Reduces manual calculation errors.
4. Helps students learn and visualize engineering concepts.

**Textbooks:**

1. S. S. Sastry – Introductory Methods of Numerical Analysis, PHI
2. S Kalavathy, M Joice Punitha- Numerical Methods second Edition, Mc Graw-hill Education Pvt. Ltd
3. B. S. Grewal - Numerical Methods in Engineering and Science, Khanna Publishers
4. Jaan Kiussalaas – Numerical Methods in Engineering with Python, Cambridge University Press
5. Steven C. Chapra – Applied Numerical Methods with Python for Engineers and Scientists, McGraw-Hill
6. Reema Thareja - Python Programming: Using Problem Solving Approach, Oxford University Press

**Reference Books:**

1. Steven C. Chapra, Raymond P. Canale - Numerical Methods for Engineers, McGraw-Hill
2. Amos Gilat, Vish Subramaniam - Numerical Methods for Engineers and Scientists, Wiley
3. Ruben R. Gonzalez - A First Course in Scientific Computing: Symbolic, Graphic, and Numeric Modeling Using MATLAB, Princeton University Press
4. Claude Gomez - Numerical Computation Using Python, Wiley (Scientific Computing series)
5. Rakesh Nayak - Python for Engineers and Scientists, BPB Publications

**MOOCs Links and additional reading material:**

1. Numerical Methods for Engineers by Prof. Niket Kaisare, IIT Madras:  
<https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ge20/>
2. Computational Science and Engineering Using Python by Prof. Mahendra Verma, IIT Kanpur:  
<https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-ph02/>
3. Numerical Methods and Simulation Techniques for Scientists and Engineers by Prof. Saurabh Basu, IIT Guwahati: [https://onlinecourses.nptel.ac.in/noc22\\_ph42/preview?utm\\_source=chatgpt.com](https://onlinecourses.nptel.ac.in/noc22_ph42/preview?utm_source=chatgpt.com)
4. Numerical Analysis and Methods by Ahmad Bazzi: <https://youtube.com/playlist?list=PL-DDW8QIRjNOxxzJLhxrenUXH5G-pjUC&si=B9ua1-4bEwa15BSr>  
Numerical Methods and Computer Programming by John T. Foster  
<https://www.youtube.com/playlist?list=PLCnlJOMhMC0PW7IUv312SgQauEujq1HdU>

**Strength of CO-PO-PSO Mapping**

| CO   | PO1         | PO2         | PO3      | PO4         | PO5        | PO6 | PO7 | PO8 | PO9 | PO10 | PO11     | PSO1     | PSO2     | PSO3     |
|------|-------------|-------------|----------|-------------|------------|-----|-----|-----|-----|------|----------|----------|----------|----------|
| CO1  | 1           | 3           | -        | -           | 3          | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| CO2  | 1           | -           | -        | 2           | 3          | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| CO3  | 2           | 2           | 1        | 1           | 1          | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| CO4  | -           | 3           | 1        | 1           | 1          | -   | -   | -   | -   | -    | 1        | 1        | 2        | 2        |
| Avg. | <b>1.33</b> | <b>2.66</b> | <b>1</b> | <b>1.33</b> | <b>2.2</b> | -   | -   | -   | -   | -    | <b>1</b> | <b>1</b> | <b>2</b> | <b>2</b> |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)



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**Unit wise Weightage:**

| Exam       | Unit1 | Unit2 | Unit3 | Unit4 |
|------------|-------|-------|-------|-------|
| CCE        |       |       |       |       |
| CT1        | 10    | 10    |       |       |
| Assignment |       |       | 10    | 10    |
| Quiz       |       |       |       |       |
| ESE        | 15    | 15    | 15    | 15    |
| Total      | 25    | 25    | 25    | 25    |

**Assessment Pattern**

| BT Level | CCE |     |     |     | ESE |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|
|          | CO1 | CO2 | CO3 | CO4 | CO1 | CO2 | CO3 | CO4 |
|          | 10  | 10  | 10  | 10  | 15  | 15  | 15  | 15  |
| L1       | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| L2       | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| L3       | -   | ✓   | ✓   | ✓   | -   | ✓   | ✓   | ✓   |
| L4       | -   | -   | -   | ✓   | -   | -   | -   | ✓   |
| L5       | -   | -   | -   | -   | -   | -   | -   | -   |
| L6       | -   | -   | -   | -   | -   | -   | -   | -   |

**This course serves as a prerequisite for / maps with the following future courses:** Control Systems, Power System Analysis, Machine Learning, Signal Processing, and Simulation & Modeling.

**Job Mapping:**

Job opportunities that one can get after learning this course: Software Developer, Data Analyst, Simulation Engineer



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------|---------------|---------------------------|---------------------|-----------|----------------|----------------------|
| <b>Program:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                 | <b>S. Y. B. Tech (Electrical Engineering)</b>           |               |                           | <b>Semester:</b>    |           | IV             |                      |
| <b>Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                 | <b>Environmental Awareness for Electrical Engineers</b> |               |                           | <b>Course Code:</b> |           | R25-EE-VEC-221 |                      |
| <b>Teaching Scheme</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                 |                                                         |               | <b>Examination Scheme</b> |                     |           |                |                      |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Practical</b>                                                                                | <b>Tutorial</b>                                         | <b>Credit</b> | <b>CCE</b>                | <b>ESE</b>          | <b>TW</b> | <b>PR</b>      |                      |
| 02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | --                                                                                              |                                                         | 2             | 50                        | --                  | --        | --             |                      |
| <b>Course Description and Relevance:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <b>Description:</b> This course introduces students to the fundamental concepts of environmental science, sustainability, and ecological balance with a special focus on electrical engineering applications. It covers environmental challenges such as pollution, climate change, resource depletion, waste management, and energy consumption, while explaining how engineering activities influence the environment. The course also discusses renewable energy systems, energy-efficient technologies, environmental impact assessment, environmental laws, and ethical responsibilities of engineers toward sustainable development. Through this course, students gain knowledge about sustainable engineering practices and the importance of conserving natural resources for future generations. |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <b>Relevance:</b> The course is highly relevant for electrical engineering students because modern engineering systems must be designed with environmental protection and energy efficiency in mind. Electrical engineers play a major role in power generation, transmission, industrial automation, and electronic systems, all of which can significantly affect the environment. Understanding environmental principles helps engineers develop cleaner technologies, reduce energy losses, minimize pollution, and comply with environmental regulations. The course also builds professional ethics and sustainability awareness, enabling students to contribute responsibly toward green energy solutions, smart power systems, and environmentally sustainable industrial development.            |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <b>Prerequisite:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| --                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <b>Bridge Content:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <div>1. Environmental Studies serves as an important bridge between basic scientific knowledge and practical engineering applications in the field of electrical engineering.</div> <div>2. The course also bridges the gap between conventional engineering methods and sustainable technological development by introducing clean energy solutions, environmental regulations, and ethical engineering practices.</div> <div>3. This interdisciplinary connection enhances both professional competence and social responsibility among future engineers.</div>                                                                                                                                                                                                                                          |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <b>Course Objectives:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <div>1. To develop an understanding of environmental concepts, challenges, and sustainability issues relevant to engineering practice.</div> <div>2. To enable students to identify the impact of electrical engineering activities on the environment.</div> <div>3. To introduce environmentally sustainable technologies and energy-efficient practices in the electrical domain.</div> <div>4. To promote ethical responsibility and awareness toward environmental conservation.</div>                                                                                                                                                                                                                                                                                                                |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <b>Course Outcomes:</b> After learning the course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                 |                                                         |               |                           |                     |           |                |                      |
| <b>CO</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Course Outcome</b>                                                                           |                                                         |               |                           |                     |           |                | <b>Bloom's Level</b> |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Understand</b> the principles of environmental science and the importance of sustainability. |                                                         |               |                           |                     |           |                | 2                    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Analyze</b> the environmental impacts of electrical engineering processes and systems.       |                                                         |               |                           |                     |           |                | 4                    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Identify</b> sustainable and clean energy solutions relevant to electrical engineering.      |                                                         |               |                           |                     |           |                | 2                    |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Apply</b> environmental laws and ethical practices in professional engineering activities.   |                                                         |               |                           |                     |           |                | 3                    |

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| Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                    |               |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------|------------|
| <b>Unit 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Fundamentals of Environment and Sustainability</b>              | <b>7 Hrs.</b> | <b>CO1</b> |
| Definition and Scope of Environmental Studies; Components of Environment: Atmosphere, Hydrosphere, Lithosphere, Biosphere; Ecosystems: Structure, Function, and Energy Flow; Sustainable Development: Goals and Indicators; Relationship between Technology and Environment; Importance of Environmental Awareness for Electrical Engineers.                                                                                                                                                                                                                                                                                                                                                   |                                                                    |               |            |
| <b>Unit 2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Pollution and its control</b>                                   | <b>7 Hrs.</b> | <b>CO2</b> |
| Air, water, soil, and noise pollution its causes, effects, and control measures; E-waste: origin, environmental impact, and safe disposal methods; Thermal and electromagnetic pollution due to electrical systems; Pollution control acts and environmental regulations (Air Act, Water Act, EPA, EIA); Role of electrical engineers in pollution prevention (e.g., green electrical systems)                                                                                                                                                                                                                                                                                                 |                                                                    |               |            |
| <b>Unit 3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Renewable Energy and Green Technologies</b>                     | <b>8 Hrs.</b> | <b>CO3</b> |
| Need for Renewable Energy in Sustainable Development; Overview of Solar, Wind, Biomass, and Small Hydro Energy; Distributed Generation and Grid Integration Challenges; Energy Auditing and Management in Electrical Installations; Green Buildings and Smart Grid Concept; Case Studies: Solar Rooftop Installations, Wind Energy Parks                                                                                                                                                                                                                                                                                                                                                       |                                                                    |               |            |
| <b>Unit 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Climate Change, Carbon Footprint, and Sustainable Practices</b> | <b>8 Hrs.</b> | <b>CO4</b> |
| Global Warming and Climate Change: Causes, Effects, and Mitigation; Carbon Footprint Calculation and Reduction Strategies; Role of Electric Vehicles and Battery Storage Systems; Environmental Risk Assessment and Disaster Management; Corporate Environmental Responsibility (CER) and Role of Engineers; Local and Global Case Studies in Sustainable Electrical Practices                                                                                                                                                                                                                                                                                                                 |                                                                    |               |            |
| <b>Comprehensive Continuous Evaluation (CCE) components for the course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                    |               |            |
| 1. <b>Course Projects (Mini/Micro Project):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                    |               |            |
| 2. <b>Class Tests / Unit Tests: Unit ..... and Unit....(any two units)</b><br>Unit 1 and 2: Unit Test: 10 Marks<br>Unit 3 and 4: Assignments: 5 marks<br>Total CCE Marks: 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                    |               |            |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                    |               |            |
| 1. A Textbook of Environmental Studies, Dr. D. K. Asthana, S. Chand<br>2. The textbook of Environmental studies, Dr. P. D. Raut, Shivaji University, 2013<br>3. Textbook on Environmental Science and Sustainability, Dr. C. Jeyaprabha, Dr. V.Sribharathy, Evincepub Publishing                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                    |               |            |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                    |               |            |
| 1. Air Pollution, M. N. Rao, McGraw Hill, Publication.<br>2. E-waste Management and Procurement of Environment, Dr. Suresh Kumar, Authors press, 2021.<br>3. Hazardous Waste Incineration, Brunner R.C., 1989, , McGraw Hill Inc.<br>4. Pollution, Clark R.S., Marine Clanderson Press Oxford (TB)<br>5. Environmental Science, Miller T.G. Jr., Wadsworth Publishing Co. (TB)<br>6. Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Trivedi R.K., Enviro Media ®<br>7. Renewable Energy and Green Technology, Ritu Dogra, Brillion Publishing                                                                                                      |                                                                    |               |            |
| <b>MOOCs Links and additional reading material:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                    |               |            |
| 1. Dr. Monica Jain, Devi Ahilya Vishwavidyalaya, Indor <a href="https://onlinecourses.swayam2.ac.in/cec21_ge21/preview">https://onlinecourses.swayam2.ac.in/cec21_ge21/preview</a><br>2. Prof. Mukesh Sharma, IIT Kanpur <a href="https://archive.nptel.ac.in/courses/105/102/105102089">https://archive.nptel.ac.in/courses/105/102/105102089</a><br>3. Prof. J. Bhattacharyya, IIT Kharagpur <a href="https://archive.nptel.ac.in/courses/123/105/123105001">https://archive.nptel.ac.in/courses/123/105/123105001</a><br>4. Prof. Bhola Ram Gurjar, IIT Roorkee <a href="https://archive.nptel.ac.in/courses/105/107/105107213/">https://archive.nptel.ac.in/courses/105/107/105107213/</a> |                                                                    |               |            |



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5. Environment Policy and Administration Dr. Tejpal Dhewa Central University of Haryana, Mahendergarh, Haryana [Preview: Environment Policy and Administration | SWAYAM](#)
6. Environmental Science and Engineering Dr. M. Anil Kumar & Dr. M. Seenivasan (NITTTR), Chennai [Preview: Environmental Science and Engineering | SWAYAM](#)

**e-Books**

- E1. Textbook of Environmental Studies for Undergraduate Courses”, Bharucha, Erach (2005): University Press (India) Pvt. Ltd., Hyderabad, India
- E2. Environmental Education, Kothari Dr Milind- 2005- - Universal Publication Agra.
- E3. MEV-011E.xps
- E4. India\_Green\_Stimulus\_Report\_NITI\_VF\_June\_29.pdf

**CO-PO-PSO Mapping**

| CO   | PO1  | PO2  | PO3  | PO4 | PO5  | PO6 | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|------|------|------|-----|------|-----|-----|-----|------|------|------|------|------|------|
| CO1  | 2    | 1    | 1    | 1   | 1    | 2   | 2   | 1   | 2    | 1    | 2    | -    | -    | -    |
| CO2  | 2    | 2    | 1    | 2   | 1    | 3   | 2   | 1   | 2    | 1    | 2    | -    | -    | -    |
| CO3  | 1    | 1    | 1    | 1   | 1    | 2   | 2   | 1   | 1    | 1    | 2    | -    | -    | -    |
| CO4  | 2    | 2    | 2    | 2   | 2    | 3   | 2   | 1   | 2    | 1    | 3    | -    | -    | -    |
| Avg. | 1.75 | 1.50 | 1.25 | 1.5 | 1.25 | 2.5 | 2   | 1   | 1.75 | 1    | 2.22 | -    | -    | -    |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Unit wise Weightage:**

| Exam       | Unit1 | Unit2 | Unit3 | Unit4 |
|------------|-------|-------|-------|-------|
| CCE        |       |       |       |       |
| CCE1       | 5     | 5     | -     | -     |
| Assignment | NA    | NA    | 3     | 2     |
| ESE        | 08    | 09    | 09    | 09    |
| Total      | 13    | 14    | 12    | 11    |

**Assessment Pattern**

| BT Level | CCE |     |     |     | ESE |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|
| CO       | CO1 | CO2 | CO3 | CO4 | CO1 | CO2 | CO3 | CO4 |
| Weight   | 5   | 5   | 3   | 2   | 8   | 9   | 9   | 9   |
| L1       |     |     |     |     |     |     |     |     |
| L2       | ✓   |     | ✓   |     | ✓   |     | ✓   |     |
| L3       |     |     |     | ✓   |     |     |     | ✓   |
| L4       |     | ✓   |     |     |     | ✓   |     |     |
| L5       |     |     |     |     |     |     |     |     |
| L6       |     |     |     |     |     |     |     |     |

This course serves as a prerequisite for / maps with the following future courses:

Solar Energy Basics; Installation of Solar: Commercial

**Job Mapping:**

Job opportunities that one can get after learning this course:

After completing this course, students can explore career opportunities in industries and organizations focused on environmental sustainability, energy management, and green technologies.

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