Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

National Education Policy (NEP)-2020 Compliant Curriculum

SE-Second Year Engineering (2024 Pattern)-Revised

Electrical Engineering

(With effect from Academic Year: 2026-27)

Preface by Board of Studies

Dear Students and Teachers,

We, the members of Board of Studies Electrical Engineering, are very happy to present Second Year Electrical Engineering revised syllabus effective from the Academic Year 2026-27.

Electrical Engineering plays a vital role in the development of modern society through advancements in power systems, electronics, automation, electric mobility, and renewable energy technologies. Emerging areas such as smart grids, sustainable energy solutions, the Internet of Things (IoT), industrial automation, and artificial intelligence are transforming the discipline and redefining industry expectations. This curriculum addresses these evolving trends by integrating application-oriented topics, laboratory experiences, and experiential learning activities to equip students with strong technical foundations, practical skills, and the adaptability required to meet future technological challenges.

The syllabus has been developed through consultations with academicians, industry experts, alumni, and other stakeholders to ensure its relevance to current technological advancements and societal needs. The inclusion of laboratory work, tutorial activities, experiential learning, and multidisciplinary components is intended to enhance students' analytical thinking, innovation, teamwork, and lifelong learning abilities.

It is expected that this curriculum will provide students with a solid foundation for higher studies, research, entrepreneurship, and successful professional careers in Electrical Engineering and allied domains.

The Board of Studies in Electrical Engineering expresses its sincere gratitude to all experts, faculty members, industry representatives, and stakeholders whose valuable suggestions and contributions have helped in shaping this curriculum.

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Nomenclature

AEC	Ability Enhancement Course
CEP	Community engagement project
EEM	Entrepreneurship/Economics/ Management
FP	Field Project
HSSM	Humanities, Social Science, and Management
MDM	Multidisciplinary Minor
MOOC	Massive Open Online Course
OE	Open Elective
PCC	Programme Core Course
PEO	Programme Educational Objectives
PO	Program Outcomes
PSO	Program Specific Outcomes
SEC	Skill Enhancement Courses
SWAYAM	Study Webs of Active Learning for Young Aspiring Minds
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course
VSC	Vocational Skill Courses
WK	Knowledge and Attitude Profile

SE-Second Year of Engineering (2024 Course)-Revised

(With effect from Academic Year: 2026-27)

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Program Specific Outcomes (PSO)

Program Specific Outcomes (PSOs) refer to specific statements that describe what students are expected to know, think, or be able to do upon completion of a particular engineering program, reflecting the specialized knowledge and skills relevant to their field of study.

- **PSO1**: Test, operate, install and protect AC/DC Electrical machines, power system and design of transformer & induction motor.
- **PSO2**: Select, measure, control, simulate & analyse; Systems in Electrical Engineering by using analog & digital circuits, power electronics, Microprocessors / Microcontrollers, PLC / SCADA and numerical methods

Program Educational Objectives (PEO)

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that engineering graduates are expected to achieve 4 to 5 years after completing the program.

PEO	PEO Focus	PEO Statements
PEO1	Core Technical Excellence	Graduates will establish themselves as competent professionals by applying core concepts of electrical engineering to analyze, design, and maintain electrical systems in industry, research, and academic settings
PEO2	Ethical, Social, and Global Responsibility	Graduates will exhibit professionalism, ethical behavior, and a commitment to societal and environmental responsibility while working in multidisciplinary teams and contributing to national and global development
PEO3	Professional Growth and Lifelong Learning	Graduates will pursue higher education, certifications, or self-directed learning to continuously enhance their knowledge and stay updated with evolving technologies in electrical and allied engineering domains.

Knowledge and Attitude Profile (WK)

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 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.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPCV4.0) -(August 2024) Page55.

Program Outcomes (POs)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, attitude and behavior that students acquire through the program. On successful completion graduating students/graduates will be able to:

PO1	Engineering knowledge	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified inWK1 toWK4 respectively to develop solutions of complex engineering problems
PO2	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	Design creative solutions for 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 & 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 & 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)

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPCV4.0) -(August 2024) Page56.

General Rules and Guidelines

- **Course Outcomes (CO):** Course Outcomes are narrower statements that describe what students are expected to know and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course
- **Assessment**: Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.
- **Evaluation**: Evaluation is one or more processes, done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program.

Guidelines for Examination Scheme

Theory Examination: The theory examination shall be conducted in two different parts Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE).

Comprehensive Continuous Evaluation (CCE):

1. CCE of 40 marks based on all the Units of the course syllabus to be scheduled and conducted at institute level.
2. Case studies included under each unit are intended to support applied learning and are part of Comprehensive Continuous Evaluation
3. These case studies will be assessed through internal assessment components such as presentations, assignments, or group discussions. They shall not be included in the End-Semester Theory Examination.
4. 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:

Sr.	Parameters	Marks	Coverage of Units
a	Unit Test	15 Marks	Units 1 & Unit 2 (7/8 Marks/Unit)
b	Assignments / Case Study	15 Marks	Units 3 & Unit 4 (7/8 Marks/Unit)
c	Seminar Presentation / Open Book Test/ Quiz	10 Marks	Unit 5

5. CCE of 20 marks based on all the Units of the course syllabus to be scheduled and conducted at institute level. To design a CCE scheme for a theory subject of 20 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
a	Unit Test	10 Marks	Units 1 & Unit 2 (5 Marks/Unit)
b	Seminar Presentation / Open Book Test/ Assignments/Case Studies	10 Marks	Units 3 & Unit 4

Format and Implementation of Comprehensive Continuous Evaluation (CCE)

- **Unit Test**
  - **Format:** Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyse, Evaluate, Create).
  - **Implementation:** Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.
- **Sample Question Distribution** [Topics from Units 1 and 2].
  - **Remembering (3 Marks):** Define related key terms.
  - **Understanding (3 Marks):** Explain the principle of [Concept] in [Context].
  - **Applying (3 Marks):** Demonstrate how [Concept] can be used in [Scenario].
  - **Analysing (3 Marks):** Compare & contrast [Two related concepts].
  - **Evaluating (3 Marks):** Evaluate the effectiveness of [Theory/Model] in [Situation].
- **Assignments / Case Study:** Students should submit one assignment, or one Case Study Report based on Unit 3 and one assignment, or one Case Study Report based on Unit 4.
  - **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.
  - **Implementation:** Distribute the assignments or case study after covering Units 3 and 4. Provide clear guidelines and a rubric for evaluation.
- **Seminar Presentation**:
  - **Format:** Oral presentation on a topic from Unit 5, followed by a Q&A session.
  - **Deliverables:** Presentation slides, a summary report in 2 to 3 pages, and performance during the presentation.
  - **Implementation:** Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.
- **Open Book Test:**
  - **Format:** Analytical and application-based questions to assess depth of understanding.
  - **Implementation:** Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5.
- **Quiz:**
  - **Format:** Quizzes can help your students practice existing knowledge while stimulating interest in learning about new topic in that course. You can set your quizzes to be completed individually or in small groups.
  - **Implementation:** Online tools and software can be used to create quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false etc
- **Example Timeline for conducting CCE:**
  - **Weeks 1-4** : Cover Units 1 and 2
  - **Week 5** : Conduct Unit Test (15 marks)

- **Weeks 6-9** : Cover Units 3 and 4
- **Week 10** : Distribute and collect Assignments / Case Study (15 marks)
- **Weeks 11-12** : Cover Unit 5
- **Week 13** : Conduct Seminar Presentations or Open Book Test or Quiz (10 marks)

- **Evaluation and Feedback:**
  - **Unit Test**: Evaluate promptly and provide constructive feedback on strengths and areas for improvement.
  - **Assignments / Case Study:** Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.
  - **Seminar Presentation:** Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.
  - **Open Book Test:** Evaluate based on the depth of analysis and application of concepts. Provide feedback on critical thinking and problem-solving skills.

End-Semester Examination (ESE)

End-Semester Examination (ESE) of 60 marks written theory examination based on all the unit of course syllabus scheduled by university. Question papers will be sent by the University through QPD (Question Paper Delivery). University will schedule and conduct ESE at the end of the semester.

- **Format and Implementation:**
  - **Question Paper Design:** Below structure is to be followed to design an End Semester Examination (ESE) for a theory subject of 60 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 12 marks allocated per unit.
  - **Balanced Coverage:** Ensure balanced coverage of all units with questions that assess different cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyse, Evaluate, and Create. The questions should be structured to cover:
    - **Remembering**: Basic recall of facts and concepts.
    - **Understanding**: Explanation of ideas or concepts.
    - **Applying:** Use of information in new situations.
    - **Analysing:** Drawing connections among ideas.
    - **Evaluating**: Justifying a decision or course of action.
    - **Creating**: Producing new or original work (if applicable).

Unit wise marks allocation (for 60 Marks and 30 Marks Question Paper)

60 Marks Question Paper	30 Marks Question Paper
12 Marks per Unit	06 Marks /unit

Details: Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation

Curriculum Structure- Semester III

Second Year Engineering (2024 Pattern) [Revised]– Electrical Engineering

Level 5.0

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			Theory	Tutorial	Practical	CCE	End-Sem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-201-ELE	Program Core Course	Electrical Measurements & Instrumentation	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC-202-ELE	Program Core Course	Analog and Digital Electronics	3	-	-	40	60	-	-	-	100	3	-	-	3
PCC-203-ELE	Program Core Course	Power System Engineering-I	2	1	-	40	60	25	-	-	125	2	1	-	3
PCC-204-ELE	Program Core Course Lab	Electrical Measurements & Instrumentation Lab	-	-	2	-	-	25	25	-	50	-	-	1	1
PCC-205-ELE	Program Core Course Lab	Analog and digital Electronics Lab	-	-	2	-	-	25	25	-	50	-	-	1	1
	Open Elective	*Open Elective-I	2	-	-	20	30	-	-	-	50	2	-	-	2
MDM-222-ELE	Multidisciplinary Minor-I	Engineering Mathematics-III	3	-	-	40	60	-	-	-	100	3	-	-	3
EEM-231-ELE	Entrepreneurship/ Economics/ Management	Engineering Economics	-	2	-	-	-	25	-	-	25	-	2	-	2
VEC-232-ELE	Value Education	Universal Human Values & Professional Ethics	2	-	-	20	30	-	-	-	50	2	-	-	2
CEP-241-ELE	Community Engagement Project	Energy Literacy & Electrical Safety Education	-	-	4	-	-	50	-	-	50	-	-	2	2
Total			**15**	**03**	**08**	**200**	**300**	**150**	**50**	**-**	**700**	**15**	**03**	**04**	**22**

***Note: Students can opt for Open Electives offered by different faculty, like Arts, Commerce, Management, Humanities or Inter-Disciplinary studies.**

Example:

Open Elective I - Financial Accounting, Digital Finance, Digital Marketing, Digital Business, Personal financial Management, Wine technology, Dairy Technology, Supply chain Management, Digital Manufacturing can be opted from Commerce and Management faculty.

Curriculum Structure- Semester IV

Second Year Engineering (2024 Pattern) [Revised] – Electrical Engineering

Level 5.0

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			Theory	Tutorial	Practical	CCE	End-Sem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-251-ELE	Program Core Course	Electrical Machines-1	3	-	-	40	60	-		-	100	3	-	-	3
PCC-252-ELE	Program Core Course	Numerical Methods and Computer Programming	2	-	-	40	60	-		-	100	2	-	-	2
PCC-253-ELE	Program Core Course	Network Analysis	2	-	-	40	60	-	-	-	100	2	-	-	2
PCC-254-ELE	Program Core Lab	Electrical Machines-1 Lab	-	-	2	-	-	-	25	-	25	-	-	1	1
PCC-255-ELE	Program Core Lab	Numerical Methods and Computer Programming Lab	-	-	2	-	-	-	25	-	25	-	-	1	1
PCC-256-ELE	Program Core Lab	Network Analysis Lab	-	-	2	-	-	-	-	25	25	-	-	1	1
	Open Elective	*Open Elective-II	2	-	-	20	30	-	-	-	50	2	-	-	2
MDM-272-ELE	Multidisciplinary Minor-II	Fundamentals of Data Science & Machine Learning	2	-	-	40	60	-	-	-	100	2	-	-	2
VSE-281-ELE	Vocational and Skill Enhancement Course	Electrical Workshop	-	-	4	-	-	25	-	25	50	-	-	2	2
AEC-282-ELE	Ability Enhancement Course	Modern Indian Languages (Marathi/Hindi)	-	1	2	-	-	50	-	-	50	-	1	1	2
EEM-283-ELE	Entrepreneurship /Economics/ Management	Industrial Organization and Management	-	2	-	-	-	25	-	-	25	-	2	-	2
VEC-284-ELE	Value Education Course	Environmental Awareness for Electrical Engineers	2	-	-	20	30	-	-	-	50	2	-	-	2
Total			**13**	**03**	**12**	**200**	**300**	**100**	**50**	**50**	**700**	**13**	**03**	**06**	**22**

***Note: Students can opt for Open Electives offered by different faculty, like Arts, Commerce, Management, Humanities or Inter-Disciplinary studies.**

Example: Open Elective II - Project Management, Optimization techniques, Business Analytics, Financial Management, Business Essentials for Rural development, Nanoscience and Nano technology can be opted from Inter- Disciplinary studies, Commerce and Management faculty respectively.

Savitribai Phule Pune University, Pune

Maharashtra, India

National Education Policy (NEP) Compliant Curriculum

SEMESTER-III

Second Year Engineering (2024 Pattern)-Revised

Electrical Engineering

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-201-ELE	**Course Name: Electrical Measurements & Instrumentation**	
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hrs	**03**	**CCE : 40 Marks**
		ESE : 60 Marks

Prerequisite: Fundamentals of Electrical and Electronics Engineering

Course Objectives:

1. To familiarize students with a variety of measurement instruments used in engineering applications, such as voltmeters, ammeters, wattmeter's, multimeters, oscilloscopes, and signal analyzers.
2. To learn about various types of measurement techniques, instruments and sensors.
3. To apply proper methods of measurement and use of sensors in instrumentation

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1:** Classify the measuring instruments along with extension of range of ammeter, voltmeter & wattmeter using CT and PT.
2. **CO2:** Measure the resistance, inductance and capacitance of a given electrical system.
3. **CO3:** Measure the active/reactive power of a given electrical three-phase and single-phase system using 1-Wattmeter & 2-wattmeter methods.
4. **CO4:** Analyze different measuring methods and transducers for electrical and physical quantity measurements.
5. **CO5:** Analyze the given electrical network by measuring voltage, current, frequency, power, energy using power quality analyser & DSO.

Course Contents

Unit No: I	Measuring Instruments and Instrument Transformer	08 Hours

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, effect of sudden open circuit on current transformer. Transformation ratio, Turns ratio, Nominal ratio, Burden.

Exemplars/Case Studies	A case study of HT consumer measuring system with MI Ammeter, Voltmeter
Reference Books	**T1, T2, R1, R2, R3, R4**

Unit No: II	Measurement of Resistance, Inductance and Capacitance	08 Hours

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. Numerical on DC and AC bridges.

Exemplars/Case Studies	Resistance, inductance, capacitance of various apparatus used in day to day life.
Reference Books	**T1, T2, R1, R3, R4**

Unit No: III	Measurement of Power and Energy	08 Hours

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 Net metering.

Necessity of Calibration, Calibration of wattmeter & energy meter. Numerical on Calibration of wattmeter & energy meter

Exemplars/Case Studies	Measurement of Power and Energy in residential and Industrial consumer.
Reference Books	**T1, T2, R1, R2, R3, R4**

Unit No: IV	Transducers & Measurement of Non - Electrical Quantities	08 Hours

Transducers: Introduction, classification, basic requirements for transducers selection, and its applications.
Pressure Measurement: Introduction, Pressure measurement using electrical methods: resistive, inductive, capacitive. Pressure measurement by McLeod gauge and Pirani gauge.
Level Measurement: Introduction and importance of level measurement. Methods of level measurement: resistive, inductive, capacitive, ultrasonic. Measurement of liquid level using float.
Displacement Measurement: LVDT & RVDT: construction, working, specifications, advantages and disadvantages, applications.

Exemplars/Case Studies	Vacuum Pressure, Industrial Vacuum Systems, Process Industries. Domestic Water Tanks, Oil Tanks, Chemical Tanks
Reference Books	**T1, T2, R2, R5**

Unit No: V	Sensors & Introduction to Digital Instruments	08 Hours

Sensors: Introduction to sensors, Temperature sensor, Hall effect sensor, Piezoelectric sensor
Advantages of digital meters over analog meters. Resolution & sensitivity of digital meters. Types of tools used in digital systems. Block diagram and operation of digital Voltmeter, Multimeter, Frequency meter, Power Quality Analyzer and Digital Storage Oscilloscope, Basics of Data Acquisition System (DAS).

Exemplars/Case Studies	Marine Applications. Robotics, Military and Aerospace, Voltmeter, Ammeter, Energy meter, Multimeter etc.
Reference Books	**T1, R1.**

Learning Resources

1. Text Books

[T1]. A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai & Co.
[T2]. J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", S. K. Kataria & Sons

2. Reference Books

[R1]. E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.
[R2]. Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers.
[R3]. Fundamentals of Electrical Measurements by C.T. Baldwin , Publisher- George G.Harrap & Co Ltd
[R4]. Problems In Electrical Engineering by Smith S, parker, Asia Publications
[R5]. Instrumentation: Devices and Systems by C. Rangan, G Sarma, V.S.V. Mani, McGraw Hill Education

3. Links to online SWAYAM/NPTEL Courses

[M1]. https://archive.nptel.ac.in/courses/108/105/108105153

CO PO Mapping

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-202-ELE	**Course Name: Analog and Digital Electronics**	
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hrs	**03**	**CCE : 40 Marks**
		ESE : 60 Marks

Prerequisite:

Basic Electronics Engineering, Numbering system, Logic Gates and flip flops, Diode and BJT

Course Objectives:

1. To **use** K map for Boolean algebra reduction and design digital circuit
2. To **construct** sequential and combinational circuits using flip flops and K map
3. To **develop** the concept of basics of operational Amplifier and its applications
4. To **Understand** IC 555 timer and its applications
5. To **design** uncontrolled rectifier

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1: Simplify** complex logic expression by using Boolean algebra
2. **CO2: Design** logical, sequential and combinational 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
5. **CO5: Design** uncontrolled rectifier with given specifications

Course Contents

Unit No: I	**Design of combinational circuit**	**08 Hours**
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		
Exemplars/Case Studies	Traffic Light Control System, Elevator Control Logic, Home Automation, Digital Voting Machine, Keyboard Key Press Encoding, Seven-Segment Display, Basic Calculator	
Reference Books	**T1, T2, T8, R1, R2, R7, R8, M1**	

Unit No: II	**Design of Sequential circuit**	**08 Hours**
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		
Exemplars/Case Studies	Washing Machine Controller, Digital Clocks and Timers, Event Counting and Frequency Dividers, Digital Elevator Floor Display, Traffic Light Controllers	
Reference Books	**T1, T2, T3, T8, R1, R2, R7, R8, M1**	

Unit No: III	**Operational Amplifier Applications**	**08 Hours**
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		
Exemplars/Case Studies	Precision Control Systems, Sine Wave Detection in Inverters, Battery Charger Over/Under Voltage Detection, LED Brightness Control, ECG, Audio processing	
Reference Books	**T4, T5, T6, R3, R4, R5, R7, R8, M2**	

Unit No: IV	**Other Analog circuits**	**08 Hours**
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		
Exemplars/Case Studies	Audio Equalizers, Blinking LEDs, Square wave generator, Touch or vibration, Automatic lighting patterns sensor response, Power supply, battery charger	

Reference Books	**T4, T5, T6, R3, R4, R5, R8, M2**	
Unit No: V	**Diode rectifier (Uncontrolled Rectifier)**	**08 Hours**
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.		
Exemplars/Case Studies	Speed control of small DC motors, Power adapters for calculators, Power supply in Phone chargers & laptops, DC motor drives used in cranes, elevators	
Reference Books	**T7, R6, R8, M3**	

List of Experiments

Perform any eight (three experiments should be on bread board/trainer kit) experiment from following list:

1. Design of logical circuit for display of decimal number on seven segment display. (Hardware)
2. Design 3:8 decoder for binary to octal decoding. **(Hardware)**
3. Design three-bit full adder using any open-source software. **(Software)**
4. Design a digital clock or stopwatch using decade counter. (IC74192) **(Hardware)**
5. Find phase angle difference between same frequency signal using ZCD and AND gate. **(Hardware)**
6. Design of comparator and Schmitt trigger. **(Hardware)**
7. Study of Instrumentation amplifier using three Op-amp, CMRR measurement **(Hardware)**
8. Design sine, and triangular wave generator. **(Hardware)**
9. Design first order high pass and low pass filter using OPAMP in any open-source software. (For this provide one statement to each of four students to perform with desired cut-off frequency. Each group will demonstrate their result and prepare documentation) **(Software)**
10. Design of monostable multivibrator using IC555 and digital circuit to count number of pulses**. (Hardware)**
11. Design astable multivibrator using IC-555. **(Hardware)**
12. Design of regulated power supply **(Hardware)**
13. Design of single-phase bridge rectifier with output voltage and specified ripple. (this practical should be designed by each student, perform in simulation and demonstrate with hardware in laboratory with design documents) **(Software and Hardware)**

Guidelines for Instructor's Manual

The Instructor's Manual should contain the following related to every experiment:

- Brief theory related to the experiment
- Connection diagram /circuit diagram
- Observation table
- Sample calculations for one reading
- Result table
- Graph and Conclusions
- Data sheets of the ICs used
- Few questions related to the experiment (10 marks)
- List of components required with their specifications.

Guidelines for Students Lab Manual

The student's Lab Journal should contain the following related to every experiment:

- Theory related to the experiment,
- Connection diagram /circuit diagram,
- Observation table,
- Sample calculations for one reading,
- Result table
- Graph and Conclusions,
- Data sheets of the ICs used,
- List of components required with their specifications,

Guidelines for Lab assessment

There should be continuous assessment.

- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do connections on bread board and get the results.
- Timely submission of journal.

Guidelines for Lab conduction

- The first half hour should be utilized for explaining the circuit diagram and theory related to the experiment.
- Next one hour for connection and conduction of the experiment
- Remaining half hour for continuous assessment and timely checking of the experiment (This time slot can be adjusted as per convenience)

A separate breadboard should be provided for every student for those experiments which are compulsory to be performed on breadboard or trainer kit **(ready-made set up is not allowed)**

Learning Resources

1. Text Books

[T1]. Floyd and Jain, "Digital Fundamentals", Pearson Education.
[T2]. R. P. Jain, "Digital Electronics", Tata McGraw Hill, New Delhi.
[T3]. Malvino, "Digital Computer Electronics- An Introduction to Microcomputers," Tata McGraw Hill.
[T4]. Gaikwad R., "Operational Amplifier", PHI New Delhi.
[T5]. Floyd, "Electronics Devices", Pearson Education.
[T6]. Mottershed, "Electronics Devices & Circuits", PHI New Delhi
[T7]. Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd edition, Pearsons
[T8]. Fundamental of digital circuits, 4th Edition, by A Anand Kumar, PHI learning private limited publication.

2. Reference Books

[R1]. Tokheim, "Digital Electronics-Principles and Application", 6th edition, Tata McGraw Hill, New Delhi.
[R2]. A Jaico and Charles H. Roth, "Fundamentals of Logic Design" Jr. Fourth Edition.
[R3]. K. R. Botkar, "Integrated Circuits", Khanna Publication, New Delhi.
[R4]. James, "Operational Amplifier and Linear Integrated Circuits Theory and Application."
[R5]. P John Paul, "Electronics Devices and circuits", New Age International Publications.
[R6]. P. S. Bimbhra, "Power Electronics", Khanna Publications.
[R7]. Digital Principles and Application by Leach & Malvino, McGraw Hill Education
[R8]. Foundations of Analog and Digital Electronic Circuits by Agarwal, Publisher

3. Links to online SWAYAM/NPTEL Courses

[M1]. NPTEL course on Digital Electronics Circuit, IIT, Kharagpur. https://nptel.ac.in/courses/108105132/
[M2]. NPTEL course on Integrated circuit, MOSFET, OPAMP and their applications IISC Bangalore, https://nptel.ac.in/courses/108/108/108108111/
[M3]. NPTEL course on power electronics by IIT Kharagpur. https://nptel.ac.in/courses/108/105/108105066/

CO PO Mapping

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)			
Course Code: PCC-203-ELE		**Course Name: Power System Engineering-I**	
Teaching Scheme		**Credits**	**Examination Scheme**
Theory	**: 02 Hrs**	**02**	**CCE : 40 Marks**
Tutorial	**: 01 Hr**	**01**	**ESE : 60 Marks**
			TW : 25 Marks

Prerequisite:

Power Generation, Various insulating materials and properties, Knowledge of fundamentals of electrical circuit components and engineering mathematics.

Course Objectives:

1. To **learn** the basics of electrical power systems, various electrical terms related with power system and understand various types of tariffs.
2. To **get** knowledge of mechanical and electrical design of overhead and underground transmission systems.
3. To **learn** representation of transmission lines for performance evaluation.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

CO1. Understand the electrical terminology related to power plant & tariffs used in India.

CO2. Design electrical & mechanical aspects of a given underground cable & overhead transmission line.

CO3. Compute the inductance of a given 3-phase overhead transmission line with symmetrical & unsymmetrical conductor Spacing.

CO4. Evaluate the capacitance of a given 3-phase overhead transmission line with and without considering the earth surface effect.

CO5. Compute the voltage regulation and transmission efficiency of short & medium overhead transmission line using ABCD parameters with T and π model.

Course Contents

Unit No: I	**Basics of Power Systems and its tariff**	**06 Hours**

A) Basics of power systems: Structure of electrical power system, Different factors associated with generating stations such as Connected load, Maximum demand, Demand factor, Average load, Load factor, Diversity factor, Plant capacity factor, Reserve capacity, Plant use factor, Load curve, Load duration curve, Concept of base load and peak load stations, Advantages of interconnected grid system.

B) Tariff: Introduction to Tariff, Tariff setting principles, desirable characteristics 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 for H.T and L.T industrial and commercial consumers, Introduction to Availability based tariff (ABT), kVAh tariff (Descriptive treatment only).

Reference Books	**A) T1, T4, T5, R1, R4** **B) T1, T3, R2**

Unit No: II	**Underground Cables, Mechanical Design of Overhead line and its Insulators**	**06 Hours**

A) Underground Cables: Overview on Construction and Classification of Cables, Dielectric stresses in single core cable, Importance of grading of cables.

B) 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).

C) 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).	
Reference Books	**A) T2, T6** **B) T2, T5, R1** **C) T2, T5**

Unit No: III	**Resistance and Inductance of Transmission Line**	**06 Hours**
Resistance of transmission line, Skin and proximity effect, Factors responsible for production of Skin and proximity effects, Internal and external flux linkages of single conductor, Inductance of single phase two wire line, Concept of G.M.R and G.M.D, Necessity of transposition, Inductance of three phase line with symmetrical and unsymmetrical spacing with transposition, Inductance of bundled conductors.		
Reference Books	**T2, R1**	

Unit No: IV	**Capacitance of Transmission Line**	**06 Hours**
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), Concept of G.M.R and G.M.D for capacitance calculations, need of transposition for capacitance calculations, Capacitance of three phase line with symmetrical and unsymmetrical spacing with transposition. Capacitance of three phase line with symmetrical and unsymmetrical spacing with transposition. Concept of double circuit three phase line.		
Reference Books	**T2, T5, R1**	

Unit No: V	**Performance of Transmission Line**	**06 Hours**
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 Π' and 'Nominal T' circuits using R,L and C parameters, Ferranti effect, Representation of 'T' and 'Π' models of lines as two port networks, Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of efficiency and regulation of short and medium lines.		
Reference Books	**T2, T6, R1, R4, R5**	

Tutorials/ Activities

(Minimum 08 Tutorials should be conducted) (Maintain record in file or separate notebook)

1. Numerical based on load-curve and calculation of different terminologies like Demand factor, Average load, Load factor, Diversity factor, Plant capacity factor, Reserve capacity, Plant use factor (5 Numerical)
2. Numerical on Tariff (3 Numerical)
3. Numerical on Dielectric stress on single core cable (2 Numerical)
4. Calculation of sag for Equal and Unequal support from ground (3 Numerical)
5. Numerical on string efficiency (3 Numerical)
6. Calculation of Inductance of Single-Phase and Three-Phase transmission line (With symmetrical and Unsymmetrical spacing with Transposition) (5 Numerical)
7. Calculation of Inductance of Bundled Conductor (Along with calculation of G.M.D. and G.M.R.) (3 Numerical)
8. Calculation of Capacitance of Single-Phase and Three-Phase transmission line (With symmetrical and Unsymmetrical spacing with Transposition) (5 Numerical)
9. Estimation of Efficiency, Regulation of Short and Medium transmission line ('Nominal Π' and 'Nominal T' model) (3 Numerical)
10. Evaluation of ABCD Parameters of Short and Medium ('Nominal Π' and 'Nominal T' model) transmission line (3 Numerical)

Learning Resources

1. Text Books

[T1]. V. K. Mehta, Rohit Mehta, "Principles of Power System", S. Chand Publication.

[T2]. J. B. Gupta, "Transmission and Distribution", S. K. Kataria and Sons, New Delhi.

[T3]. J. B. Gupta, "Generation and Economic Considerations. K. Kataria & Sons, New Delhi.

[T4]. Dr. B. R. Gupta, "Generation of Electrical Energy", S. Chand Publication.

[T5]. A Chakraborty, M. L. Soni, P.V. Gupta, U. S. Bhatnagar, "A textbook on Power System Engineering", Dhanpat rai & Co, Delhi.

[T6]. S. N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India.

2. Reference Books

[R1]. Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications

[R2]. D. Das, "Electrical Power System", New Age Publication

[R3]. W. D. Stevenson, "Power System Analysis", Tata McGraw Hill Publications.

[R4]. M. V. Deshpande, "Elements of Power Station Design", Wheeler Publishing.

[R5]. I.J. Nagrath and D. P. Kothari, "Modern Power System Analysis", Tata McGraw Hill

3. Links to online SWAYAM/NPTEL Courses

[M1]. NPTEL course on Power System Engineering, IIT Kharagpur
https://nptel.ac.in/courses/108/105/108105104/

[M2]. NPTEL course on Power System Analysis, IIT Kharagpur
https://nptel.ac.in/courses/108/105/108105067/

[M3]. NPTEL Power System Analysis, IIT Kharagpur
https://www.youtube.com/playlist?list=PLRWKj4sFG7-6gWwDMLI0Wy5DDRqyKP1uQ

[M4]. MAHADISCOM Website for tariff: https://wss.mahadiscom.in/wss/wss?uiActionName=getEnergyBillCalculator

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	2	-	1	-	-	-	2	1
CO2	3	2	2	2	-	2	-	-	-	-	1
CO3	3	3	2	2	-	-	-	-	-	-	1
CO4	3	3	2	2	-	-	-	-	-	-	1

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-204-ELE	**Course Name: Electrical Measurements & Instrumentation Lab**	
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hrs	**01**	**TW : 25 Marks**
		PR : 25 Marks

Prerequisite: Fundamentals of Electrical and Electronics Engineering

Course Objectives:

1. To learn the extension range of ammeter, voltmeter and wattmeter using CT & PT.
2. To calculate the low resistance (R) and low inductance (L)
3. To measure/ determine the active/reactive power in 3-phase circuit using one wattmeter/ two wattmeter method.
4. To calibrate 1-phase static energy meter.
5. To understand the applications of DSO

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1:** Determine and extend the range of ammeters, voltmeters, and wattmeters in electrical circuits using Current Transformers (CTs) and Potential Transformers (PTs).
2. **CO2:** Measure the low value of resistance & inductance of a given electrical circuit using Kelvin's double bridge and Maxwell's bridge respectively.
3. **CO3:** Calculate active and reactive power in three-phase balanced and unbalanced loads using one-wattmeter and two-wattmeter methods.
4. **CO4:** Calibrate a single-phase static energy meter under different power factor conditions-lagging, leading, and unity.
5. **CO5:** Measure voltage, current, power, frequency, and analyze transient response and frequency spectrum (FFT) of electrical signals using a Digital Storage Oscilloscope (DSO).

List of Experiments

Perform any eight experiments from the following list:

1. Extension of ammeter range using CT, voltmeter range using PT and watt meter range using CT / PT.
2. Measurement of low resistance using Kelvin's Double Bridge.
3. Measurement of inductance using Maxwell's bridge.
4. Study of programmable LCR meter; Measure L, C, R, Q Factor, dissipation factor, and power factor of the given component.
5. Measurement of active & reactive power in three phase balanced circuit using one wattmeter method with two-way switch.
6. Measurement of three phase active & reactive power by two wattmeter method.
7. Calibration of single-phase static energy meter at different power factors.
8. To study and plot the characteristics of LVDT.
9. Measurement of voltage, current, time period, frequency & phase angle using DSO.
10. Study of Digital Storage Oscilloscope:
    a. Different modes in DSO such as Roll, Average, Peak detection.
    b. Capture transients
    c. FFT analysis

d. Various MATH operations

11. 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)

Guidelines for Instructor's Manual

The Instructor's Manual should contain the following related to every experiment:

- Brief theory related to the experiment
- Connection diagram /circuit diagram
- Observation table
- Sample calculations for one reading
- Result table
- Graph and Conclusions

Guidelines for Students Lab Manual

The student's Lab Journal should contain the following related to every experiment:

- Theory related to the experiment,
- Connection diagram /circuit diagram,
- Observation table,
- Sample calculations for one reading,
- Result table
- Graph and Conclusions

Guidelines for Lab assessment

There should be continuous assessment.

- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do connections on breadboard and get the results.
- Timely submission of journal.

Guidelines for Lab conduction

- The first half hour should be utilized for explaining the circuit diagram and theory related to the experiment.
- Next one hour for connection and conduction of the experiment
- Remaining half hour for continuous assessment and timely checking of the experiment (This time slot can be adjusted as per convenience)

Learning Resources

1. Text Books

[T1]. A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai & Co.

[T2]. J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", S. K. Kataria & Sons

2. Reference Books

[R1]. E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.

[R2]. Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers.

[R3]. Fundamentals of Electrical Measurements by C.T. Baldwin , Publisher- George G.Harrap & Co Ltd

[R4]. Problems In Electrical Engineering by Smith S, parker, Asia Publications

[R5]. Instrumentation: Devices and Systems by C. Rangan, G Sarma, V.S.V. Mani, McGraw Hill Education

3. Links to online SWAYAM/NPTEL Courses

[M1]. https://archive.nptel.ac.in/courses/108/105/108105153

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	3	–	–	1	–	1	2
CO2	3	3	2	2	2	–	–	1	–	–	2
CO3	3	3	3	2	2	–	1	1	1	–	2
CO4	2	2	2	3	3	–	–	–	–	–	3
CO5	1	2	1	2	2	3	2	3	–	2	3

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-205-ELE	**Course Name: Analog and Digital Electronics Lab**	
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hrs	**01**	**TW : 25 Marks**
		PR : 25 Marks

Prerequisite: Basic Electronics Engineering, Numbering system, Logic Gates and flip flops, Diodes.

Course Objectives:

1. To familiarise students with analog and digital circuits, different ICs
2. To study Operational Amplifier for various applications
3. To design regulated power supply

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1**: Design logical, sequential and combinational digital circuits.
2. **CO2:** Design and demonstrate various types of counters and Registers using Flip-flops.
3. **CO3**: Demonstrate and Analyze Operational Amplifier circuits and their applications
4. **CO4**: Understand different analog circuits e.g. filters, IC555, voltage regulators and uncontrolled rectifiers

List of Experiments

Perform any eight (three experiments should be on bread board/trainer kit) experiment from following list:

1. Design of logical circuit for display of decimal number on seven segment display. (Hardware)
2. Deign 3:8 decoder for binary to octal decoding. **(Hardware)**
3. Design three-bit full adder using any open-source software. **(Software)**
4. Design a digital clock or stopwatch using decade counter. (IC74192) **(Hardware)**
5. Find phase angle difference between same frequency signal using ZCD and AND gate. **(Hardware)**
6. Design of comparator and Schmitt trigger. **(Hardware)**
7. Study of Instrumentation amplifier using three Op-amp, CMRR measurement **(Hardware)**
8. Design sine, and triangular wave generator. **(Hardware)**
9. Design first order high pass and low pass filter using OPAMP in any open-source software. (For this provide one statement to each of four students to perform with desired cut-off frequency. Each group will demonstrate their result and prepare documentation) **(Software)**
10. Design of monostable muti-vibrator using IC555 and digital circuit to count number of pulses**. (Hardware)**
11. Design astable multivibrator using IC-555. **(Hardware)**
12. Design of regulated power supply **(Hardware)**
13. Design of single-phase bridge rectifier with output voltage and specified ripple. (this practical should be designed by each student, perform in simulation and demonstrate with hardware in laboratory with design documents) **(Software and Hardware)**

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The Instructor's Manual should contain the following related to every experiment:

- Brief theory related to the experiment
- Connection diagram /circuit diagram
- Observation table
- Sample calculations for one reading
- Result table
- Graph and Conclusions

- Data sheets of the ICs used
- Few questions related to the experiment (10 marks)
- List of components required with their specifications.

Guidelines for Students Lab Manual

The student's Lab Journal should contain the following related to every experiment:

- Theory related to the experiment,
- Connection diagram /circuit diagram,
- Observation table,
- Sample calculations for one reading,
- Result table
- Graph and Conclusions,
- Data sheets of the ICs used,
- List of components required with their specifications,

Guidelines for Lab assessment

There should be continuous assessment.

- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do connections on bread board and get the results.
- Timely submission of journal.

Guidelines for Lab conduction

- The first half hour should be utilized for explaining the circuit diagram and theory related to the experiment.
- Next one hour for connection and conduction of the experiment
- Remaining half hour for continuous assessment and timely checking of the experiment (This time slot can be adjusted as per convenience)

A separate breadboard should be provided for every student for those experiments which are compulsory to be performed on breadboard or trainer kit **(ready-made set up is not allowed)**

Learning Resources

1. Text Books

[T1]. Floyd and Jain, “Digital Fundamentals”, Pearson Education.
[T2]. R. P. Jain, “Digital Electronics”, Tata McGraw Hill, New Delhi.
[T3]. Malvino, “Digital Computer Electronics- An Introduction to Microcomputers,” Tata McGraw Hill.
[T4]. Gaikwad R., “Operational Amplifier”, PHI New Delhi.
[T5]. Floyd, “Electronics Devices”, Pearson Education.
[T6]. Mottershed, “Electronics Devices & Circuits”, PHI New Delhi
[T7]. Muhammad H. Rashid, “Power Electronics: Circuits, Devices and Applications”, 3rd edition, Pearsons
[T8]. Fundamental of digital circuits, 4th Edition, by A Anand Kumar, PHI learning private limited publication.

2. Reference Books

[R1]. Tokheim, “Digital Electronics-Principles and Application”, 6th edition, Tata McGraw Hill, New Delhi.
[R2]. A Jaico and Charles H. Roth, “Fundamentals of Logic Design” Jr. Fourth Edition.
[R3]. K. R. Botkar, “Integrated Circuits”, Khanna Publication, New Delhi.
[R4]. James, “Operational Amplifier and Linear Integrated Circuits Theory and Application.”
[R5]. P John Paul, “Electronics Devices and circuits”, New Age International Publications.

[R6]. P. S. Bimbhra, "Power Electronics", Khanna Publications.

[R7]. Digital Principles and Application by Leach & Malvino, McGraw Hill Education

[R8]. Foundations of Analog and Digital Electronic Circuits by Agarwal, Publisher

3. Links to online SWAYAM/NPTEL Courses

[M1]. NPTEL course on Digital Electronics Circuit, IIT, Kharagpur. https://nptel.ac.in/courses/108105132/

[M2]. NPTEL course on Integrated circuit, MOSFET, OPAMP and their applications IISC Banglore, https://nptel.ac.in/courses/108/108/108108111/

[M3]. NPTEL course on power electronics by IIT Kharagpur. https://nptel.ac.in/courses/108/105/108105066/

CO PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	-	1	-	-	-	1	-	2
CO2	2	2	2	-	1	-	-	-	1	-	2
CO3	2	2	2	-	1	-	-	-	1	-	2
CO4	2	2	2	-	1	-	-	-	1	-	2

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: MDM-222-ELE	**Course Name: Engineering Mathematics-III**	
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hrs	**03**	**CCE : 40 Marks**
		ESE : 60 Marks

Prerequisite:

Differential and Integral calculus, Taylor series, Differential equations of first order and first degree, Fourier series, Vector algebra and Algebra of complex numbers.

Course Objectives:

To familiarize the students with concepts and techniques in Ordinary differential equations, Laplace transform, Fourier transform, Z-transform, Statistics & Probability and Vector calculus. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1**: **Solve** higher order linear differential equation using appropriate techniques for modelling, analyzing of electrical circuits and control systems.
2. **CO2: Apply** Integral transforms such as Laplace transform, Fourier transform and Z-Transform to solve problems related to signal processing and control systems.
3. **CO3**: **Apply** Statistical methods like Correlation, Regression and Probability theory as applicable to analyze and interpret experimental data related to energy management, power systems, testing and quality control.
4. **CO4**: **Perform** Vector differentiation & integration, analyze the vector fields and apply to electro-magnetic fields & wave theory.

Course Contents

Unit No: I	**Linear Differential Equations (LDE) and Applications**	**08 Hours**
LDE of nth order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous DE. Modeling of Electrical circuits.		
Exemplars/Case Studies	RLC Circuits, DC Motor Dynamics, Transient and Steady-State Analysis of Circuits, Simulation software, filter circuit design	
Reference Books	**T1, T2, R1-R4**	

Unit No: II	**Laplace transforms**	**08 Hours**
Laplace Transform (LT): Definition of LT, Inverse LT, Properties & theorems, LT of some special functions viz. Periodic, Unit Step, Unit Impulse. Applications of LT for solving LDE.		
Exemplars/Case Studies	RLC circuits analysis, PID Controllers, signal filters design, machine protection systems, inverter control, smartphone audio signal processing	
Reference Books	**T1, T2, R1-R3**	

Unit No: III	**Fourier and Z - transforms**	**08 Hours**
Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integral representation, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine & Cosine transforms, Fourier Sine & Cosine inverse transforms and applications. **Z - Transform (ZT):** Introduction, Definition, Standard properties, ZT of standard sequences and their inverses.		

Applications of Z – transform to solve difference equations.		
Exemplars/Case Studies	Noise filtering, frequency Division Multiplexing, harmonics analysis, control of robotic arms, drones, renewable energy inverters	
Reference Books	**T1, T2, R1-R3**	
Unit No: IV	**Statistics and Probability**	**08 Hours**
Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Reliability of Regression estimates. Probability, Probability density function, Probability distributions: Binomial, Poisson, Normal, Test of hypothesis: Chi-square test.		
Exemplars/Case Studies	Power Consumption Analysis, Predictive Maintenance, Renewable Energy Forecasting, Electrical Load Forecasting, Power System Reliability	
Reference Books	**T1, T2, R1-R3, R6**	
Unit No: V	**Vector Calculus**	**08 Hours**
Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal and Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem. Applications to problems in Electro-magnetic fields.		
Exemplars/Case Studies	Electromagnetic Field Analysis, Wireless power transfer, magnetic shielding, high-voltage insulation, dielectric breakdown analysis	
Reference Books	**T1, T2, R1-R5**	

Guidelines for Tutorial:

Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.

Learning Resources

1. Text Books

[T1]. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
[T2]. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

2. Reference Books

[R1]. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
[R2]. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
[R3]. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
[R4]. Differential Equations, 3e by S. L. Ross (Wiley India).
[R5]. Numerical Methods for Engineers,7e by S. C. Chapra and R. P. Canale (McGraw-Hill Education)
[R6]. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M.Ross (Elsevier Academic Press).

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	--	--	--	--	--	--	--	--	--
CO2	3	2	--	--	--	--	--	--	--	--	--
CO3	3	2	--	--	--	--	--	--	--	--	--
CO4	3	2	--	--	--	--	--	--	--	--	--

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: EEM-231-ELE		**Course Name: Engineering Economics**
Teaching Scheme	**Credits**	**Examination Scheme**
Tutorial :02 Hrs	**02**	**TW: 25 Marks**

Prerequisite Courses, if any: Basic Mathematics, Basic Economics, General Engineering Knowledge

Course Objectives:

1. To provide students with a comprehensive understanding of engineering economics principles.
2. To equip students with knowledge and analytical skills to evaluate engineering projects.
3. To develop a foundational understanding of accounting principles, financial analysis, and funding strategies.
4. To provide students with an understanding of market structures, pricing strategies, and the influence of government policies and economic factors.
5. To explore the role of engineers in economic development and industrialization.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1**: Apply engineering economic principles to perform cost analysis, time value of money calculations, break-even analysis, and investment evaluation.
2. **CO2**: Apply cost estimation techniques, evaluate depreciation methods, perform capital budgeting, and conduct replacement analysis.
3. **CO3:** Analyze financial statements, evaluate financial ratios, assess sources of finance, manage working capital, and perform project appraisal.
4. **CO4:** A**nalyze** different market structures, pricing strategies, assess the impact of government policies and taxation on engineering projects, and evaluate how inflation affects project costs.
5. **CO5:** E**valuate** the economic impact of engineering on industrial growth.
6. **CO6**: Analyze emerging trends such as Green Economics, Circular Economy, and Industry 4.0 from an economic perspective.

Course Contents

Unit No: I	Introduction to Engineering Economics	03 Hours

Basic Concepts: 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. Conventional Economics, Principles of Engineering Economics, Applications of Engineering Economics in Various Fields, Microeconomics vs. Macroeconomics.

Cost Concepts: Fixed, Variable, Marginal, Sunk, and Opportunity Costs

Time Value of Money: Present Worth, Future Worth, Annuities, and Compounding Techniques

Break-even Analysis: Cost Volume -Profit Analysis, Contribution Margin.

Unit No: II	Cost Estimation and Capital Budgeting	03 Hours

Cost Estimation Techniques: Direct and Indirect Costs, Overheads

Depreciation Methods: Straight Line, Declining Balance, and Sum of Years' Digits

Capital Budgeting: Payback Period, Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index

Replacement Analysis: Economic Life and Useful Life of Equipment

Profitability Index (PI) calculation and comparison of investment alternatives.

Unit No: III	Financial Management and Accounting	03 Hours

Basic Accounting Principles: Balance Sheet, Profit and Loss Statement, Cash Flow

Financial Ratios: Liquidity, Profitability, and Solvency Ratios

Sources of Finance: Equity, Debt, Venture Capital, Working Capital Management

Project Appraisal: Feasibility Studies, Risk Analysis in Investment Decisions

Unit No: IV	Market Structures and Economic Decision Making	03 Hours

Types of Market Structures: Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition
Pricing Strategies: Cost-Based Pricing, Market-Based Pricing, Penetration Pricing, Skimming Pricing
Government Policies and Taxation: GST, Income Tax, Corporate Tax, Incentives for Industries
Inflation and Its Impact on Engineering Projects

Unit No: V	Industrial Economics, Sustainability and Engineering Ethics	03 Hours

Industrialization and Economic Development: Role of Engineers in Economic Growth
Public Sector vs. Private Sector Enterprises
Engineering Ethics and Professionalism: Corporate Social Responsibility (CSR), Sustainable Development
Emerging Trends: Green Economics, Circular Economy, Industry 4.0 and Economic Impacts

Tutorial Activities (Any Seven tutorials from 1 to 11, Tutorial 12 is compulsory)

Tutorial 1: Time Value of Money
Objective: Understand the concept of money value over time.
Activity: Calculate Present Worth (PW) and Future Worth (FW) of given cash flows. Solve numerical problems involving simple and compound interest.
Deliverable: Submission of calculations and interpretation of results

Tutorial 2: Break-Even Analysis
Objective: Determine the break-even point of a manufacturing system.
Activity: Calculate Break-Even Quantity and Break-Even Sales Value. Plot Cost–Volume–Profit (CVP) graph.
Deliverable: Graphical representation and calculations.

Tutorial 3: Opportunity Cost and Economic Decision Making
Objective: Understand economic decision-making in engineering applications.
Activity: Analyze alternative engineering options and identify opportunity costs. Select the most economical alternative based on given data.
Deliverable: Short report with justification.

Tutorial 4: Cost Estimation of an Engineering Project
Objective: Estimate project cost using cost classification.
Activity: Identify direct costs, indirect costs, fixed costs, variable costs, and overheads for a small engineering project.
Deliverable: Cost estimation sheet.

Tutorial 5: Depreciation Analysis
Objective: Evaluate depreciation of engineering assets.
Activity: Calculate depreciation using Straight Line Method, Declining Balance Method, Sum-of-Years-Digits Method
Deliverable: Comparative depreciation table

Tutorial 6: Capital Budgeting Techniques
Objective: Assess investment proposals.
Activity: Evaluate projects using Payback Period, Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI)
Deliverable: Recommendation report based on calculations.

Tutorial 7: Replacement Analysis of Equipment
Objective: Decide replacement of existing equipment.
Activity: Compare operating and maintenance costs of old and new equipment. Determine economic replacement decision.
Deliverable: Technical-economic analysis report.

Tutorial 8: Preparation of Financial Statements
Objective: Understand basic accounting statements.
Activity: Prepare Balance Sheet, Profit and Loss Account, Cash Flow Statement from given financial data.
Deliverable: Completed financial statements.

Tutorial 9: Financial Ratio and Working Capital Analysis
Objective: Analyze financial performance of a company.
Activity: Calculate Liquidity Ratios, Profitability Ratios, Solvency Ratios, Estimate working capital requirement.
Deliverable: Ratio analysis report.

Tutorial 10: Market Structure and Pricing Strategy Study
Objective: Understand market behavior and pricing decisions.
Activity: Study real-world examples of Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition, identify pricing strategies adopted by electrical industries.
Deliverable: Comparative analysis report.

Tutorial 11: Impact of Inflation and Taxation on Engineering Projects
Objective: Analyze economic factors affecting projects.
Activity: Study impact of inflation and GST on project cost. Compare project costs before and after inflation/tax considerations.
Deliverable: Case study report.

Tutorial 12: Case Study on Industrial Economics, Sustainability and Engineering Ethics
Objective: Understand the broader economic and social role of engineers.
Activity (Any One):
Economic impact of renewable energy projects.
Public Sector vs Private Sector enterprise comparison.
Corporate Social Responsibility (CSR) practices.
Circular Economy and Green Economics.
Industry 4.0 applications in manufacturing.
Engineering ethics case study.
Deliverable: Presentation and report

Learning Resources

1. Text Books

[T1]. Engineering Economics by R. Panneerselvam Publisher- PHI learning private limited
[T2]. "Engineering Economy (16th Edition)" by William G. Sullivan & Elin M. Wicks
[T3]. "Fundamentals of Engineering Economics (2nd Edition)" by Chan S. Park
[T4]. "Principles of Engineering Economic Analysis" by John A. White, Kenneth E. Case, and David B. Pratt

2. Reference Books

[R1]. "Principles of Engineering Economy", (8th Edition) by Eugene L. Grant, W.G. Ireson and Richard Leavenworth.
[R2]. "Engineering Economy: Analysis of Capital Expenditures" by Gerald W. Smith
[R3]. "Applied Economic Analysis for Technologists, Engineers, and Managers" by Michael S. Bowman
[R4]. "Engineering Economics for Capital Investment Analysis" by Tung Au and Thomas P. Au
[R5]. "Schaum's Outline of Engineering Economics" by Jose A. Sepulveda and William E. Souder

3. e-Books

[E1]. "Engineering Economics – Open Textbook" by Schmid & Vanderby
[E2]. Engineering Economy (7th Edition) by William G. Sullivan, Elin M. Wicks and C. Patrick Koelling.
[E3]. "Engineering Economic Analysis (11th Edition)" by Donald G. Newnan et al.
[E4]. "Fundamentals of Engineering Economics (4th Edition)" by Chan S. Park
[E5]. 'Engineering Economics" by Ricardo Rodriguez

4. YouTube/Video Links

https://www.youtube.com/watch?v=9aX-4xp3oq8&utm
https://www.youtube.com/playlist?list=PLJoALJA_KMOCRRx-0Di7hTJj2vI2XnYNT&utm

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: VEC-232-ELE	**Course Name: Universal Human Values and Professional Ethics**	
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hrs	**02**	**CCE : 20 Marks**
		ESE : 30 Marks

Prerequisite: Student Induction Program (SIP)

Course Objectives:

1. To help the students develop a holistic, humane world-vision, and appreciate the essential complementarity between values and skills to ensure mutual happiness and prosperity
2. To elaborate on 'Self-exploration' as the process for Value Education
3. To facilitate the understanding of harmony at various levels starting from self and going towards family and society.
4. To elaborate on the salient aspects of harmony in nature and the entire existence
5. To explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.
6. To provide the vision for a holistic way of living and facilitate transition from chaotic life to an orderly life.

Course Outcomes:

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

1. **CO1: Recognize** 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: Explore** the human being as the coexistence of self and body to see their real needs/basic aspirations clearly.
3. **CO3: Explain** the relationship between oneself and the other self as the essential part of relationship and harmony in the family.
4. **CO4: Interpret** the interconnectedness, harmony and mutual fulfilment inherent in nature and the entire existence.
5. **CO5: Draw** ethical conclusions in the light of Right understanding facilitating the development of holistic technologies production systems and management models.

Course Contents

Unit No: I	Introduction to Value Education	07 Hours

a) Understanding Value Education
b) Self-exploration as the Process for Value Education
c) Continuous Happiness and Prosperity - the Basic Human Aspirations and their Fulfilment
d) Right Understanding, Relationship and Physical Facility
e) Happiness and Prosperity - Current Scenario
f) Method to Fulfil the Basic Human Aspirations

Unit No: II	Harmony in the Human Being	07 Hours

a) Understanding Human being as the Co-existence of the Self and the Body
b) Distinguishing between the Needs of the Self and the Body
c) The Body as an Instrument of the Self, Understanding Harmony in the Self
d) Harmony of the Self with the Body
e) Program to Ensure self-regulation and Health

Unit No: III	Harmony in the Family and Society	08 Hours

a) Harmony in the Family - the Basic Unit of Human Interaction "Trust' - the Foundational Value in Relationship, 'Respect' - as the Right Evaluation

b) Values in Human-to-Human Relationship
c) Understanding Harmony in Society
d) Vision for the Universal Human Order

Unit No: IV	Harmony in the Nature (Existence)	08 Hours

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

Learning Resources

1. Text Books

[T1]. 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-

[T2]. 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

2. Reference Books

[R1]. 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.

[R2]. A. Nagaraj, 1999, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak

[R3]. B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.

[R4]. A. N. Tripathy, 2003, Human Values, New Age International Publishers

[R5]. E. G. Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University

[R6]. B. L. Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

[R7]. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.

[R8]. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

3. Links to online SWAYAM/NPTEL Courses

[M1]. 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

[M2]. Swayam Course on "Understanding Human Being Nature and Existence Comprehensively" by Dr. Kumar Sambhav, Director, UP Institute of Design (UPID), Noida.
Understanding Human Being Nature and Existence Comprehensively - Course

4. E-Resources, YouTube/Video Links

[E1]. https://fdp-si.aicte-india.org/download.php#1/

[E2]. http://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/

[E3]. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

CO PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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
CO5	2	2	2	-	1	3	3	3	3	3	3

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: CEP-241-ELE	**Course Name: Energy Literacy & Electrical safety education**	
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hrs	**02**	**TW : 50 Marks**

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

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:

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

1. **CO1:** Improve access to essential services or technologies tailored to local needs
2. **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
5. **CO5:** Apply theoretical knowledge to real-world problems
6. **CO6:** Understand the diverse perspectives and challenges faced by local populations

General Instructions & Guidelines:

1. **Identify and Understand Community Needs**
   - **Conduct Needs Assessment:** Collaborate with local communities, municipalities, or non-profit organizations to identify their electrical-related needs. For example, these might include access to electricity, renewable energy projects, electrical infrastructure improvements, or electrical safety education.
   - **Understand the Local Context**: Consider the specific challenges, resources, and cultural context of the community. The solutions should be tailored to local needs, infrastructure, and economic realities.
2. **Safety and Ethics**
   - **Prioritize Safety:** Ensure that safety protocols are followed rigorously. Electrical work, especially in community settings, must comply with local and international safety standards.
   - **Ethical Responsibility:** Maintain a high ethical standard in all engagements. Avoid exploitation, ensure that the community's voice is heard, and strive for transparency in all activities. Be mindful of the sustainability and impact of the proposed solutions.
3. **Collaboration with Stakeholders**
   - **Engage Local Experts and Stakeholders**: Work with local engineers, electricians, or community leaders who understand the environment and challenges of the area. Their input can help identify practical, culturally appropriate solutions.
   - **Involve Community Members:** Empower the community by including them in the decision-making process. This builds trust and ensures that the solutions are embraced and maintained after the project is completed.
4. **Promote Sustainable and Scalable Solutions**
   - **Energy Efficiency:** Focus on energy-efficient electrical systems that minimize long-term operational costs for

the community. This can include low-energy lighting, solar power, or smart grid technologies.

- Renewable Energy Projects: Consider renewable energy solutions (solar, wind, etc.) that can provide sustainable electricity to underserved or off-grid communities.
- **Scalability:** The solution should be scalable, meaning it can grow or evolve over time to meet future needs. This is especially important in communities where infrastructure is limited or constantly changing.

5. **Educational and Training Opportunities**
   - **Hands-on Learning:** Offer hands-on fieldwork opportunities for students to learn by directly engaging with the community. This can include installing solar panels, repairing electrical infrastructure, or designing energy-efficient systems.
   - **Workshops and Training:** Conduct workshops or training sessions for community members to educate them about electrical safety, energy conservation, and the use of new technology. This can empower the community and ensure the long-term success of your project.
   - **Skill Transfer:** If possible, train local electricians or technicians to maintain and repair the systems put in place. This can improve local employment and enhance the sustainability of electrical infrastructure.
6. **Social Responsibility**
   - **Promote Social Equity:** Address electrical disparities focusing on providing equitable access to electricity and technology for all members of the community, regardless of socioeconomic status.
   - **Inclusion**: Ensure that your fieldwork activities are inclusive and cater to all sections of society with the aim of improving the quality of life for everyone.

Suggested Community Problems:

1. **Electrical Safety and Awareness Campaign**

   Conduct workshops or campaigns to raise awareness about electrical safety in low-income or rural communities. To educate the community on the dangers of poor electrical installations, safety measures, prevention of electric shocks and remedies and simple electrical troubleshooting.
2. **Energy-Efficient Home Upgrades**

   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.
3. **Electrical Infrastructure Assessment and Upgrades**

   Conduct a survey of the electrical infrastructure in a community (e.g., wiring, circuit breakers, transformers) and propose and implement upgrades
4. **Community Energy Audits**

   Perform energy audits for homes or small businesses in the community and provide recommendations for improving energy efficiency.
5. **Awareness about renewable energy's**

   To raise awareness about renewable energy's cost-saving potential for businesses and household while promoting sustainability.
6. **Power Theft Awareness Campaign and Educational Workshops**

   Conduct an educational campaign to raise awareness about power theft, its social and economic impacts, and ways to prevent it. This could include hosting workshops, distributing flyers, and providing information on how consumers can report suspected theft.
7. **Repair and Refurbish Used Electronics**

Organize a workshop to repair and refurbish used electronics and small appliances.

8. **Understand Electricity bills**

   Residential and commercial tariff

9. **Repair of household electrical appliances**

   Visit to electrical repair shop and understand basic repairing and maintenance procedure

ASSIGNMENTS:

1. Write a report on workshops or campaigns to raise awareness about electrical safety in low-income or rural communities.
2. Write a detailed report on home upgradation which helps their electrical systems to be more energy-efficient
3. Write a report on survey of the electrical infrastructure in a community (e.g., wiring, circuit breakers, transformers) and propose and implement upgrades
4. 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.
5. Presentation on awareness of renewable energy.
6. Write report on the Conduction of an educational campaign to raise awareness about power theft.
7. Write a report on workshop conducted (Workshop activities: repair and refurbish used electronics and small appliances.
8. Write a report on guest lecture delivered by an Energy Auditor.
9. Write a report on calculation of own house electricity bill.
10. Write a report on the visit to an electrical appliances repair shop.

IMPLEMENTATION:

1. A group of 5 to 6 students or a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay/college premises.
2. Each group is allotted to a faculty member of the department as a mentor.
3. An activity book must be maintained by each of the students to record the activities undertaken/involved and will be countersigned by the concerned mentor/Head of department (HOD).
4. Report shall be submitted by each student/group of students.
5. An internal evaluation shall also be conducted by a committee constituted by HOD. An evaluation be done based on the active participation of the student and marks could be awarded by the mentor/HOD.
6. Every student must **submit at least seven assignments** from the above list.

PROPOSAL SUBMISSION:

CEP Group should Submit a two-page project proposal, preferably prior to the term commencement outlining the following: -

- Title of the project
- Aim, Objective and expected outcome
- Plan of execution (timeline and activities).
- Place of the CEP and involvement of any local authority, NGP
- Required resources (if any).
- Get approval from the designated faculty mentor.

Learning Resources

1. Text Books

[T1]. "Electrical Safety", D.R. Nagpal, Standard Publishers Distributors, ISBN: 9788180141058

[T2]. "Electrical Safety, Fire Safety Engineering and Safety Management", Prof. Sunil S. Rao, R.K. Jain and Prof. H.L. Saluja, ISBN: 978-81-7409-306-6

[T3]. Electric Energy, An Introduction, Mohamed A. El-Sharkawi, CRC Press, ISBN 9781466503038

2. Reference Books

[R1]. "Electrical Safety: A guide to causes and prevention of hazards" J. M. Adams, The Institute of Engineering & technology, ISBN: 978-0-85296-806-2

[R2]. Electrical Safety Handbook, Dennis K. Neitzel, Mary Capelli-Schellpfeffer, Al Winfield, ISBN: 9781260134858

3. Links to online SWAYAM/NPTEL Courses

1. https://onlinecourses.swayam2.ac.in/aic22_ge31/preview
2. https://onlinecourses.swayam2.ac.in/nou25_ec07/preview
3. https://onlinecourses.swayam2.ac.in/nou20_cs08/preview
4. https://onlinecourses.nptel.ac.in/noc20_mg43/preview

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	2	2		2	2	2	-	2	-	2
CO2	2	2	-	2	-	2	2	2	2	-	2
CO3	2	2	-	2	-	3	-	2	-	-	2
CO4	2	-	2	2	-	2	2	2	2	-	2
CO5	3	3	2	2	2	2	2	-	-	-	2
CO6	2	2	-	2	-	2	2	2	2	2	2

Savitribai Phule Pune University, Pune

Maharashtra, India

National Education Policy (NEP) Compliant Curriculum

SEMESTER-IV

Second Year Engineering (2024 Pattern)-Revised

Electrical Engineering

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-251-ELE		**Course Name: Electrical Machines-I**
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hrs	**03**	**CCE : 40 Marks**
		ESE : 60 Marks

Prerequisite: Introduction of Electrical Machines, Magnetic circuit, mutual induced EMF, dynamically induced EMF, Direction of magnetic field in current carrying conductor, Flemings LHR & RHR, Electromechanical energy conversion

Course Objectives:

1. To **understand** energy conversion process.
2. To **understand** selection of machines for specific applications.
3. To **test & analyze** the performance of machines.
4. To **understand** the construction, principle of operation of transformers, DC Machine & Induction Machine

Course Outcomes:

Upon successful completion of this course, the students will be able to:

CO1. Compute the voltage regulation and efficiency of a given 1-phase transformer at a specified power factor & load

CO2. Understand the standard connections and parallel operation of 1-phase and 3-phase transformers.

CO3. Calculate the efficiency of a given DC motor

CO4. Compute the losses and efficiency of a given three phase Induction motor

CO5. Evaluate the equivalent circuit parameters by conducting no load and blocked rotor test & performance parameters by drawing circle diagram for a given 3-Phase Induction motor

Course Contents

Unit No: I	Single Phase Transformer (Part-A)	08 Hours

Single phase Transformer: Concept of 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. side of the transformer. Phasor diagrams for no-load and on-load conditions. Efficiency and condition for maximum efficiency. Concept of all day efficiency. Auto transformers and their applications.

Reference Books	**T1, T2, T3, T4, R2, R4, R5**

Unit No: II	Single Phase and Three Phase Transformer (Part-B)	08 Hours

Single phase Transformer: Polarity test. Parallel operation of single-phase transformers, conditions of parallel operations and load sharing.

Three Phase Transformers: Standard connections of three phase transformers and their suitability for various applications, voltage Phasor diagrams and vector groups. Descriptive treatment of Parallel operation of three phase transformers Scott connection and V-V connections. Three winding (tertiary windings) transformers.

Reference Books	**T1, T2, T3, T4, R2, R4, R5**

Unit No: III	DC Machines	08 Hours

Part A: 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. Emerging Applications of DC Machines (Descriptive treatment only)

Part B: 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,

resistance commutation, EMF commutation, interpole or compoles. (Descriptive treatment only)		
Reference Books	**T2, T3, T4, R1, R3, R5, R7**	
Unit No: IV	**Three Phase Induction Motor (Part-A)**	**08 Hours**
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, condition for maximum torque. Relation between starting torque, full load torque and maximum torque. Losses in three phase induction motor, power-flow diagram, relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency.		
Reference Books	**T1, T3, T4, T5, T6, R4, R5, R6, R8**	
Unit No: V	**Three Phase Induction Motor (Part-B)**	**08 Hours**
Induction motor as a generalized transformer; phasor diagram. Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent circuit parameters and plotting the circle diagram. Necessity & types of starters for 3-phase induction motors.		
Reference Books	**T1, T3, T4, T5, T6, R4, R5, R6, R8**	

Industrial Visit:

Minimum One visit to the above machines manufacturing industry (mentioned in syllabus) is recommended.

Learning Resources

1. Text Books

[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.

2. 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

3. e-Books

"Electrical Machines" by Slobodan N. Vukosavic (Springer Free Access)

https://link.springer.com/book/10.1007/978-1-4614-0400-2

"Electric Machines" (IIT Kanpur Lecture Notes)

4. Links to online SWAYAM/NPTEL Courses

[M1]. NPTEL course on Electrical Machines---, IIT Kharagpur Electrical Machines - I - Course

[M2]. NPTEL Course on Electrical Machines, IIT Delhi **Electrical Machines - Course**

CO PO Mapping Table

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-252-ELE	**Course Name: Numerical Methods and Computer Programming**	
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hrs	**02**	**CCE : 40 Marks**
		ESE : 60 Marks

Prerequisite: Basic Calculus, Linear Algebra, Basic Programming Skills, Basic Electrical Engineering

Course Objectives:

1. To **promote** computational thinking and problem-solving using numerical methods.
2. To **develop** multidisciplinary analytical skills through the use of Python in engineering applications.
3. To **enable** experiential learning through hands-on projects, simulations, and coding.
4. To **nurture** lifelong learning habits through use of open-source tools and online platforms.
5. To **encourage** teamwork, communication, and ethics through collaborative project work.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **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.
5. **CO5: Work** in teams to build solutions and present projects using Python

Course Contents

Unit No: I	Introduction to Python and Numerical Methods	06 Hours

Python Basics: Data types, control statements, loops, functions, modules, file handling.

Libraries: Introduction to NumPy, Matplotlib, SymPy and SciPy for scientific computation.

Errors in Computation: Round-off and truncation errors and error sources.

Overview of Numerical Methods: Need and scope of numerical methods in multidisciplinary domains. Importance in electrical engineering applications (circuit analysis, control systems, electromagnetics, etc.)

Integrated Activities:

Online module: Python basics via any MOOCs

Real-life error examples (e.g., incorrect meter readings)

Exemplars/Case Studies	Smart Metering Systems: Impact of Computational Precision ▪ Study how small computational errors can affect energy billing over long durations. ▪ Implement simple billing logic in Python and demonstrate the effect of round-off.
Reference Books	**T2, T4, T5 – R2, R4**

Unit No: II	Algebraic and Transcendental Equations	06 Hours

Bisection Method, False Position (Regula Falsi) Method, Newton-Raphson Method (for one variable), Rate of Convergence and limitations of methods.

Engineering Applications: Solving nonlinear equations in electrical circuits (e.g., diode IV characteristics, motor speed equations)

Skill Integration:

Develop reusable Python modules for root-finding

Small group activity: Select and solve an interdisciplinary real-world nonlinear problem

Exemplars/Case Studies	Finding Operating Point of a PN Junction Diode

	Use Newton-Raphson method to solve $I = I_s\left(e^{\frac{V}{nV_t}} - 1\right) - I_L = 0$
Reference Books	**T1, T2, T3, T4 - R1, R2, R4, R5**

Unit No: III	Systems of Linear Algebraic Equations	06 Hours

Direct Methods: Gauss Elimination, Partial Pivoting, Gauss-Jordan, LU Decomposition.

Iterative Methods: Jacobi Method, Gauss-Seidel Method.

Applications: Power system equations, network analysis: Solving node-voltage and mesh- current equations in electric circuits.

Practical Integration:

Solve nodal/mesh equations using NumPy

Team coding challenge: Solve a large circuit matrix and plot results

Exemplars/Case Studies	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.
Reference Books	**T1, T2, T3, T4 – R1, R2, R3, R4**

Unit No: IV	Interpolation, Numerical Differentiation, and Integration	06 Hours

Interpolation: Newton's Forward and Backward Difference, Lagrange Interpolation.

Numerical Differentiation: Using finite differences for equally spaced points (Only Forward Newton)

Numerical Integration: Trapezoidal Rule, Simpson's 3/8 Rule, Simpson's 1/3 Rule (for single & double integration).

Applications: Area under waveforms, energy calculations in electrical signals.

21st Century Skill Component

Python visualization using Matplotlib

Analyze sensor data or waveform signals from IoT kits (if available)

Exemplars/Case Studies	Area Under Voltage-Time Curve ▪ Given sampled data from an oscilloscope, use Simpson's Rule to compute the RMS voltage or energy.
Reference Books	**T1, T2, T3, T4 – R1, R2, R4, R5**

Unit No: V	Ordinary Differential Equations and Curve Fitting	06 Hours

Solution of First Order ODEs: Euler's Method, Modified Euler Method, Runge-Kutta Methods (2nd & 4th order).

Curve Fitting: Least Squares Method (Linear and 2nd Order).

Applications: Transient analysis of RL, RC, and RLC circuits; fitting performance curves for machines.

Project Integration:

Build and simulate electrical system models

Data fitting for experimental datasets (motor torque-speed curve, IV curves)

Exemplars/Case Studies	Motor Speed Control using Curve Fitting ▪ Fit torque-speed data of a DC motor to a polynomial model using least squares.
Reference Books	**T1,T2,T3, T4 – R2, R3, R4**

Learning Resources

1. Text Books

[T1]. S. S. Sastry – Introductory Methods of Numerical Analysis, PHI

[T2]. S Kalavathy, M Joice Punitha- Numerical Methods second Edition, Mc Graw-hill Education Pvt. Ltd.

[T3]. B. S. Grewal - Numerical Methods in Engineering and Science, Khanna Publishers
[T4]. Jaan Kiusalaas – Numerical Methods in Engineering with Python, Cambridge University Press
[T5]. Steven C. Chapra – Applied Numerical Methods with Python for Engineers and Scientists, McGraw-Hill
[T6]. Reema Thareja - Python Programming : Using Problem Solving Approach, Oxford University Press

2. Reference Books

[R1]. Steven C. Chapra, Raymond P. Canale - Numerical Methods for Engineers, McGraw-Hill
[R2]. Amos Gilat, Vish Subramaniam - Numerical Methods for Engineers and Scientists, Wiley
[R3]. Ruben R. Gonzalez - A First Course in Scientific Computing: Symbolic, Graphic, and Numeric Modeling Using MATLAB, Princeton University Press
[R4]. Claude Gomez - Numerical Computation Using Python, Wiley (Scientific Computing series)
[R5]. Rakesh Nayak - Python for Engineers and Scientists, BPB Publications

3. e-Books/ e-contents

[E1]. MIT Open Courseware (Numerical Computing with Python)
[E2]. Kaggle datasets for real-world examples

4. Links to online SWAYAM/NPTEL Courses

[M1]. Numerical Methods for Engineers by Prof. Niket Kaisare, IIT Madras: https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ge20/
[M2]. Computational Science and Engineering Using Python by Prof. Mahendra Verma, IIT Kanpur: https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-ph02/
[M3]. 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

5. YouTube/Video Links

1. Numerical Methods and Computer Programming by John T. Foster
   https://www.youtube.com/playlist?list=PLCnlJOMhMC0PW7IUv312SgQauEujq1HdU
2. Numerical methods and Programming by NPTEL HRD: https://youtu.be/zjyR9e-
   N1D4?si=SBWCNJ57WHXrwnd3
3. Numerical Analysis and Methods by Ahmad Bazzi:
   https://youtube.com/playlist?list=PL-DDW8QIRjNOxxzsJLhxrenUXH5G-pjUC&si=B9ua1-4bEwa15BSr
4. Python Tutorial by Programming with Mosh:
   https://youtube.com/playlist?list=PLTjRvDozrdlxj5wgH4qkvwSOdHLOCx10f&si=Q9i61BgdIDTt313H
5. Numerical Analysis by Dr. Gajendra Purohit :
   https://youtube.com/playlist?list=PLU6SqdYcYsfLrTna7UuaVfGZYkNo0cpVC&si=zhUPN5c09c_Mcgu4

CO PO Mapping

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-253-ELE		**Course Name: Network Analysis**
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hrs	**02**	**CCE : 40 Marks**
		ESE : 60 Marks

Prerequisite: Terminology of electrical networks, series and parallel combinations of resistance, Laplace transforms, linear differential equations

Course Objectives:

1. To develop the strong foundation for Electrical Networks.
2. To develop analytical qualities in Electrical circuits by application of various theorems.
3. To understand the behavior of circuits by analyzing the transient response using classical methods and Laplace Transform approach.
4. To develop understating of basics of Network Functions and design of other circuits like filters.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1:** Calculate current/voltage in electrical circuits using simplification techniques, Mesh, Nodal analysis.
2. **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.
5. **CO5:** Apply the knowledge of network theory to find transfer function, poles and zeroes location to perform stability analysis and Design of filters

Course Contents

Unit No: I	**Types of Networks, Mesh and Nodal analysis**	**06 Hours**
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).		
Reference Books	**T1-T3, R1-R5**	

Unit No: II	**Network Theorems**	**06 Hours**
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.		
Reference Books	**T1-T7, R1-R6**	

Unit No: III	**Transient Analysis in RLC circuit-Time domain approach**	**06 Hours**
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).		
Reference Books	**T1-T7, R1-R6**	

Unit No: IV	**Transient Analysis in RLC circuit: Laplace Transform approach**	**06 Hours**
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.		

Reference Books	**T1-T7, R1-R6**	
Unit No: V	**Network Functions and Filters**	**06 Hours**
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.		
Reference Books	**T1-T7, R1-R5**	

Learning Resources

1. Text Books

[T1]. Network Analysis Third Edition by M. E. Van Valkenburg, Prentice Hall of India Private Limited.
[T2]. Network Analysis & Synthesis by G. K. Mittal, Khanna Publication.
[T3]. Network Analysis and Synthesis by Ravish R Singh, McGraw Hill.
[T4]. Introduction to Electric Circuits by Alexander & Sadiku, McGraw Hill.
[T5]. Introduction to Electric Circuits by S. Charkarboorty, Dhanpat Rai & Co.
[T6]. Fundamentals of Electrical Networks by B.R.Gupta & Vandana Singhal- S.Chand Publications
[T7]. Electrical Circuit Analysis 2nd Edition by P. Ramesh babu, Scitech Publication India Pvt Ltd.

2. Reference Books

[R1]. Network Analysis by Cramer, McGraw Hill Publication.
[R2]. Engineering Circuit Analysis by William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication
[R3]. Schaum's Outline of Electric Circuits, McGraw-Hill Education; 7 edition
[R4]. Joseph A. Edminister, Mahmood Maqvi, "Theory and Problems of Electric Circuits", Mc Graw hill
[R5]. "A Course in Electrical Circuits and Analysis" M. L. Soni, J. C. Gupta, Dhanpat rai and sons
[R6]. 3000 solved problems in Electrical circuits, Syed A. Nasar, Mc Graw hill

3. Links to online SWAYAM/NPTEL Courses

https://onlinecourses.nptel.ac.in/noc20_ee46/preview

CO PO Mapping

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-254-ELE		**Course Name: Electrical Machines-I Lab**
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hrs	**01**	**PR : 25 Marks**

Prerequisite: Introduction of Electrical Machines, Magnetic circuit, mutual induced EMF, dynamically induced EMF, Direction of magnetic field in current carrying conductor, Flemings LHR & RHR, Electromechanical energy conversion

Course Objectives:

1. To **Conduct** OC/SC test on single phase transformer.
2. To **Conduct** the polarity test on a single-phase and three-phase transformer.
3. To **Test** the performance of DC Shunt motor by various methods.
4. To **Perform** load test on three phase Induction Machine
5. To **Find** the performance characteristics of 3- phase induction motor by conducting No Load and Blocked Rotor test.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

CO1. **Determine** the equivalent circuit parameter, voltage regulation and efficiency of a given 1-phase transformer.

CO2. **Find** the polarity of single phase and three phase transformers.

CO3. **Calculate** the torque, speed and efficiency of a given DC shunt motor by conducting Brake test, Hopkinson's Test & Swinburn Test.

CO4. **Calculate** the torque speed and efficiency of three phase Induction Motor by direct / indirect loading method

CO5. **Plot** the circle diagram & compute slip, pf, torque, rotor & stator losses & efficiency by conducting No Load & Blocked Rotor test on given three phase induction motor.

List of Experiments

Perform eight experiments from the following list:

Compulsory Experiments:

1. O.C. and S.C. test on single phase Transformer
   - **a.** Determination of equivalent circuit parameters from the test data
   - **b.** Determination of voltage regulation and efficiency

2. Parallel operation of two single phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedances.

3. Speed control of D.C. Shunt motor and study of starters.

4. Load test on 3-phase induction motor.

Any four experiments from the following list are to be conducted:

1. Polarity test on single phase, three phase transformer.

2. Brake test on D.C. Shunt motor

3. Load characteristics of D.C. series motor.

4. Hopkinson's test on D.C. shunts machines.

5. No load & blocked-rotor test on 3-phase induction motor:
   - **a.** Determination of parameters of equivalent circuit.
   - **b.** Plotting of circle diagram.
   - **c.** Calculation of motor performance from (a) & (b) above.

6. Determination of sequence impedance of the transformer

7. Measurements of non-sinusoidal current waveform of transformer at no load
8. Swinburne Test on DC shunt Motor.

Guidelines for Instructor's Manual

The Instructor's Manual should contain the following related to every experiment:

- Brief theory related to the experiment
- Connection diagram /circuit diagram
- Observation table
- Sample calculations for one reading
- Result table
- Graph and Conclusions

Guidelines for Students Lab Manual

The student's Lab Journal should contain the following related to every experiment:

- Theory related to the experiment,
- Connection diagram /circuit diagram,
- Observation table,
- Sample calculations for one reading,
- Result table,
- Graph and Conclusions,

Guidelines for Lab assessment

There should be continuous assessment.

- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do connections on bread board and get the results.
- Timely submission of journal.

Guidelines for Lab conduction

- The first half hour should be utilized for explaining the circuit diagram and theory related to the experiment.
- Next one hour for connection and conduction of the experiment
- Remaining half hour for continuous assessment and timely checking of the experiment (This time slot can be adjusted as per convenience)

Learning Resources

1. Text Books

[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.

2. 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

3. e-Books

"Electrical Machines" by Slobodan N. Vukosavic (Springer Free Access)
https://link.springer.com/book/10.1007/978-1-4614-0400-2
"Electric Machines" (IIT Kanpur Lecture Notes)

4. Links to online SWAYAM/NPTEL Courses

[M1]. NPTEL course on Electrical Machines---, IIT Kharagpur Electrical Machines - I - Course
[M2]. NPTEL Course on Electrical Machines, IIT Delhi **Electrical Machines - Course**

CO PO Mapping Table

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-255-ELE	**Course Name: Numerical Methods and Computer Programming Lab**	
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hrs	**01**	**PR : 25 Marks**

Prerequisite: Basic Calculus, Linear Algebra, Basic Programming Skills, Basic Electrical Engineering

Course Objectives:

1. To learn the basics of Python
2. To solve the linear equations of Electrical circuits
3. To interpolate the values of look up table using Lagrange's and Numerical forward method
4. To understand the applications of Simpson's 1/3rd and 1/8th rule.
5. To learn the applications of Runge-Kutta method

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1:** Write the Python programme to compute and plot truncation and round-off error
2. **CO2**: Solve the linear equations derived from mesh and node analysis for a given electrical circuit.
3. **CO3:** Interpolate the values of look up table using Lagrange's and Numerical forward method
4. **CO4:** Calculate the area under voltage/ current waveform using Simpson's 1/3rd and 1/8th rule.
5. **CO5:** Simulate the transient response of a given RL circuit using Runge-Kutta method.

List of Experiments

Perform eight experiments from following list: (using any open-source python software)

(Take numerical from electrical engineering only)

Compulsory Experiment:**1,2,3,8,9,10**

Anyone from 4 or 5 and Anyone from 6 or 7

1. Write a Python program to compute and plot truncation and round-off error.
2. Implement root-finding methods and compare their performance.
3. Solve a system of linear equations derived from mesh or node analysis.
4. Interpolate values from a lookup table using Lagrange's method.
5. Interpolate values from a lookup table using Newton forward difference method.
6. Calculate current/voltage waveform area using Simpson's 1/3rd rule.
7. Calculate current/voltage waveform area using Simpson's 3/8th rule.
8. Simulate an RL circuit's transient response using RK4 method.
9. Fit a curve to noisy voltage-time data and analyze goodness of fit.
10. Mini project: Create a Python GUI (Tkinter or Streamlit) for solving numerical problems in electrical engg.

Guidelines for Instructor's Manual

The Instructor's Manual should contain the following related to every experiment:

- Aim & Objectives
- Brief theory related to the experiment
- Numerical and Solution
- Algorithm
- Python Code & Print of Ipython Console
- Result table

- Conclusions
- Annexure of Keywords, Libraries and Commands used
- Few questions related to the experiment (Pre Lab -5 & Post Lab -5)

Guidelines for Students Lab Manual

The student's Lab Journal should contain the following related to every experiment:

- Aim & Objectives
- Brief theory related to the experiment
- Numerical and Solution
- Algorithm
- Computer drawn Flowchart
- Python Code & Print of Ipython Console
- Result table
- Conclusions
- Annexure of Keywords, Libraries and Commands used
- Few questions related to the experiment (Pre Lab-5 & Post Lab -5)

Guidelines for Lab assessment

There should be continuous assessment.

- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do code and get the results.
- Timely submission of journal.

Guidelines for Lab conduction

- The first half hour should be utilized for explaining the numerical and theory related to the experiment.
- Next one hour for code of the experiment
- Remaining half hour for continuous assessment and timely checking of the experiment (This time slot can be adjusted as per convenience)
- A separate Personal Computer should be provided to each student.
- **Optional** (To promote innovative teaching pedagogy code submission can be done by any online tool)

Learning Resources

1. Text Books

[T1]. S. S. Sastry – Introductory Methods of Numerical Analysis, PHI

[T2]. S Kalavathy, M Joice Punitha- Numerical Methods second Edition, Mc Graw-hill Education Pvt. Ltd.

[T3]. B. S. Grewal - Numerical Methods in Engineering and Science, Khanna Publishers

[T4]. Jaan Kiusalaas – Numerical Methods in Engineering with Python, Cambridge University Press

[T5]. Steven C. Chapra – Applied Numerical Methods with Python for Engineers and Scientists, McGraw-Hill

[T6]. Reema Thareja - Python Programming : Using Problem Solving Approach, Oxford University Press

2. Reference Books

[R1]. Steven C. Chapra, Raymond P. Canale - Numerical Methods for Engineers, McGraw-Hill

[R2]. Amos Gilat, Vish Subramaniam - Numerical Methods for Engineers and Scientists, Wiley

[R3]. Ruben R. Gonzalez - A First Course in Scientific Computing: Symbolic, Graphic, and Numeric Modeling Using MATLAB, Princeton University Press

[R4]. Claude Gomez - Numerical Computation Using Python, Wiley (Scientific Computing series)

[R5]. Rakesh Nayak - Python for Engineers and Scientists, BPB Publications

3. e-Books/ e-contents

[E1]. MIT Open Courseware (Numerical Computing with Python)

[E2]. Kaggle datasets for real-world examples

4. Links to online SWAYAM/NPTEL Courses

[M1]. Numerical Methods for Engineers by Prof. Niket Kaisare, IIT Madras: https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ge20/

[M2]. Computational Science and Engineering Using Python by Prof. Mahendra Verma, IIT Kanpur: https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-ph02/

[M3]. 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

5. YouTube/Video Links

1. Numerical Methods and Computer Programming by John T. Foster
   https://www.youtube.com/playlist?list=PLCnlJOMhMC0PW7IUv312SgQauEujq1HdU
2. Numerical methods and Programming by NPTEL HRD: https://youtu.be/zjyR9e-**N1D4?si=SBWCNJ57WHXrwnd3**
3. Numerical Analysis and Methods by Ahmad Bazzi:
   https://youtube.com/playlist?list=PL-DDW8QIRjNOxxzsJLhxrenUXH5G-pjUC&si=B9ua1-4bEwa15BSr
4. Python Tutorial by Programming with Mosh:
   https://youtube.com/playlist?list=PLTjRvDozrdlxj5wgH4qkvwSOdHLOCx10f&si=Q9i61BgdIDTt313H
5. Numerical Analysis by Dr. Gajendra Purohit :
   https://youtube.com/playlist?list=PLU6SqdYcYsfLrTna7UuaVfGZYkNo0cpVC&si=zhUPN5c09c_Mcgu4

CO PO Mapping

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: PCC-256-ELE		**Course Name: Network Analysis Lab**
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hrs	**01**	**OR : 25 Marks**

Prerequisite: Terminology of electrical networks, series and parallel combinations of resistance, Laplace transforms, linear differential equations

Course Objectives:

1. To analyze electrical networks using various theorems.
2. To learn applications of maximum power transfer theorem.
3. To determine time response of RL, RC, RLC series circuit for step DC voltage input.
4. To design high pass and low pass filter for electrical circuit.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1:** Analyze the given electrical network using Superposition, Thevenin's and Norton theorems.
2. **CO2:** Calculate maximum power and load impedance of a given electrical network by using maximum power transfer network.
3. **CO3:** Determine the time response of a given RL, RC, RLC series circuit by step input DC voltage.
4. **CO4:** Design and simulate the HPF and LPF for a given electrical network impedance and cut off frequency.

List of Experiments

Any four experiments from the first six of the following and any four experiments from rest of the list. (Minimum four experiments should be performed on both hardware and simulation environment.)

1. Verification of Superposition Theorem in A.C. circuits.

2. Verification of Thevenin's Theorem in A.C. circuits.

3. Verification of Norton's Theorem in A.C. circuits.

4. Verification of Reciprocity Theorem in A.C. circuits.

5. Verification of Millmans' Theorem.

6. Verification of Maximum Power Transfer Theorem in A.C. circuits.

7. Determination of time response of series R-C circuit to a step D.C. voltage input. (Charging and discharging of a capacitor through a resistor)

8. Determination of time response of series R-L circuit to a step D.C. voltage input. (Rise and decay of current in an inductive circuit)

9. Determination of time response of series R-L-C circuit to a step D.C. voltage input.

10. Design and Simulate a HPF for given values of design impedance and cut-off frequency.

11. Design and Simulate a LPF for given values of design impedance and cut-off frequency.

Guidelines for Instructor's Manual

- Specify objective(s) of the experiment.
- List out equipment required to perform the experiment with their ratings.
- Include circuit diagram with specifications.
- Related theory of the experiment must be included.
- Include step by step procedure to perform the experiment.
- Tabular representation of results taken /observation table must be included wherever applicable.
- It should include the formula required to calculate desired results. Instructions for plotting the graphs must be included wherever required.
- Provide space to write conclusion on their own.

  For simulation experiments using MATLAB, the Simulink diagram with proper details must be included.

Guidelines for Students Lab Manual

- Students are expected to write the journal in the following sequence:
  - Aim, Equipment, Circuit diagram, Theory Procedure, Observation table, Calculations, Graphs, Conclusion.

Students are expected to draw the circuit diagrams on 1mm graph paper. For plotting the characteristics, they must use 1mm graph papers. Students should write conclusion. Students should get the assignment and lab write up checked within 1 week after performing the experiment.

Guidelines for assessment

TW Assessment should be on the basis of:

- Neatness of circuit diagram.
- Completed write up including theory, procedure.
- Detailed calculations to obtain results.
- Graph with title, scale, labeling of axes etc.
- Conclusion.

Punctuality, discipline, attendance, understanding and neatness of the journal. Few questions on the basis of the experiment can be asked to verify the understanding of the students about that experiment.

Guidelines for Lab conduction

- Perform the experiment in the presence of an instructor.
- Verify the results obtained.

Learning Resources

1. Text Books

[T1]. Network Analysis Third Edition by M. E. Van Valkenburg, Prentice Hall of India Private Limited.

[T2]. Network Analysis & Synthesis by G. K. Mittal, Khanna Publication.

[T3]. Network Analysis and Synthesis by Ravish R Singh, McGraw Hill.

[T4]. Introduction to Electric Circuits by Alexander & Sadiku, McGraw Hill.

[T5]. Introduction to Electric Circuits by S. Charkarboorty, Dhanpat Rai & Co.

[T6]. Fundamentals of Electrical Networks by B.R.Gupta & Vandana Singhal- S.Chand Publications

[T7]. Electrical Circuit Analysis 2nd Edition by P. Ramesh babu, Scitech Publication India Pvt Ltd.

2. Reference Books

[R1]. Network Analysis by Cramer, McGraw Hill Publication.
[R2]. Engineering Circuit Analysis by William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication
[R3]. Schaum's Outline of Electric Circuits, McGraw-Hill Education; 7 edition
[R4]. Joseph A. Edminister, Mahmood Maqvi, "Theory and Problems of Electric Circuits", Mc Graw hill
[R5]. "A Course in Electrical Circuits and Analysis" M. L. Soni, J. C. Gupta, Dhanpat rai and sons
[R6]. 3000 solved problems in Electrical circuits, Syed A. Nasar, Mc Graw hill

3. Links to online SWAYAM/NPTEL Courses

https://onlinecourses.nptel.ac.in/noc20_ee46/preview

CO PO Mapping

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: MDM-272-ELE	**Course Name: Fundamentals of Data science & Machine Learning**	
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hrs	**02**	**CCE : 40 Marks**
		ESE : 60 Marks

Course Objectives:

1. To apply basic Python programming for data analysis and engineering computation.
2. To understand core data science concepts, tools, and applications in electrical engineering.
3. To develop skills in data collection, preprocessing, visualization, and basic statistics for engineering decisions.
4. To introduce machine learning types, workflows, and applications in electrical engineering using standard tools.
5. To apply supervised and unsupervised ML techniques and evaluation metrics using scikit-learn in engineering tasks.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1**: Write and execute Python programs, manipulate data using NumPy and Pandas.
2. **CO2**: Differentiate structured and unstructured data, apply in electrical engineering, and identify data science roles and tools.
3. **CO3:** Collect, clean, visualize electrical data, apply descriptive statistics, understand hypothesis testing concepts.
4. **CO4:** Differentiate AI, ML, DL, describe ML workflow, apply in electrical systems, and build models with scikit-learn.
5. **CO5:** Apply Linear Regression, K-Nearest Neighbors, K-Means Clustering to electrical data, evaluate models, implement using scikit-learn.

Course Contents

Unit No: I	Python Programming Basics for Data Science	06 Hours

a) **Python environment**: Jupyter, Google Colab
b) **Data types**: int, float, string, list, tuple, dictionary
c) Python Functions, Arrays and Data Frames
d) Classes & Objects in Python
e) **File operations:** Reading and writing CSVs

Unit No: II	Fundamentals of Data Science and Applications in Electrical Engg	06 Hours

a) **Data Science**: Concept, Key components and lifecycle, Introduction to Numpy, Pandas.
b) **Descriptive statistics**: mean, median, mode, std deviation
c) **Applications in Electrical Engineering**: Load forecasting using curve fitting method, Smart grids for next monthly electric bill (energy consumption) prediction, Fault prediction.
d) **Roles in data science**: Analyst, Engineer, Scientist
e) **Overview of tools**: Python, R, Jupyter, Excel (Limited to Self-Study)

Unit No: III	Data Acquisition, Visualization, and Hypothesis Testing	06 Hours

a. **Data sources**: SCADA, IoT sensors, meters, (Limited to Data Extraction), Structured vs unstructured data, time-series in electrical systems.
b. **Data preprocessing:** handling missing values, outliers, duplicates
c. **Visualization tools:** matplotlib, seaborn: Line plot, histogram, boxplot, scatter plot
d. **Descriptive statistics** Hypothesis testing: outliers, duplicates, Null and alternate hypotheses, p-value, significance level, type I/II errors, t-test and z-test (conceptual introduction).

e. **Use case**: Load comparison before and after optimization

Unit No: IV	Introduction to Machine Learning (ML)	06 Hours

a) **Machine Learning (ML):** Concept, scope of ML
b) Differences between Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL)
c) **ML Types:** Supervised, Unsupervised (overview)
d) **ML pipeline**: Data → Train → Predict → Evaluate
e) **Electrical Applications**: Predictive maintenance, Load and outage forecasting, Fault classification

Unit No: V	Basic ML Algorithms and Model Evaluation	06 Hours

a. Introduction to scikit-learn and model-building steps.
b. **Supervised Learning:** Linear Regression (for load forecasting), K-Nearest Neighbors (for fault classification)
c. **Unsupervised Learning:** K-Means Clustering (load profile segmentation)
d. **Model Evaluation:** Confusion Matrix, Accuracy, Precision, Recall, F1-Score, Cross-validation basics
e. Simple Python implementation using scikit-learn

Learning Resources

1.Text Books

[T1]. VanderPlas, Jake. Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media, 2016.
[T2]. Raschka, Sebastian & Mirjalili, Vahid. Python Machine Learning. Packt Publishing, 3rd Edition, 2019.
[T3]. McKinney, Wes. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. O'Reilly Media, 2nd Edition, 2017.
[T4]. Alpaydin, Ethem. Introduction to Machine Learning. MIT Press, 4th Edition, 2020.

2. 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

3. Online resources

[E1]. https://colab.research.google.com – Google Colab 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

4. Links to online SWAYAM/NPTEL Courses

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

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: VSE-281-ELE		**Course Name: Electrical Workshop**
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hrs	**02**	**TW : 25 Marks**
		OR : 25 Marks

Prerequisite: Knowledge of working of different electrical domestic and industrial appliances,

Course Objectives:

1. To **develop** hardware skills such as soldering and winding etc
2. To **develop** debugging skills.
3. To **increase** ability of analysis and test circuits.
4. To **give** an exposure to market survey for available components.
5. To **develop** an ability to do proper documentation of experimentation.
6. To **enhance** employability of a student.
7. To **prepare** students for working on various hardware projects.

Course Outcomes:

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

1. **CO1:** Design/draw the electrical circuit for given application.
2. **CO2:** Read data Manual/data sheet for a specified application.
3. **CO3:** Repair and test electrical appliances/circuits.
4. **CO4:** Acquire Hardware skills to fabricate designed Circuits.
5. **CO5:** Test and Debug circuits.
6. **CO6:** Write the test report of a given electrical system.

Practical's (General Instructions & Guidelines)

- The exercises must be carried out in a group of maximum of 3 students
- Minimum 8 exercises must be carried out.
- Students will present the design, procedure observations and conclusion report which will be evaluated for term work

Group A (Electrical Components) (Minimum 3 Exercises from this group)

1. Design and fabrication of reactor for various inductance values.
2. Wiring and realization of contactor-based Star Delta starter.
3. Distribution box wiring for components like MCB, MCCB, ELCB, RCCB.
4. Repairing of Mixer/Grinder, Electric Iron.
5. Repairing of Ceiling / Table fan.
6. Demonstrative model of domestic wiring to control one fan and two lamps through switch board.
7. Wring of DOL starter and forward Reverse control of three phase induction motor.

Group B (Electronic Circuits) (Minimum 2 Exercises from this group)

This group consist of Electronic Circuits that must be assembled on general purpose PCB.

1. Design and Development of combined Dual 12 volt and Dual 5 volt regulated power supply.
2. Design and Development of PWM generator for various values of PWM.
3. Design and Development of Object counter circuit.
4. Design and Development of Electronic Fan speed regulator
5. Design of Traffic light control using time delay circuits.
6. Design of 7 segment display driver to display numbers from 0 to 9.

7. Design circuit to flash group of LEDs.

Group C (Arduino based applications) (Minimum 3 Exercises from this group)

(All interfacing circuits for Arduino boards must be assembled on general purpose PCB's/ Bread board)

1. Switch based Relay control using Arduino board.
2. DC motor speed control using Arduino board.
3. Stepper motor speed control using Arduino board.
4. String of character display on 16 X 2 LCD display using Arduino board.
5. Measurement and display of Temperature using Arduino board.
6. Distance measurement using Arduino board.
7. Generate Square and Triangular wave using Arduino board.

Learning Resources

1. Text Books

[T1]. Electrical Workshop by R.P. Sing

2. Reference Books

[R1]. Electrical workshop Practices by Dr. Umesh Rathod & Naresh kumar sharma

3. Links to online SWAYAM/NPTEL Courses

M1. http://archive.nptel.ac.in/courses/108/105/108105112/

4. E-Resources, YouTube/Video Links

E1. https://www.youtube.com/@JrElectricSchool/playlists

E2. https://www.youtube.com/@EngineeringMindset/playlists

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	3	2	2	1	3	2	3	2
CO2	2	1	3	2	2	1	1	1	2	2	2
CO3	3	3	2	3	2	2	0	2	1	3	2
CO4	3	2	3	2	2	1	0	2	2	3	2
CO5	3	3	3	2	2	2	1	3	2	3	3
CO6	2	1	1	1	1	2	1	1	2	1	2

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: AEC-282-ELE		**Course Name: Modern Indian Languages (Marathi)**
Teaching Scheme	**Credits**	**Examination Scheme**
Tutorial : 01 Hr	**01**	**TW : 50 Marks**
Practical : 02 Hrs	**01**	

Course Objectives: The course aims to

अभ्यासक्रमाची उद्दिष्टे :

१. प्रगत भाषिक कौशल्यांची क्षमता विकसित करणे.
२. प्रसारमाध्यमांतील संज्ञापनातील स्वरूप आणि स्थान स्पष्ट करणे.
३. व्यक्तिमत्त्व विकास आणि भाषा यांच्यातील सहसंबंध स्पष्ट करणे.
४. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे यांचे परस्पर संबंध स्पष्ट करणे.
५. प्रसारमाध्यमांसाठी लेखनक्षमता विकसित करणे.

Course Contents

Unit No: I & Unit II (07 Hrs & 08 Hrs)

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

Unit No: III & Unit IV (07 Hrs & 08 Hrs)

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

Learning Resources

1. Text Books

संदर्भ ग्रंथ :

१ सायबर संस्कृती, डॉ. रमेश वरखेडे

२ उपयोजित मराठी, संपादक डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई

३ ओळख माहिती तंत्रज्ञानाची, टिमोथी जे. ओ लिअरी

४ संगणक, अच्युत गोडबोले, मौज प्रकाशन, मुंबई.

५ इंटरनेट, डॉ. प्रबोध चोबे, मनोरमा प्रकाशन, मुंबई.

६ व्यावहारिक मराठी, डॉ. ल. रा. नसिराबादकर, फडके प्रकाशन, कोल्हापूर.

७ आधुनिक माहिती तंत्रज्ञानाच्या विश्वात, शिक्रापूरकर दीपक, मराठे उज्ज्वल, उत्कर्ष प्रकाशन, पुणे.

Guidelines

Term Work Evaluation

1. Subject teacher should frame minimum 08 assignments-based covering on all four units.

   शिक्षकाने सर्व चार युनिट्सचा समावेश करणारे किमान ०८ असाइनमेंट्स तयार करावे.

2. They can identify students depending upon the degree of difficulty in understanding the language and frame the assignments accordingly

   शिक्षक विद्यार्थ्यांना भाषा समजण्यात किती अडचण येते यावर अवलंबून आणि त्यानुसार असाइनमेंट्स तयार करू शकतात.

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, परवाणगी 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 स्पर्धांमध्ये 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.

Savitribai Phule Pune University **Second Year of Engineering (2024 Course)**		
Course Code: EEM-283-ELE	**Course Name: Industrial Organization Management**	
Teaching Scheme	**Credits**	**Examination Scheme**
Tutorial : 02 Hrs	**02**	**TW : 25 Marks**

Prerequisite: --

Course Objectives:

1. **Understand** the basic concepts management quality of good leadership and teamwork, leadership skill, and industrial economics.
2. **Possess** knowledge of types of business organizations.
3. **Explore** the fundamentals of Industrial economics and Management.
4. **Understand** the basic concepts of Technology management and Quality management.
5. **Analyze** and differentiate between marketing management and financial management.
6. **Recognize** the importance of Motivation, Group dynamics, Teamwork, leadership skill and entrepreneurship.
7. **Explain** the fundamentals of Human Resource management.
8. **Identify** the importance of Intellectual property rights and understand the concept of patents, copy rights and trademarks.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. **CO1: Discuss** the fundamentals of management, quality of good leadership and teamwork, leadership skill, and industrial economics.
2. **CO2: Explain** the importance of quality, technology management and quality management.
3. **CO3: Identify** the importance of Intellectual property rights and understand the concept of patents, copy rights and trademarks. role of Human Resource Management
4. **CO4: Analyze** and differentiate between marketing management and financial management
5. **CO5: Differentiate** between different types of business organizations, business ownership and road map to Entrepreneurship

Course Contents

Unit No: I	**Introduction to Management, Industrial Economics and Leadership**	**03 Hours**

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/Case Studies	Administration & management difference, Qualities of Good Leadership
Reference	**T1, T5, R2, R10, M1, M2, M5**

Unit No: II	**Technology Management and Quality Management**	**03Hours**

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/Case Studies	Kaizen. Use of 5S in implementation of Kaizen.
Reference	**T3, T4, T5, R3, R5, R11, M1 M3 M4**

Unit No: III	**Intellectual Property Rights (IPR) & Human Resource Management (HRM)**	**03Hours**

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/Case Studies	Patent types, Copy rights and trademark.	
Reference Books	**T2 T4 T6, R3, R5. R6, M2 M4 M5**	
Unit No: IV	**Marketing and Financial Management**	**03Hours**
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/Case Studies	Online Marketing, Debit, credit, Profit and loss statement, Balance sheet.	
Reference Books	**T1, T6, R1, R2, M2 M3 M4 M5**	
Unit No: V	**Business Organization, Business Ownership and its Types**	**03 Hours**
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/Case Studies	Entrepreneurship, Case study on small scale industries in India.	
Reference Books	**T4, T5, T6, R8, M1, M4, M5**	

Industrial Visit:

Compulsory visit to small / large scale industry which is near to the college where the students should observe all the basics from the subjects. The intention is to identify and understand the industry's work.

Tutorial Contents

In tutorial session, the following activities must be carried out by students

Group 1 (Minimum 5 Poster compulsory, 2.0 mark for each poster among 4 student group). Repetition of the content should be avoided. Poster Presentation on A3 size paper print.

1. Management work
2. Industrial Economics
3. Technology Management
4. Quality Management.
5. Intellectual Property Rights (IPR)
6. Human Resource Management (HRM)
7. Marketing
8. Business Organization

Group 2 (Minimum 5 compulsory.2.0 mark for each PPT presentation among 4 student group) Repetition of the content should be avoided. 15 Min, Power Point Presentation on Management work

1. Leadership.
2. Financial Management
3. Marketing (online and offline)
4. Entrepreneurship

5. Patent structure and filing procedure
6. Business Ownership and its Types
7. Case study of small-scale Industry

Group 3 (Compulsory act at least 30 min. For 5 Mark each student)

- Make group act of demo Industry model and recruit which consists of all the content from the syllabus among 30 to 35 students in a group or as per the student intake.

Assessment Guidelines

1. Marks should be given according to the performance
2. Keep all the record at department as a termwork
3. Maintain Record in file or separate notebook, A3 size poster Printouts and PPT Presentation)

Learning Resources

1. Text Books

[T1]. Khanna, industrial engineering and management, Dhanpat Rai and sons, New Delhi.
[T2]. E. H. McGraw, S. J. Basic managerial skills for all.
[T3]. Tarek Khalil, Management of Technology Tata McGraw Hill Publication Pvt. Ltd.
[T4]. Prabuddha Ganguli Intellectual Property rights Tata McGraw Hill Publication Company
[T5]. Management Accounting and financial management by M. Y. Khan and P.K. Jain, Tata McGraw Hill-Tata-

2. Reference Books

[R1]. C. B. Mamoria and V. S. P. Rao- Personnel Management, Himalaya Publishing House, 30th Edition 2014.
[R2]. Harold Koonlz and OD'onnel–Management. Tata McGraw Hill Publication1980.
[R3]. Philip Kotler-Marketing Management. Pearson Edition 2008.
[R4]. Robert Heller, Managing Teams, Dorling Kindersley, London.
[R5]. Kelly John M, Total Quality Management, InfoTech Standard, Delhi.
[R6]. Joseph M. Juran, Juran's Quality Handbook TATA McGraw-Hill.
[R7]. Dale H. Bester field and Carol Bester field Total Quality Management Prentice Hall of India Pvt. Ltd.
[R8]. Shiv Sahai Singh [Editor] The Law of Intellectual Property rights.
[R9]. N. R. Subbaram, What Everyone Should Know About Patents, Pharma Book Syndicate, Hyderabad.
[R10]. Principles and Practices of Management –Dr. P.C. Shejwalkar, Dr. Anjali Ghanekar, Deepak Bhivpathki.
[R11]. Financial Management by I. M. Pandey, Vikas Publishing House Pvt. Ltd., Delhi Philip Kotler-Marketing Management.

3. e-Books

[E1]. https://knowledgegainer.delnet.in/Record/EB-0000133166
[E2]. https://www.bloomsbury.com/us/industrial-economics-9781349233069/
[E3]. https://info.email.online.hbs.edu/leadership-ebook
[E4]. https://www.bloomsbury.com/us/technology-management-9781137431868/
[E5]. https://my.uopeople.edu/pluginfile.php/57436/mod_book/chapter/121631/BUS5116TextbookQualityMgmt.pdf
[E6]. https://open.umn.edu/opentextbooks/textbooks/introduction-to-intellectual-property-law
[E7]. https://ecampusontario.pressbooks.pub/humanresourcesmgmt/
[E8]. https://www.amazon.in/Marketing-Management-Keller-Philip-Kotler-ebook/dp/B071GNMDDM
[E9]. https://www.amazon.in/Fundamentals-Financial-Management-Chandra-Bose-ebook/dp/B00K7YG36O
[E10]. https://www.sultanchandandsons.com/Images/BookImages/Chapters/628_TC%201279%20Booklet%20%28%29.pdf?utm_source=chatgpt.com

[E11]. https://www.emporia.edu/documents/1737/Types_of_Business_Ownership.pdf?utm_source=chatgpt.com

4. Links to online SWAYAM/NPTEL Courses

[M1]. https://youtu.be/w-wxvJFfKEw

[M2]. https://youtu.be/SoUjQpIO3YY

[M3]. https://youtu.be/NWsw9tKhRg8

[M4]. https://youtu.be/5fvpsqPWZac

[M5]. https://youtu.be/HX8_UdIwy58

5. YouTube/Video Links

[1]. https://youtu.be/uB-j2koAPwk?si=_kZwiVs9oT72tAuB

[2]. https://youtu.be/4G9CJLwR3SM?si=8ajLh3SfexP71_rx

[3]. https://youtu.be/usrfNll7oqM?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=1QMmOs6XgN2zvHDr

[8]. https://youtu.be/zkWJAvg6_ME?si=pjmtv0tpdfHIif9y

[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

[14]. https://youtu.be/bQrk8yE2m3I?si=3n5NCQ5wgWg1gQlr

[15]. https://youtu.be/vw6xWV7Jqi8?si=UWLM8TrCvBZFP1e7

[16]. https://youtu.be/xuSaHf6SsvE?si=7eftQHw7RUn_L0Vy

[17]. https://youtu.be/CPOS7w7SsHk?si=FUF6fby77hTQYyBb

[18]. https://youtu.be/4T1WdgrfDms?si=z-jA53VsJLzxTsQ9

CO PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	-	1	2	-	2	3	2
CO2	2	-	1	2	1	1	2	1	2	3	2
CO3	2	2	-	3	1	2	-	-	2	3	2
CO4	1	3	1	2	-	2	3	-	-	2	1
CO5	-	-	1	4	2	1	-	-	3	2	-

Savitribai Phule Pune University Second Year of Engineering (2024 Course)		
Course Code: VEC-284-ELE	**Course Name: Environmental Awareness for Electrical Engineers**	
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hrs	**02**	**CCE : 20 Marks**
		ESE : 30 Marks

Course Objectives:

1. To develop an understanding of environmental concepts, challenges, and sustainability issues relevant to engineering practice.
2. To enable students to identify the impact of electrical engineering activities on the environment.
3. To introduce environmentally sustainable technologies and energy-efficient practices in the electrical domain.
4. To promote ethical responsibility and awareness toward environmental conservation.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

CO1. Understand the principles of environmental science and the importance of sustainability.
CO2. Analyze the environmental impacts of electrical engineering processes and systems.
CO3. Identify sustainable and clean energy solutions relevant to electrical engineering.
CO4. Apply environmental laws and ethical practices in professional engineering activities.
CO5. Integrate environmental awareness into future project planning and decision-making.

Course Contents

Unit No: I	Fundamentals of Environment and Sustainability	07 Hours

a) Definition and Scope of Environmental Studies
b) Components of Environment: Atmosphere, Hydrosphere, Lithosphere, Biosphere
c) Ecosystems: Structure, Function, and Energy Flow
d) Sustainable Development: Goals and Indicators
e) Relationship between Technology and Environment
f) Importance of Environmental Awareness for Electrical Engineers

Unit No: II	Pollution and its control	07 Hours

a) Air, water, soil, and noise pollution: causes, effects, and control measures
b) E-waste: origin, environmental impact, and safe disposal methods
c) Thermal and electromagnetic pollution due to electrical systems
d) Pollution control acts and environmental regulations (Air Act, Water Act, EPA, EIA)
e) Role of electrical engineers in pollution prevention (e.g., green electrical systems)

Unit No: III	Renewable Energy and Green Technologies	08 Hours

a) Need for Renewable Energy in Sustainable Development
b) Overview of Solar, Wind, Biomass, and Small Hydro Energy
c) Distributed Generation and Grid Integration Challenges
d) Energy Auditing and Management in Electrical Installations
e) Green Buildings and Smart Grid Concept
f) Case Studies: Solar Rooftop Installations, Wind Energy Parks

Unit No: IV	Climate Change, Carbon Footprint, and Sustainable Practices	08 Hours

a) Global Warming and Climate Change: Causes, Effects, and Mitigation

b) Carbon Footprint Calculation and Reduction Strategies
c) Role of Electric Vehicles and Battery Storage Systems
d) Environmental Risk Assessment and Disaster Management
e) Corporate Environmental Responsibility (CER) and Role of Engineers
f) Local and Global Case Studies in Sustainable Electrical Practices

Learning Resources

1. Text Books

[T1]. A Textbook of Environmental Studies, Dr. D. K. Asthana, S. Chand

[T2]. The textbook of Environmental studies, Dr. P. D. Raut, Shivaji University, 2013

[T3]. Textbook on Environmental Science and Sustainability, Dr. C. Jeyaprabha, Dr. V.Sribharathy, Evincepub Publishing

2. Reference Books

[R1]. "Air Pollution", M. N. Rao, McGraw Hill, Publication.

[R2]. "E-waste Management and Protection of Environment", Dr. Suresh Kumar, Authors press, 2021.

[R3]. Hazardous Waste Incineration, Brunner R.C., 1989, , McGraw Hill Inc.

[R4]. Pollution, Clark R.S., Marine Clanderson Press Oxford (TB)

[R5]. Environmental Science, Miller T.G. Jr., Wadsworth Publishing Co. (TB)

[R6]. Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Trivedi R.K., Enviro Media ®

[R7]. Renewable Energy and Green Technology, Ritu Dogra, Brillion Publishing

3. 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. **India_Green_Stimulus_Report_NITI_VF_June_29.pdf**

4. Links to online SWAYAM/NPTEL Courses

[M1]. Dr. Monica Jain, Devi Ahilya Vishwavidyalaya, Indore
https://onlinecourses.swayam2.ac.in/cec21_ge21/preview

[M2]. Prof. Mukesh Sharma, IIT Kanpur
https://archive.nptel.ac.in/courses/105/102/105102089

[M3]. Prof. J. Bhattacharyya, IIT Kharagpur
https://archive.nptel.ac.in/courses/123/105/123105001

[M4]. Prof. Bhola Ram Gurjar, IIT Roorkee
https://archive.nptel.ac.in/courses/105/107/105107213/

CO PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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

Savitribai Phule Pune University, Pune

Maharashtra, India

Task Force for Curriculum Design and Development

Overall Coordination and Compilation

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Dr. M. S. Thakare	PVG COET & GKPIM, Pune

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Dr. A. B. Patil	AISSMS College of Engineering, Pune

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Universal Human Values & Professional Ethics	
Prof. M. S. Kore	PVG College of Engineering and Technology, Pune
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Dr. H. S. Avchat	HSBPVT'S GOI Faculty of Engineering, Kashti
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Prof. A. A. Netake	MET'S Institute of Engineering Bhujbal Knowledge City, Nashik
Prof. Ritu Soni	JSPM's Bhivarabai Sawant Institute of Techn & Research, Wagholi
Numerical Methods and Computer Programming	
Prof. S. R. Prasad	Dr. D. Y. Patil Institute of Technology, Pimpari
Dr. S. V. Tade	Sinhgad Institute of technology, Lonavala
Dr. K. D. Vidhate	Dr. Vithalrao Vikhe Patil College of Engineering, Ahmednagar.
Prof. A. R. Shelar	Samarth Group of Institutions, Belhe
Network Analysis	
Prof. U. S. Thakar	PVG COET & GKPIM, Pune
Prof. C. V. Deshpande	Zeal College of Engineering, Pune
Prof. S. D. Datey	Sinhgad Institute of technology, Lonavala
Prof. P. D. Upadhye	Vidya Protistan's Kamalnayan Bajaj Institute of Engg & Tech, Baramati
Fundamentals of Data Science and Machine Learning	
Dr. S. A. Deokar	Sharadchandra Pawar College of Engineering and Technology, Baramati
Dr. M. S. Thakare	PVG COET & GKPIM, Pune
Electrical Workshop	
Prof. S. P. Koparkar	S R.H. SAPAT College of Engg, Mgmt Studies & Research, Nasik
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Prof. C. R. Shinde	Sandip Institute of Engineering & Management, Nasik
Industrial Organization Management	
Prof. S. D. Managate	SVPM, College of Engineering Malegaon, Baramati
Dr. P. C. Tapre	S.N.D. College of Engineering and Research Center, Yeola
Environmental Awareness for Electrical Engineers	
Prof. Ekta Mishra	ASM Next gen Technical Campus, Talegaon Dabhade
Prof. G. G. Gadhave	Sharadchandra Pawar College of Engineering and Technology, Baramati
Prof. G. R. Padule	S. B. Patil College of Engineering, Indapur
Prof. J. H. Pawar	SVPM, College of Engineering Malegaon, Baramati

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