VPKBIET

# Vidya Pratishthan's Kamalnayan Bajaj Institute of Institute of Engineering and Technology, Baramati

## Faculty of Science & Technology
## Board of Studies
## Electrical Engineering

## SY B. Tech. Electrical Engineering
(Pattern: 2025)
(w.e.f. AY: 2026-27)

# Vidya Pratishthan's
# Kamalnayan Bajaj Institute of Engineering and Technology
## Board of Studies: Electrical Engineering
### Syllabus: Second Year (SY B.Tech.) Electrical Engineering
### 2025 Pattern w.e.f. AY: 2026-2027
### SEMESTER III

| Course Type | Course Code | Course Name | Teaching Scheme | | | Examination Scheme and Marks | | | | | | | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TH | PR | TUT | CAA | ISE | ESE | TW | PR | OR | Total | TH | PR | TUT | Total |
| BSC | BS25206TH | Application of Mathematics in Electrical Engineering | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | - | - | 3 |
| PCC | EL25201TH | Electrical Measurement and Instrumentation | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | - | - | 4 |
| PCC | EL25201PR | Electrical Measurement and Instrumentation | - | 2 | - | - | - | - | - | 30 | - | 30 | - | 1 | - | |
| PCC | EL25202TH | Electrical Circuit Analysis | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | - | - | 4 |
| PCC | EL25202PR | Electrical Circuit Analysis | - | 2 | - | - | - | - | - | - | 30 | 30 | - | 1 | - | |
| PCC | EL25203TH | Analog and Digital Electronics | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | - | - | 4 |
| PCC | EL25203PR | Analog and Digital Electronics | - | 2 | - | - | - | - | - | 30 | - | 30 | - | 1 | - | |
| VSEC | EL25204PR | Energy Audit | - | 2 | - | - | - | - | - | - | 30 | 30 | - | 1 | - | 2 |
| VSEC | EL25204TU | Energy Audit | - | - | 1 | 10 | - | - | 30 | - | - | 40 | - | - | 1 | |
| MDM | MD250XXTH | Multi-disciplinary minor | 2 | - | - | 10 | | 60 | - | - | - | 70 | 2 | - | - | 3 |
| MDM | MD250XXPR | Multi-disciplinary minor | - | 2 | - | - | - | - | 30 | - | - | 30 | - | 1 | - | |
| CORE | EL25205PR | Community Engagement Project | - | 4 | - | 10 | - | - | 30 | | 30 | 70 | - | 2 | - | 2 |
| | | **Total** | **14** | **14** | **1** | **70** | **120** | **300** | **90** | **60** | **90** | **730** | **14** | **7** | **1** | **22** |

### List of Multi-Disciplinary Minor

| Code | Multi-Disciplinary Minor |
|---|---|
| ET25053 | Internet of Things |

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Dr. G. S. Gadge
28/03/2026
Head of Department

Dr. S. M. Bhosle
Dean Academics

Dr. A. H. Kolekar
Controller of Examination

Dr. S. B. Lande
Principal

Principal
Vidya Pratishthan's
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# Vidya Pratishthan's
# Kamalnayan Bajaj Institute of Engineering and Technology
## Board of Studies: Electrical Engineering
### Syllabus: Second Year (SY B. Tech.) Electrical Engineering
### 2025 Pattern w.e.f. AY: 2026-2027
### SEMESTER IV

| Course Type | Course Code | Course Name | Teaching Scheme | | | Examination Scheme and Marks | | | | | | | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TH | PR | TUT | CAA | ISE | ESE | TW | PR | OR | Total | TH | PR | TUT | Total |
| PCC | EL25211TH | Electrical Machines-I | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | - | - | 4 |
| PCC | EL25211PR | Electrical Machines-I | - | 2 | - | - | - | - | - | 30 | - | 30 | - | 1 | - | |
| PCC | EL25212TH | Power Electronics | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | | - | 4 |
| PCC | EL25212PR | Power Electronics | - | 2 | - | - | - | - | - | - | 30 | 30 | - | 1 | - | |
| PCC | EL25213TH | Power System Engineering | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | - | - | 3 |
| MDM | MD250XXTH | Multi-disciplinary minor | 3 | - | - | 10 | 30 | 60 | - | - | - | 100 | 3 | - | - | 4 |
| MDM | MD250XXPR | Multi-disciplinary minor | - | 2 | - | - | - | - | 30 | - | - | 30 | - | 1 | - | |
| OE | OE250XXTH | Open Electives | 2 | - | - | 10 | - | 60 | - | - | - | 70 | 2 | - | - | 2 |
| AEC | HS25201TH | Public Speaking and Aptitude | 1 | - | - | 40 | - | - | - | - | - | 40 | 1 | - | - | 2 |
| AEC | HS25201PR | Public Speaking and Aptitude | - | 2 | - | - | - | - | - | - | 30 | 30 | - | 1 | - | |
| VEC | HS25211TH | Environment Studies | 2 | - | - | 10 | - | 60 | - | - | - | 70 | 2 | - | - | 2 |
| | Total | | 17 | 8 | 0 | 100 | 120 | 360 | 30 | 30 | 60 | 700 | 17 | 4 | 0 | 21 |

### List of Multi-Disciplinary Minor and Open Elective

| Code | Multi-Disciplinary Minor | Code | Open Elective |
|---|---|---|---|
| ET25052 | Drone Technology | OE25016 | Accounting and Finance |

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# Bucket of Multidisciplinary Minor Courses and Open Electives

| Multidisciplinary Minor Courses | | | |
|---|---|---|---|
| **Course Code** | **Course Name** | **Course Code** | **Course Name** |
| **3 Credit MDM** | | **4 Credit MDM** | |
| AI25052 | Data Science | ET25052 | Drone Technology |
| IT25051 | Cyber security | ET25053 | Internet of Things |
| IT25052 | Full Stack Development | CE25051 | Waste Management |
| EL25052 | Industrial Automation | CO25052 | High Performance Computing (Sem V+) |
| ET25051 | Embedded Systems | CO25053 | Computer Graphics & Gaming |
| EL25051 | Photovoltaic Technology and Solar Power System | ME25052 | Robotics & Automation |
| GS25052 | Linear Algebra and Statistics | AI25051 | AI & Machine Learning |
| CO25053 | Object Oriented Programming | CO25051 | Cloud Computing |
| IT25054 | Data Structure | ME25051 | 3-D Printing |
| ET25054 | Microprocessor | CE25052 | Green building & smart cities |
| GS25051 | Nanotechnology | | |

| Open Elective Courses | | | |
|---|---|---|---|
| **Course Code** | **Course Name** | **Course Code** | **Course Name** |
| OE25001 | Digital Marketing | OE25011 | Biotechnology |
| OE25002 | Professional Leadership | OE25012 | International Relations |
| OE25003 | Organizational Behavior | OE25013 | Universal Human Values |
| OE25004 | Industrial Management | OE25014 | Education Technology |
| OE25005 | Disaster Management | OE25015 | Design Thinking |
| OE25006 | Energy Economics & Management | OE25016 | Accounting & Finance |
| OE25007 | Operations Research | OE25017 | Sustainability & Climate Change |
| OE25008 | Intellectual Property Rights | OE25018 | Agriculture Technology |
| OE25009 | Cyber Laws | OE25019 | Architectural Technology |
| OE25010 | Bioinformatics | | |

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| BS25206: Applications of Mathematics in Electrical Engineering | | |
|---|---|---|
| **Teaching Scheme** | **Credits: 03** | **Examination Scheme** |
| **Theory: 3 Hrs./week** | | **Activity:10 Marks** |
| | | **End-Semester: 60 Marks** |
| | | **In-Semester: 30Marks** |

**Prerequisite Courses:**
Differential & Integral calculus, Taylor series, Differential equations of the first order and first degree, Fourier series, Vector algebra and Complex numbers.

**Course Objectives:**
1. To familiarize the students with concepts and techniques in Ordinary differential equations, Fourier Transform & Z-Transform, Numerical methods, and Vector Calculus.
2. 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 discipline.

**Course Outcomes (COs):** On successful completion of the course, the learner will be able to:
**CO1:** Solve higher-order linear differential equations using appropriate techniques for modeling and analyzing electrical circuits.
**CO2:** Apply Laplace transform to solve differential equations and problems related to signal processing and control systems.
**CO3:** Learn the concept of fourier transform and apply it to engineering problems.
**CO4:** Understand the concept of Z-transform and apply them to solve difference equations.
**CO5:** Perform vector differentiation & integration, to analyze the vector fields, and apply them to electromagnetic fields.
**CO6:** Analyze Complex functions, and conformal mappings, and perform contour integration in their study.

## Course Content

**Unit I: Linear Differential Equations (LDE) and Applications (7 Hrs)**

Introduction, Solution of LDE, General method, short-cut method, Method of variation of parameters, Cauchy's, and Legendre's DE, Modeling of Electrical circuits.

**Unit II: Laplace Transform (LT) (7 Hrs)**

Properties and theorems of Laplace and Inverse Laplace transform. Laplace transform of standard functions and some special functions. Applications of LT for solving linear differential equations in Electrical systems.

**Unit III: Fourier Transform (7 Hrs)**

Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine and Cosine transforms, and inverse transforms.

**Unit IV: Z Transform (7 Hrs)**

Introduction, Theorems and Properties of Z-transform, and Inverse Z-transform. Applications of Z-transforms to solve differential equations.

**Unit V: Vector Calculus (7 Hrs)**

Vector differentiation: Gradient, Divergence and Curl, Directional derivative, Solenoidal, Conservative fields, Scalar potential, and vector identities.

Vector Integration: Line, Surface, and Volume integrals, Work-done, Green's Lemma, Stoke's theorem, Gauss's Divergence theorem. Applications to problems in Electromagnetic fields.

**Unit VI: Complex Variables (7 Hrs)**

Functions of a Complex variable, Analytic functions, Cauchy-Riemann equations. Conformal mapping, Bilinear transformation. Cauchy's integral theorem, Cauchy's integral formula, Residue theorem, and applications.

**Guidelines for termwork Marks and Assessment:**

1. Tutorials for the subject shall be engaged in a minimum of three batches (batch size of 22 students) per division.
2. Term work shall consist of six assignments on each unit and is based on performance and continuous internal assessment.

**Books and other Resources:**

**Textbooks:**

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

**Reference Books:**

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
4. Differential Equations, 3e by S. L. Ross (Wiley India).
5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press).
6. Complex Variables and Applications, 8e, by J. W. Brown and R. V. Churchill (McGraw-Hill)

**MOOC/NPTEL Courses:**

1. Course on "Integral & Vector Calculus" https://nptel.ac.in/courses/111/105/111105122/
2. Course on "Complex Analysis" https://nptel.ac.in/courses/111/103/111103070/
3. Course on "Transform Calculus and its applications in differential equations." https://nptel.ac.in/courses/111/105/111105123/

Course Coordinator (PAC-1) | PAC-2 | PAC-3 | BOS Chairman

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| EL25201: Electrical Measurement and Instrumentation | | |
|---|---|---|
| **Teaching Scheme:**<br>**TH: 03 Hrs/Week**<br>**PR: 02 Hrs/Week** | **Credits:04** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**In-Semester Exam: 30 Marks**<br>**End-Semester Exam: 60 Marks**<br>**Practical Exam: 30 Marks** |

**Prerequisite Courses:**

Basic Electrical Engineering

**Course Objectives:**

1. To study the principle of operation and working of different types of instruments.
2. To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance.
3. To explain the construction, working principle of various types of instruments for measurement of electrical power.
4. To demonstrate construction, working principle of various types of instruments for measurement of energy.
5. To explain the principles of oscilloscope, transducer and sensor for measurement of various electrical quantities.
6. To study various types of measurement techniques like level, displacement and flow measurement.

**Course Outcomes**

On completion of the course, learner will be able to:

**CO-1:** Interpret the concepts of three-phase AC circuits, and evaluate the characteristics, classification, and working principles of various measuring instruments for electrical measurements.

**CO-2:** Apply appropriate measurement techniques for extending the range of measuring instruments and accurately determining resistance, inductance, and capacitance using various bridge and circuit methods.

**CO-3:** Describe the construction and working principles of various types of instruments used for power measurement.

**CO-4:** Describe the construction and working principles of various instruments used for energy measurement.

**CO-5:** Apply knowledge of energy measurement instruments, oscilloscopes, transducers, and sensors to accurately measure electrical quantities and analyze system performance.

**CO-6:** Apply various level, displacement, and flow measurement techniques, including mechanical, electrical, and ultrasonic methods, to assess their working principles, applications, and performance characteristics in industrial and engineering systems.

## Course Contents

**Unit I: Three Phase AC Circuits and Measuring Instruments (7 Hrs.)**

**A. Three Phase AC Circuits:**

Concept of three-phase supply and phase sequence. Balanced and unbalanced load, voltages, currents and power relations in three phase balanced star-connected loads and delta-connected loads along with phasor diagrams.

**B. Measuring Instruments:**

Characteristics of measuring instruments: static and dynamic, accuracy, linearity, speed of response, dead zone, repeatability, resolution, span, reproducibility, drifts. Necessity of calibration, standards and their classification, absolute and secondary instruments, types of secondary instruments: indicating, integrating, and recording, analog and digital. Laser distance meter, Laser tachometer, Ammeter, and Voltmeter Theory: Essentials of indicating instruments deflecting, controlling, and damping systems. Construction, working principle, torque equation, advantages, and disadvantages of Moving Iron (MI) instruments (attraction and repulsion). Block diagram and operation of digital ammeter & voltmeter.

**Unit II: Range Extension and Measurement of Resistance, Inductance and Capacitance (7 Hrs.)**

**A. Range Extension:**

Instrument Transformers: Construction, connection of CT & PT in the circuit, advantages of CT / PT for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, and burden, ratio, and phase angle error.

**B. Measurement of Resistance:**

Measurement of low, medium, and high resistance. Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, Megger. Earth tester for earth resistance measurement.

**C. Measurement of Inductance and Capacitance:**

Introduction, sources, and detectors for A.C. Bridge. General equation for bridge balances, Maxwell's inductance - Capacitance Bridge, Anderson's bridge. Introduction, types of capacitances, measurement of capacitance by Schering Bridge.

**Unit III: Measurement of Power** **(7 Hrs.)**

Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type wattmeter, low power factor wattmeter, poly-phase wattmeter. Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method, two wattmeter method & one wattmeter method.

**Unit IV: Measurement of Energy** **(6 Hrs.)**

Construction, working principle, torque equation of single phase conventional (induction type) energy meter. Block diagram and operation of single phase and three phase static energy meter. Calibration of static energy meter, TOD meter, Digital energy meter, Bidirectional net meter.

**Unit V: Oscilloscope, Transducers & Sensors** **(6 Hrs.)**

A. **Oscilloscope:** Introduction, various parts, front panel controls, use of CRO for measurement of voltage, current, period, frequency. Phase angle & frequency by Lissajous pattern. Introduction to DSO.

B. **Transducers:** Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers.

C. **Sensors:** Position sensors, Pressure sensors, Temperature sensors, Force sensors, Vibration sensors, Piezo sensors, Humidity sensors, Fluid property sensors.

**Unit VI: Level, Displacement and Flow Measurement** **(6 Hrs.)**

A. **Level Measurement:** Introduction and importance of level measurement, level measurement methods: mechanical, hydraulic, pneumatic, electrical, nucleonic, and ultrasonic.

B. **Displacement Measurement:** LVDT & RVDT construction, working, applications, specifications, advantages & disadvantages, effect of frequency on performance.

C. **Flow Measurement:** Introduction, characteristics, construction & working of solenoid valve and its applications.

**Books & Other Resources:**

**Text Books:**


1. A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai & Co.
2. J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", S. K. Kataria & Sons.
3. R. K. Jain, "Mechanical and Industrial Measurements", Khanna Publishers.
4. B. C. Nakra & K. K. Chaudhari, "Instrumentation Measurement and Analysis", Tata McGraw Hill.


**Reference Books:**


1. E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.
2. Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers.
3. Arun K. Ghosh, "Introduction to Measurements and Instrumentation", PHI Publication.
4. M. M. S. Anand, "Electronics Instruments and Instrumentation Technology", PHI Publication.


**Guidelines for Laboratory - Term work Assessment:**

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals students are expected to inform about their progress/lagging.

**Guidelines for Laboratory Conduction:**

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before

performing.

**Guidelines for Students Lab Journal:**

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

**List of Practicals (Any 08 experiments to be performed by the student)**

1. To verify the relation between phase and line quantities in three phase balanced Delta and Star connected load.
2. To perform measurement of medium resistance by Ammeter - Voltmeter method.
3. To perform measurement of low resistance using Kelvin's double bridge.
4. To perform demonstration of power analyzer and multifunction meter for measurement of various electrical quantities.
5. To perform extension of ammeter range using CT, voltmeter range using PT and watt meter range using CT / PT.
6. To perform calibration of single-phase wattmeter at different power factors.
7. To perform measurement of three phase active & reactive power by two wattmeter method for balanced as well as unbalanced load.
8. To perform measurement of reactive power by one wattmeter with all possible connections of current coil and pressure coil.
9. To perform measurement of active power in three phases, four wire system using three CTs & two wattmeter.
10. To perform calibration of single-phase energy meter at different power factors.

11. To perform measurement of the displacement by using LVDT and plotting its characteristics.
12. To perform measurement of Inductance, Capacitance and Resistance using LCR meter.

**Note : The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.**

**Industrial Visit:** Minimum one visit should be arranged to an electrical instrument manufacturing company or where electrical instruments are calibrated or where various measuring instruments (Electrical/Mechanical) can be seen or observed.

**Course Activity (Any ONE of the following):**

For the assessment of Course Activity, a student must complete at least ONE activity out of the following:

1. Chart Preparation
2. PowerPoint presentation

| Mrs. A. B. Akhade | Mrs. P. N. Jaiswal | Mrs. V. V. Deokate |
|---|---|---|
| PAC Member 1 | PAC Member 2 | PAC Member 3 |

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| EL25202: Electrical Circuit Analysis | | |
|---|---|---|
| **Teaching Scheme:**<br>**TH: 03 Hrs/Week**<br>**PR: 02 Hrs/Week** | **Credits:04** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**In-Semester Exam: 30 Marks**<br>**End-Semester Exam: 60 Marks**<br>**Oral Exam: 30 Marks** |

**Prerequisite Courses:**

Engineering Physics, Engineering Mathematics I & II, Basic Electrical Engineering

**Course Objectives:**

1. To understand types of sources and to develop the ability to solve and analyse problems on electric circuits by application of the knowledge of Mesh Analysis, Nodal Analysis, Duality and Graph Theory.
2. To develop the ability to apply knowledge of various network theorems to electrical circuits to simplify, solve and analyse the electric circuit problems.
3. To understand and analyse transient and steady-state response of RLC circuits with time domain approach.
4. To be able to obtain Laplace Transformed networks and analyse transient and steady-state response of RLC circuits with Laplace Transform approach.
5. To understand and evaluate two port network parameters and their interrelationships and to design other circuit like passive filters.
6. To be able to determine network functions and to obtain time domain behaviour from the Pole-Zero plot to perform stability analysis.

**Course Outcomes:**

On completion of the course, learner will be able to:

CO-1: Solve and analyse problems on electric circuits by applying the knowledge of Mesh Analysis, Nodal Analysis, Duality and Graph Theory.

CO-2: Simplify, solve and analyse the electric circuit problems by applying knowledge of various network theorems.

CO-3: Analyse transient and steady-state response of RLC circuits in time domain.

CO-4: Apply Laplace transform to analyse transient and steady-state behaviour of RLC circuits.

CO-5: Evaluate two port network parameters and develop their interrelationships and design other circuit like passive filters.

CO-6: Determine network functions and obtain time domain behaviour from the Pole-Zero plot to perform stability analysis.

## Course Contents

**Unit I: Source Transformation, Mesh & Nodal Analysis, Duality, Graph Theory (7 Hrs)**

Types of Sources: AC Sources, DC Independent (Ideal & Practical) and DC Dependent (controlled) voltage and current sources, Source Transformation, KVL & KCL, Mesh and Nodal Analysis of circuits with all types of sources, Concept of super node and super mesh, Concept of duality and dual networks, Dot convention for coupled circuits.

Graph Theory: Tree, Co-tree, Incidence matrix, F-cutest Matrix, Tie set B Matrix.

**Unit II: Network Theorems (7 Hrs)**

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem, Compensation theorem, Tellegence Theorem applied to electrical networks with all types of sources (AC & DC, DC independent and dependent).

**Unit III: Transient Analysis in RLC Circuits – Time Domain Approach (7 Hrs)**

Solution of first and second order differential equations for series and parallel R-L, R-C, RLC circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

**Unit IV: Transient Analysis in RLC Circuits – Laplace Transform Approach (7 Hrs)**

Introduction to Laplace transform, Properties of Laplace transforms, step, pulse, impulse & ramp functions, Laplace Transform of Basic R, L and C components, Laplace transformed networks with initial conditions, Solutions of differential equations and network equations using Laplace transform method for R-L, R-C and R-L-C circuits (series and parallel), Application of initial and final value theorem, Inverse Laplace transforms.

**Unit V: Two Port Networks and Passive Filters (7 Hrs)**

One Port and Two port networks, Open Circuit Impedance (Z) Parameters, Short circuit Admittance (Y) Parameters, Transmission (ABCD) Parameters, Inverse Transmission (A'B'C'D') Parameters, Hybrid (h) Parameters, Inverse Hybrid (g) Parameters, inter-relationships between all two port network parameters, Introduction to passive filters, low pass filters, high pass filters and m-derived LPF and HPF filters and design.

Unit VI: Network Functions (7 Hrs)

Driving Point functions for One and Two Port Networks, Transfer functions for two port network, Calculation of network functions, Poles and Zeros of network functions, Pole-Zero Plot, time domain behaviour from the Pole-Zero plot, Restrictions on poles and zeros locations for transfer functions and driving point functions, Parallel Resonance, Quality Factor.

**Books & Other Resources:**

**Text Books:**

1. Network Analysis, M. E. Van Valkenburg, Prentice Hall of India Private Limited.
2. Network Analysis & Synthesis, G. K. Mittal, Khanna Publication.
3. Network Analysis and Synthesis, Ravish R Singh, McGraw Hill.
4. Introduction to Electric Circuits, S. Charkraborty, Dhanpat Rai & Co.
5. Fundamentals of Electrical Networks, B. R. Gupta & Vandana Singhal, S. Chand Publications

**Reference Books:**

1. Introduction to Electric Circuits, Alexander & Sadiku, McGraw Hill.
2. Network Analysis, Cramer, McGraw Hill Publication.
3. Engineering Circuit Analysis, William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication.

**Guidelines for Laboratory Conduction:**

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

**Guidelines for Students Lab Journal:**

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment.

9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

**LIST OF PRACTICALS (Any 08 to be performed by the student)**

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 Maximum Power Transfer theorem in A.C. circuits.
6. Verification of Millman's theorem.
7. Determination of time response of 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 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 R-L-C series circuit to a step D.C. voltage input.
10. Determination of Z-parameters and Y-parameters of a Two Port Network.
11. Determination of h-parameters and ABCD parameters of a Two Port Network.
12. Determination of current under parallel Resonance condition.

**Note: The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However, the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.**

**Course Activity (Any ONE of the following):**

For the assessment of Course Activity, a student must complete at least ONE activity out of the followings:

1. Concept Test
2. Simulation of Electrical Circuits

| | | |
|---|---|---|
| Dr. G. S. Gadge | Mrs. J. S. Kulkarni | Mr. S. K. Raskar |
| PAC Member 1 | PAC Member 2 | PAC Member 3 |

VPKBIET BARAMATI
Affiliated to S.P.P.U. Pune
Id No./PU/PN/Engg./152/2000
PUNE (MS.)

| EL25203 : Analog and Digital Electronics | | |
|---|---|---|
| **Teaching Scheme:**<br>**TH: 03 Hrs/Week**<br>**PR: 02 Hrs/Week** | **Credits:04** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**In-Semester Exam: 30 Marks**<br>**End-Semester Exam: 60 Marks**<br>**Practical Exam: 30 Marks** |

**Prerequisite Courses:**

Basic Electronics Engineering

**Course Objectives:**

1. To design combinational circuits using fundamental logic gates, Boolean algebra & K-map to solve complex digital logic problems.
2. To construct sequential circuits including shift registers and counters using fundamental logic gates and Boolean algebra
3. To apply fundamental knowledge of diode rectifiers in power conversion of AC to DC.
4. To understand the fundamentals of operational amplifier.
5. To use basic principles of operational amplifiers to illustrate their various applications.
6. To understand the principles and types of multivibrators, filters and voltage regulators in electronic circuits.

**Course Outcomes**

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

**CO1:** Design combinational circuits using fundamental logic gates, Boolean algebra & K-map

**CO2:** Construct sequential circuits including shift registers and counters using fundamental logic gates and Boolean algebra

**CO3:** Apply fundamental knowledge of diode rectifiers in power conversion of AC to DC.

**CO4:** Explain the fundamentals of operational amplifier

**CO5:** Apply basic principles of operational amplifiers to illustrate their various applications

**CO6:** Explain the principles and types of multivibrators, filters and voltage regulators in electronic circuits.

## Course Contents

**Unit I: Combinational circuits** **(7 Hrs)**

Karnaugh map: Structure for two, three and four Variables, SOP and POS form reduction of boolean expressions by K-map, Reduction of boolean expressions not specified in standard SOP form and don't care conditions, Introduction to combinational circuits, Study of encoders : Priority encoder, 4:2 encoder, Decoders : 2:4, 3:8 decoder, Subtractor : Half subtractor and full subtractor, Multiplexer and Demultiplexer.

**Unit II: Sequential circuits** **(7 Hrs)**

Introduction to sequential circuit, Basic SR Latch, Review of RS flip flop, D FF, JK FF and T FF, Study of synchronous and asynchronous up and down counters (2-bit, 3-bit and 4-bit), Asynchronous up-down counter, Design of asynchronous MOD-N counter, Shift registers : SISO,SIPO,PISO,PIPO and universal shift register, Ring and twisted ring counters.

**Unit III: Diode rectifier** **(7 Hrs)**

Single phase half wave rectifier with R and RL load. Single phase full wave centre tapped and bridge rectifier supplying RL load, Performance parameters of single phase half wave and full wave rectifiers. Three phase half wave rectifier with R and RL load, Three phase full wave bridge rectifier with R load.

**Unit IV: Basics of operational amplifier** **(6 Hrs)**

Introduction, Block Diagram and symbol of op-amp, Types of op-amp : Ideal op-amp and practical op-amp, Important characteristics of ideal and practical op-amp, Input modes of op-amp: single ended mode, Differential mode and common mode, Concept of virtual short and virtual ground, Open loop and closed loop configuration of op-amp : inverting, non inverting and differential amplifier.

**Unit V: Applications of operational amplifier** **(6 Hrs)**

Applications of op- amp : zero crossing detector, comparator, schmitt trigger, V-I converter with grounded load and floating load, I-V converter, peak detector, Integrator, differentiator, Instrumentation amplifier, Waveform generation using op-amp : Sinewave, Squarewave and Triangular waveform generator.

**Unit VI: Filters, Multivibrators and voltage regulators** **(7 Hrs)**

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 & monostable multivibrators, voltage regulators using IC78xx, 79xx, LM 317.

**Books & Other Resources:**

**Text Books:**


1) Floyd and Jain, "Digital Fundamentals", Pearson Education.
2) R. P. Jain, "Digital Electronics", Tata McGraw Hill, New Delhi.
3) Malvino, "Digital Computer Electronics- An Introduction to Microcomputers," Tata McGraw Hill.
4) Gaikwad R., "Operational Amplifier", PHI New Delhi.
5) Floyd, "Electronics Devices", Pearson Education.
6) Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd edition, Pearsons Education.
7) Fundamental of digital circuits, 4th Edition, by A Anand Kumar, PHI learning private limited publication


**Reference Books:**


1) Tokheim, "Digital Electronics-Principles and Application", 6th edition, Tata McGraw Hill, New Delhi.
2) A Jaico and Charles H. Roth, "Fundamentals of Logic Design" Jr. Forth Edition.
3) K. R. Botkar, "Integrated Circuits", Khanna Publication, New Delhi.
4) James, "Operational Amplifier and Linear Integrated Circuits Theory and Application."
5) P John Paul, "Electronics Devices and circuits", New Age international Publications.
6) P. S. Bimbhra, "Power Electronics", Khanna Publications.


**Guidelines for Laboratory - Term work Assessment:**

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals students are expected to inform about their progress/lagging.

**Guidelines for Laboratory Conduction:**

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent

locations in the laboratory.

2. Students should be informed about DO'S and DON'T and precautions before performing.

**Guidelines for Students Lab Journal:**

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

**LIST OF PRACTICALS (Any 08 to be performed by the student)**

1. To develop a logic circuit for 3:8 decoder and realize it using logic gates.
2. To develop a logic circuit for priority encoder and realize it using logic gates.
3. To design three bit full adder to add two three digit numbers by using any open source software.
4. To develop a logical circuit to convert binary to EXCESS 3/Gray number system and implement it using logic gates.
5. To construct a toggle flip-flop using JK flip-flops and demonstrate its operation by connecting LEDs to the outputs.
6. To observe the output waveform of comparator.
7. To observe the output waveform of Schmitt Trigger.
8. To observe the output waveform of Monostable Multivibrator using IC 555.
9. To observe the output waveform of Astable Multivibrator using IC 555.
10. To observe the output waveform of single phase bridge rectifier using RL load.

**Note :**

**The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.**

**Course Activity (Any one of the following)**

For the assessment of course activity, a student must complete at least one activity out of the following

1.Unitwise objective test

2.Circuit simulation

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|---|---|---|
| Mr. A. V. Golande | Miss S. R. Sabale | Mrs. S. D. Rokade |
| PAC member 1 | PAC member 2 | PAC member 3 |

VPKBIET BARAMATI
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Id No./PU/PN/Engg./152/2000
PUNE (MS.)

| EL252044 Energy Audit | | |
|---|---|---|
| **Teaching Scheme:**<br>**PR: 02 Hrs/Week**<br>**Tut: 01 Hr/Week** | **Credits: 02** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**Oral Exam: 30 Marks**<br>**Term-Work: 30 Marks** |

**Prerequisite Courses:** Basic Electrical Engineering

**Companion Course, if any: Laboratory Practical**

**Course Objectives:**

1. To introduce fundamental concepts of energy auditing, energy management principles, and energy conservation techniques in electrical systems.
2. To develop the ability to interpret and analyze electrical energy parameters using appropriate measuring instruments for power quality and efficiency assessment.
3. To equip students with knowledge of energy-saving strategies and preliminary energy audit procedures for various sectors, ensuring awareness of sustainable energy practices.

**Course Outcomes:**

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

CO1: Identify and explain fundamental concepts of electricity billing, energy auditing, energy management principles, and the role of energy conservation in various electrical systems.

CO2: Interpret and analyze electrical energy parameters using appropriate measuring instruments for assessing power quality, efficiency, and performance in different applications.

CO3: Identify and describe energy-saving strategies and preliminary audit procedures for various sectors, including educational institutions, industries, and commercial establishments, ensuring compliance with sustainable energy practices.

**Guidelines for Laboratory - Term work Assessment:**

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals, students are expected to share their progress/lagging.

**Guidelines for Laboratory Conduction:**

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

**List of Tutorials (Any 4 tutorial should be conducted)**

1. Calculation of Electricity bill for residential and commercial consumer. (2 Numericals)
2. Study of Clean Development mechanism.
3. Study of building codes (green building).
4. Study of energy management tools.
5. Study of force field analysis from energy management point of views.
6. Study of Ethical Practices in Energy audit.

**List of Practicals (Any 8 experiments to be performed by the student)**

1. To analyse and interpret Electricity Bills for
   a) Residential consumer
   b) Commercial Consumer (e.g. College campus).
2. To perform assessment and calculations of energy generated by Solar PV or Diesel Generator available on the college campus.
3. To measure power and power factor in a single phase ac series inductive circuit and study of improvement of power factor using capacitor.
4. To study use of Power Analyser for measurement of electrical parameters useful for energy audit or power quality audit.
5. To perform adequacy assessment of Illumination systems by using Lux Meter
6. To study use of temperature measuring devices for analysis of heating systems.
7. To study use of other transducers (any one)
   a) Assessment of performance of fans and blowers by using Anemometer.

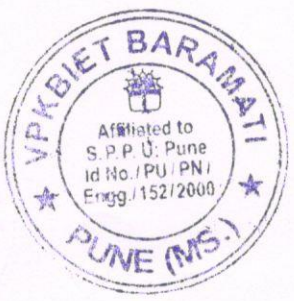
b) Use of Flow Meters for Pumping system analysis.

c) Use of pressure measuring equipment useful in audit study.

d) Smart meters and advanced energy meters

8. To execute Preliminary Energy Audit for (Any One) (Preferably this activity should be carried out with student group not exceeding 5)
   a. Laboratory
   b. Educational Institute
   c. Commercial Establishment
9. To execute Preliminary Energy Audit for (Any One) (Preferably this activity should be carried out with student group not exceeding 5)
   a. Small scale industry
   b. Residential Building
   c. Municipal Corporations
10. To perform Calculation of energy savings for following (Minimum one)
    a. Illumination
    b. Air conditioning System
    c. Irrigation/Agriculture Pumping Systems
11. To perform Calculation of energy savings for following (Minimum one)
    a. DG Sets
    b. UPS and Inverter Systems
    c. Lifts and elevators
12. Study of energy audit success stories (any one)
    a. Paper and Pulp Industry
    b. Sugar Industry
    c. Steel Industry
    d. Commercial Establishment
    e. Electrical Generation Plant

**NOTE: The list of experiments is not limited to the above, but a course coordinator may design a few new experiments based on recent technologies/trends in the relevant Engineering Domain. However, the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.**



**Books & Other Resources:**

**Text Books:**

1. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book , 1-General Aspects ( available on line )
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities ( available on line )
3. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities ( available on line )
4. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 ( available on line )

**Reference Books:**

1. Success stories of Energy Conservation by BEE (www. Bee-india.org)
2. "Utilization of Electrical Energy", S. C. Tripathi, Tata McGraw Hill.
3. "Energy Management" W. R. Murphy and Mackay, B. S. Publication.
4. "Generation and Utilization of Electrical Energy" B. R. Gupta, S. Chand Publication.
5. "Energy Auditing Made Simple" Balasubramanian, Bala Consultancy Services.

**Course Activity (Any ONE of the following):**

**For the assessment of Course Activity, a student must complete at least ONE activity out of the following:**

1. **Poster Presentation**
2. **Chart Preparation**

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|---|---|---|
| Mr. R. S. Tarade<br>PAC Member 1 | Mr. S. K. Raskar<br>PAC Member 2 | Mr. A. B. Akhade<br>PAC Member 3 |

V.P.K.B.I.E.T. BARAMATI
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| EL25205: Community Engagement Project | | |
|---|---|---|
| **Teaching Scheme:**<br>**PR: 04 Hrs/Week** | **Credits: 02** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**Term work: 30 Marks**<br>**Oral Exam: 30 Marks** |

**Prerequisites:** Basic knowledge of Electrical Systems, along with problem-solving and project management skills relevant to community-based engineering solutions

**Objectives:**

1. Utilize electrical engineering principles to solve real-world community problems through field projects.
2. Gain practical exposure to electrical systems, power distribution, renewable energy, and automation in a real-world setting.
3. Develop engineering solutions that contribute to sustainable community development, such as rural electrification, energy conservation, or smart grid implementation.
4. Enhance problem-solving skills by analyzing electrical infrastructure, conducting energy audits, and proposing improvements.
5. Work effectively in multidisciplinary teams to design, develop, and implement electrical engineering solutions.
6. Understand industry standards, electrical safety regulations, and ethical considerations in engineering projects.
7. Encourage students to propose innovative solutions using modern electrical technologies.
8. Improve technical report writing, presentation skills, and project documentation for professional and academic purposes.

**Course Outcomes:**

1. Analyze community-based electrical engineering challenges and propose feasible technical solutions.
2. Apply electrical engineering concepts to design and implement practical field-based projects.
3. Evaluate the sustainability and impact of electrical engineering solutions on society and the environment.
4. Demonstrate teamwork, leadership, and project management skills in the execution of field projects.
5. Adhere to professional ethics, electrical safety standards, and regulatory compliance in engineering projects.
6. Develop effective communication skills through technical presentations, reports, and community engagement activities.

**Procedure:** A group of 4-5 students will be assigned to a faculty member called a project guide. Based on the engineering knowledge of a group and societal and industry problems, the project guide has to guide a group to identify project problems and plan the work

schedule. Here, the expected outcomes of the project must be noted. The complete work-plan should be divided in the form of the individual tasks to be accomplished with targets. Weekly review of the completed task should be taken and further guidelines are to be given to a group. The final activity will be presenting the work completed and submitting the report. A group should be promoted to participate in a competition or write a paper.

Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content, and the structure of the activity. It may have

- A few hands-on activities that may or may not be multidisciplinary.
- Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize, and present their learning.
- Activities on solving real-life problems, investigation /study, and writing reports of in-depth study, fieldwork.

**Course Activity (10 Marks): "Identifying a Problem Statement for Community through Survey & Literature Review"**

**Objective:**

Students will conduct a survey and literature review to identify a relevant problem for a community or field project. This exercise emphasizes practical research skills and helps in formulating a problem statement for engineering solutions in real-world community settings.

1. **Community Survey – (4 Marks)**

- Design and conduct a short survey (3-5 questions) to identify a specific engineering problem faced by the local community (e.g., water access, energy efficiency, waste management, etc.).
- Interview at least 5-10 community members (either physically or via an online platform) to gather their feedback.
- Summarize the results to highlight the most pressing issue.

2. **Literature Review – (4 Marks)**

- Conduct a literature review to explore existing research, solutions, and technologies related to the identified issue.
- Find at least 2-3 studies, articles, or reports on similar problems and solutions implemented in other communities.
- Compare the results of the survey with findings from the literature to understand how the community's issue has been addressed elsewhere.

3. **Formulate a Problem Statement – (2 Marks)**

- Based on the survey and literature review, write a concise problem statement.
- The problem statement should clearly define the issue, its relevance to the community, and the need for a mechanical engineering solution.

**Evaluation Criteria: (10 Marks)**

- Effectiveness and relevance of the survey in identifying a community problem – 4 Marks
- Depth and quality of the literature review – 4 Marks
- Clarity and impact of the problem statement – 2 Marks

## Guidelines for implementing Community Engagement Project:

## Assessment Criteria for Term Work (TW) – 30 Marks

**1. Problem Identification and Research (5 Marks)**

**3 Marks:** Well-defined problem statement supported by survey data and literature review.
**2 Marks:** Effective research including community insights and background analysis.

**2. Design and Concept Development (5 Marks)**

**3 Marks:** Innovative and technically feasible solution addressing community needs.
**2 Marks:** Use of electrical design tools (MATLAB, PSCAD, ETAP, AUTOCAD, etc.) for concept visualization.

**3. Prototyping and Testing/Methodology (5 Marks)**

**3 Marks:** Development of a functional, safe, and user-friendly prototype.
**2 Marks:** Testing methodology, performance evaluation, and necessary modifications.

**4. Implementation and Community Engagement (5 Marks)**

**3 Marks:** Successful deployment of the project with community interaction, training, and feedback.
**2 Marks:** Solution modifications based on community input and real-world testing.

**5. Documentation and Report Writing (5 Marks)**

**3 Marks:** Comprehensive, well-structured project report.
**2 Mark:** Proper referencing and citation of sources.

**6. Presentation and Communication (5 Marks)**

**3 Marks:** Clear, engaging presentation demonstrating the project's impact.
**2 Marks:** Effective visual aids (circuit diagrams, graphs, or multimedia) and ability to address queries confidently.

## Assessment Criteria for Oral Examination (OR) – 30 Marks

**1. Presentation Structure (10 Marks)**

**5 Marks:** Logical flow from problem identification to solution deployment.
**5 Marks:** Well-organized content, smooth transition through key technical aspects.

**2. Technical Understanding (8 Marks)**

**4 Marks:** Demonstrates strong knowledge of electrical engineering concepts used in the project.
**4 Marks:** Effective problem-solving approach with engineering justifications.

**3. Design & Prototyping (6 Marks)**

**3 Marks:** Clear explanation of the design process, materials, and engineering tools used.
**3 Marks:** Functional explanation of the prototype with testing results.

**4. Community Engagement (4 Marks)**

**2 Marks:** Discussion on how community feedback was integrated into the solution.
**2 Marks:** Explanation of the social, economic, or environmental impact.

**5. Response to Questions (2 Marks)**

**2 Marks:** Confidence, accuracy, and clarity in answering queries.

| Mr. D. S. Yeole | Dr. H. M. Shaikh | Dr. G. S. Gadge |
|---|---|---|
| PAC Member 1 | PAC Member 2 | PAC Member 3 |

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| EL25211: Electrical Machines-I | | |
|---|---|---|
| **Teaching Scheme:**<br>**TH: 03 Hrs/Week**<br>**PR: 02 Hrs/Week** | **Credits:04** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**In-Semester Exam: 30 Marks**<br>**End-Semester Exam: 60 Marks**<br>**Practical Exam: 30 Marks** |

**Prerequisite Courses:**

Basic Electrical Engineering

**Course Objectives:**

1. To understand the fundamental principles of single-phase transformers, including their construction, operation, and applications.
2. To understand the principle and applications of three-phase transformer and autotransformer.
3. To demonstrate the principles of DC machines, including their construction, types, and operational characteristics.
4. To apply the knowledge of DC machines to demonstrate the characteristics and applications of DC motors.
5. To explain the construction, working principles, and characteristics of three-phase induction motor.
6. To evaluate various performance parameters of 3 phase Induction Motor.

**Course Outcomes**

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

**CO1:** Explain the fundamental principles of single phase transformers, including their construction, operation, and applications.

**CO2:** Explain the principle and applications of three-phase transformer and autotransformer.

**CO3:** Describe the principles of DC machines, including their construction, types, and operational characteristics.

**CO4:** Apply the knowledge of DC machines to demonstrate the characteristics and applications of DC motors.

**CO5:** Explain the construction, working principles, and characteristics of three-phase induction motor.

**CO6:** Evaluate various performance parameters of three phase Induction Motor.

## Course Contents

**Unit I: Transformers (Part- 1)** **(7 Hrs)**

Single phase transformer: Construction of corrugated core transformer, toroidal core transformer, various parts of transformer, Concept of ideal transformer and practical transformer, phasor diagram of ideal and practical transformer for no load and on load conditions. Useful and leakage flux & its effects. Equivalent 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. Transformer ratings. Losses in a transformer, their variation with load, voltage & frequency. Efficiency and condition for maximum efficiency. All day efficiency.

**Unit II: Transformers (Part- 2)** **(7 Hrs)**

Standard connections of three phase transformers( star-star, star-delta, delta-star, delta-delta), zigzag connection and their suitability for various applications, voltage phasor diagrams and vector groups. Parallel operation of transformers, need & conditions to be satisfied for parallel operation. Scott connection and V connections. Three winding (tertiary windings) transformers, welding transformer.comparison of power transformer and distribution transformer.

Auto transformers, their ratings and applications. Comparison with two winding transformers with respect to saving of copper and size.

**Unit III: DC Machines (Part- 1)** **(7 Hrs)**

Construction, main parts, magnetic circuits, poles, yoke, field winding, armature core, Armature windings: Simple lap and wave winding, commutator and brush assembly. Generating action, E.M.F equation, types of DC Generator, magnetization curves, Flashing of Generator. Motoring action. 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. Descriptive treatment of armature reaction.

**Unit IV: DC Machines (Part- 2)** **(6 Hrs)**

Starting of DC motors, Need of starter, study of starters for series and shunt motor: 2 point starter, 3 point starter and 4 point starter, solid state starters.

Speed control of various types of DC motors : Flux control method and armature voltage control method. Characteristics and applications of D.C. Shunt and Series Motors.

Brushless DC Motor : construction, working and applications.

**Unit V: Three Phase Induction Motor** **(7 Hrs)**

Construction: Stator, Squirrel cage & wound rotors. Production of rotating mmf. Principle of working, concept of slip & slip speed, effect of slip on rotor parameters, Production of torque, starting torque full load torque, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. 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. Exact & approximate equivalent circuit. Computation of performance characteristics from the equivalent circuit and circle diagram.

**Unit VI: Starters and speed control of Three Phase Induction Motor** **(6 Hrs)**

Necessity of starter for three phase induction motors. Starters for slip-ring and cage rotor induction motors : DOL, stator resistance, star-delta, rotor resistance, autotransformer. Comparison of various types of starters. Speed control methods : stator side and rotor side. Testing of three phase induction motor as per IS 325 & IS 4029.

**Books & Other Resources:**

**Text Books:**


1) Edward Hughes "Electrical Technology", ELBS, Pearson Education.
2) Ashfaq Husain, "Electrical Machines", Dhanpat Rai& Sons.
3) S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
4) Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.
5) Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
6) K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.


**Reference Books:**


1) A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.

2) A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", TataMcGraw Hill Publication Ltd., Fifth Edition.
3) A.S. Langsdorf, "Theory and performance of DC machines", Tata McGraw Hill.
4) M.G. Say, "Performance and Design of AC. Machines", CBS Publishers and Distributors.
5) Smarajit Ghosh, "Electrical Machines", Pearson Education, New Delhi.
6) Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.

**Guidelines for Laboratory Conduction:**

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

**Guidelines for Students Lab Journal:**

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

**LIST OF PRACTICALS (Any 08 to be performed by the student)**

1. To perform O.C. and S.C. test on single phase Transformer
   a) To determine equivalent circuit parameters from the test data
   b) To determine voltage regulation and efficiency
2. To perform polarity test on single phase transformer.
3. To perform parallel operation of two single phase transformers.
4. To perform Sumpner's test.

5. To perform brake test on D.C. shunt motor.

6. To perform Load characteristics of D.C. series motor.

7. To perform speed control of D.C. shunt motor by flux control and armature voltage control method.

8. To study of different types of starters of DC motor.

9. To perform load test on three phase induction motor.

10. To perform the speed control of 3-phase slip ring induction motor by rotor resistance control method.

11. To perform no load & blocked-rotor test on 3-phase induction motor to determine the parameters of equivalent circuit and efficiency.

12. To perform no load & blocked rotor test on 3-phase induction motor and plotting of circle diagram from the test data.

**Note :**

**The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.**

**Industrial Visit:** Minimum one compulsory visit to either transformer or DC Machine Manufacturing Industry

**Course Activity (Any one of the following)**

For the assessment of course activity, a student must complete at least one activity out of the following

1.Chart preparation

2.V-Lab

| | | |
|---|---|---|
| Mr. A. V. Golande | Mrs. P. N. Jaiswal | Mrs. V. V. Deokate |
| PAC member 1 | PAC member 2 | PAC member 3 |

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| EL25212: Power Electronics | | |
|---|---|---|
| **Teaching Scheme:**<br>**TH: 03 Hrs/Week**<br>**PR: 02 Hrs/Week** | **Credits:04** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**In-Semester Exam: 30 Marks**<br>**End-Semester Exam: 60 Marks**<br>**Oral Exam: 30 Marks** |

**Prerequisite Courses:**

Knowledge of semiconductor material, basic electronics, diode, BJT and its characteristics, diode, rectifier, concept of rms and average value

**Course Objectives:**

1. To demonstrate circuits using Thyristor Power Devices and understand their operational characteristics and protection requirements.
2. To design AC to DC Converters including single-phase and three-phase configurations with various load types.
3. To apply DIAC and TRIAC in practical AC voltage control circuits and implement protection strategies for power circuits.
4. To evaluate Transistor Power Devices (MOSFET, IGBT, MCT) and determine suitable applications based on their characteristics and specifications.
5. To analyze DC to DC Converters using different control techniques and understand their operational principles and filtering requirements.
6. To analyze single-phase and three-phase inverter principles, VSI, and CSI configurations.

**Course Outcomes:**

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

CO1: Demonstrate circuits using Thyristor Power Devices and understand their operational characteristics and protection requirements.

CO2: Design AC to DC Converters, including single-phase and three-phase configurations with various load types.

CO3: Apply DIAC and TRIAC in practical AC voltage control circuits and implement protection strategies for power circuits.

CO4: Evaluate Transistor Power Devices (MOSFET, IGBT, MCT) and determine suitable

applications based on their characteristics and specifications.

CO5: Analyze DC to DC Converters using different control techniques and understand their operational principles and filtering requirements.

CO6: Analyze single-phase and three-phase inverter principles, VSI and CSI configurations.

**Unit I: Thyristor Power Devices:** **(6 Hrs)**

SCR: Static and dynamic Characteristics, specifications (Latching current, Holding current, dv/dt, di/dt, I2 t rating), Two-Transistor Analogy, Gate Characteristics, Trigering Circuits (R, R-C, UJT), Commutation, GTO.

**Unit II: AC to DC Converters (1 phase & 3 phase)** **(7 Hrs)**

Single-phase Converter (Half wave, Semi-converter, Full wave), three-phase (semi-controlled and fully controlled) converter with R, R-L, and RLE loads, Rectification and Inversion mode of operation, Concept of overlap Angle, and associated Voltage drop calculation, Dual converter, Selection of transformers and semiconductor devices for Converters, Numerical for R and RL Load only, Areas of application.

**Unit III: AC Voltage Controllers & Protection of Power Circuits** **(6 Hrs)**

(a) DIAC, TRIAC- four mode operation, triggering of TRIAC using DIAC; AC Voltage regulator principle, Single phase & three phase, analysis with R & RL Load, applications of two-stage, three-stage & multi-stage Voltage Controllers.

(b) Protection of Power Circuit: Protection from over voltage, over current, thermal, design of snubber circuit.

**Unit IV: Transistor Power Devices** **(6 Hrs)**

Characteristics, Specifications, Safe Operating Areas (SOA) Protection and Switching action of Power MOSFET, IGBT, MCT and their control circuit requirement, Comparison and Area of application of these devices.

**Unit V: DC to DC Converter** **(7 Hrs)**

The chopper's operation principle is a classification based on operating quadrants. Buck, Boost, Buck-Boost converter, their working, output waveforms, performance analysis, continuous

conduction mode, Control techniques: CLC, TRC, PWM, and FM Techniques. Analysis of Step-up Chopper, Numericals with RLE load. Areas of application.

**Unit VI: DC to AC Converters (Inverter)** **(7 Hrs)**

Single phase & three phase inverters, Principle of operation, VSI and CSI inverters, applications, their operating frequency range, PWM inverters: Single Pulse, Multiple Pulse and Sinusoidal Pulse modulation PWM Techniques for voltage control and harmonic elimination. Three phase VSI for $120^0$ and $180^0$ modes of operation and their comparison,

**Books & Other Resources:**

**Text Books:**


1. M.H.Rashid – "Power Electronics" 2nd Edition, Pearson publication
2. Ned Mohan, T.M. Undeland, W.P. Robbins – "Power Electronics",3rd Edition, John Wiley & Sons (International) student edition.
3. B.W. Williams: "Power Electronics" 2nd edition, Macmillan publication
4. Ashfaq Ahmed- "Power Electronics for Technology", LPE Pearson Edition.
5. Dr. P.S. Bimbhra, "Power Electronics", Third Edition, Khanna Publication.
6. K. Hari Babu, Power Electronics , Scitech Publication.


**Reference Books:**


1. Vedam Subramanyam –" Power Electronics" , New Age International , New Delhi
2. Dubey, Donalda, Joshi,Sinha, "Thyristorised Power controllers", Wiely Eastern New Delhi.
3. M. D. Singh and K. B. Khandchandani, "Power Electronics", Tata McGraw Hill
4. Jai P. Agrawal, "Power Electronics systems theory and design LPE", Pearson Education. Asia.
5. L. Umanand, "Power Electronics – Essentials & Applications" Wiley Publication.
6. Randall Shaffer – "Fundamentals of Power Electronics with Matlab".


**Online Resources:**

NPTEL course on Power Electronics by Prof. D.Prasad, Prof. N.K. De, Dr. D.Kastha, Prof. Sabyasachi Sengupta, IIT Kharagpur

**List of Practical (Any 8 experiments, however, three (03) simulation experiments should be covered using any professional software)**

1. To study V-I characteristics of SCR, DIAC, TRIAC. ( any two )
2. To study V-I characteristics of power semiconductor devices: GTO, MOSFET, IGBT. (any two)
3. To analyze the performance of the controlled converter with R and RL load.
4. To analyze the Three-phase AC-DC fully controlled bridge converter R and RL load performance.
5. To perform Power Quality Analysis (Harmonic and PF measurement) at the AC side of a phase-controlled Converter.
6. To perform Power Quality Analysis (Harmonic and PF measurement) at the AC side of the Three-phase phase-controlled Converter.
7. To study DC step-down chopper (PWM technique).
8. To study Single-phase A.C. voltage regulators with R and RL loads.
9. To study PWM controls of a single-phase inverter.
10. To verify the performance of the Three-phase voltage source inverter using $120^0$ and $180^0$ modes.
11. To verify the performance of a three-phase cascaded H-Bridge Multilevel inverter.
12. To perform Forced commutation circuits of SCR.

**(Note: The list of experiments is not limited to the above, but a course coordinator may design a few new experiments based on recent technologies/trends in the relevant Engineering Domain. However, the course coordinator needs to get approval from the Program Assessment Committee and Chairman BOS/HOD well in time.)**

**Course Activities (Any ONE of the following):**
For the assessment of Course Activity, a student must complete at least ONE activity out of the following:

1) Poster Presentation
2) Circuit Simulation/ Modelling

Mrs. P. N. Jaiswal — PAC Member 1

Mr. S. K. Raskar — PAC Member 2

Mrs. J. S. Kulkarni — PAC Member 3

VPKBIET BARAMATI Affiliated to S.P.P.U. Pune Id No./PU/PN/Engg./152/2000

| EL25213: Power System Engineering | | |
|---|---|---|
| **Teaching Scheme:**<br>**TH: 03 Hrs/Week** | **Credits:03** | **Examination Scheme:**<br>**Course Activity: 10 Marks**<br>**In-Semester Exam: 30 Marks**<br>**End-Semester Exam: 60 Marks** |

**Prerequisite Courses:**

Electrical Engineering Materials, Basic Electrical Engineering, Electrical Measurement and Instrumentation

**Companion Course, if any: Laboratory Practical**

**Course Objectives:**

1. To introduce students to the fundamental principles of Thermal power plant.
2. To understand the technological aspects of nuclear and diesel plant.
3. To explain the technical qualities of hydro power plant
4. To understand the important aspects of wind and solar energy system.
5. To analyse the important aspects of economics of power generation.
6. To analyse the basic structure of the electrical transmission system.

**Course Outcomes**

On completion of the course, learner will be able to:

CO-1: Identify components and elaborate working principles of thermal power plants.

CO-2: Explain the key components of a diesel power plant and basic principles of nuclear physics, including fission and fusion processes.

CO-3: Describe the basic principles of hydropower generation, including the conversion of potential energy from water into mechanical and electrical energy.

CO-4: Analyze the fundamental principles of wind energy and recognize the importance and opportunities of solar energy.

CO-5: Evaluate the economics of power generation and different factors associated with it.

CO-6: Analyze the basic structure of electrical transmission systems and different electrical terms related to them.

## Course Contents

**Unit I: Thermal Power Plant** **(6 Hrs)**

Thermal power plant site selection, Thermal power plant layout, Main parts and its working, Types of boilers (fire tube and water tube), Fuel handling, Ash disposal and collection, Basics of thermodynamic cycle.

**Unit II: Nuclear and Diesel Power Plant** **(6 Hrs)**

**A. Nuclear Power Plant:** Introduction, atomic physics, nuclear reaction, materials, site selection, nuclear reactors and working of each part, classification of nuclear reactor, nuclear waste disposal.

**B. Diesel Power Plant:** Main components and its working, Diesel plant efficiency and heat balance, Site selection of diesel power plant.

**Unit III: Hydro Power Plant** **(6 Hrs)**

Site selection, Hydrology, storage and pondage, general arrangements and operation of hydro power plant, Hydraulic turbines, turbine size, Pelton wheel turbine, Francis and Kaplan turbines, selection of turbines, Dams, Spillways, gates, intake and out take works, canals and layout of penstocks, water hammer and surge tank, Numerical based on total energy generated.

**Unit IV: Wind and Solar Energy Systems** **(7 Hrs)**

**A. Wind Energy:** Historical development of wind energy, types of wind turbine, Wind turbine generators, Environmental impacts of wind turbines. Change in wind turbine blades and its effect on generation. Control of wind turbine generator, Numerical based on wind energy.

**B. Solar Energy:** Photovoltaic effect. Solar thermal energy systems. Solar photovoltaic (PV) systems and PV current equation. Solar cell, solar module and solar array. Effect of series and parallel cells arrangement. Solar radiation and its measurement.

**Unit V: Economics of Power Generation** **(7 Hrs)**

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, Interconnected grid system, Introduction to tariff, Numerical based on load curve and finding different factors.

**Unit VI: Mechanical Design of Transmission System** **(7 Hrs)**

**A. Overhead Line Insulators:** Types of insulators, its construction and their applications such as Pin type, Suspension type, Strain type, Shackle type, Post insulators, Bushing. Potential distribution over suspension insulators, String efficiency, Methods of improving string efficiency

**B. Sag Calculations:** Main components of overhead lines, Various types of line supports, Conductor spacing, Length of span, Calculation of sag for equal and unequal supports and effect of ice and wind loading, Numerical based on sag calculation.

**Books & Other Resources:**

**Text Books:**


1. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publications.
2. Dr. P. C. Sharma, "Power Plant Engineering", S.K. Kataria Publications.
3. Chetan Singh Solanki "Solar Photovotaics: Fundamentals, Technology and Application" PHI Publications.
4. J. B. Gupta, "Transmission and Distribution", S. K. Kataria & Sons, New Delhi.
5. V. K Mehta, Rohit Mehta, "Principles of Power System", S Chand.


**Reference Books:**


1. Arora and Domkundwar, "A Course in Power Plant Engineering", DhapatRai Publication.
2. Dr. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publication.
3. Mukund Patel, "Wind and Solar Power Plants", CRC Press.
4. Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications.


**Course Activities (Any ONE of the following):**

For the assessment of Course Activity, a student must complete at least ONE activity out of the following:

1. Mini project/ working model/ prototype model of any power plant.
2. Case studies/ research paper reading of any power plant.

| Dr. H. M. Shaikh | Mr. D. S. Yeole | Mr. R. S. Tarade |
|---|---|---|
| Course Coordinator | PAC Member 1 | PAC Member 2 |

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