

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELEMENTS OF ELECTRICAL ENGINEERING

SUBJECT CODE: 2110005

B.E. 1<sup>st</sup> YEAR

**Type of course:** Engineering

**Prerequisite:** N.A.

**Rationale:** The course provides introductory treatment of the field of *Electrical Engineering* to the students of various branches of engineering.

### Teaching and Examination Scheme:

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Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE Viva (V)	PA (I)	
4	0	2	6	70	30*	30	20**	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

### Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	<b>D. C. Circuits:</b>	20	40%
a)	<b>Elementary Concepts:</b> Introduction of Electrical Current, Voltage, Power and Energy; Sources of Electrical Energy – Independent and Dependent Source, Source conversion; Ideal electrical circuit elements - Resistor, Inductor and Capacitor; Fundamental laws of electric circuits - Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits; Star – Delta conversion; Node and Mesh analysis.	08	15%
b)	<b>Electrostatics:</b> Electric charge and Laws of electrostatics; Definitions - Electric field, lines of force, electric field intensity, electric flux and flux density; Electrostatic induction; Gauss's law and its application; Dielectric strength; Capacitor; Capacitor in series and parallel, Energy stored in a capacitor.	04	10%
c)	<b>Electromagnetism:</b> Faradays Laws; Lenz's Law; Fleming's Rules; Effect of magnetic field on current carrying conductor; Magnetic circuits; Statically and dynamically induced EMF; Concepts of self inductance, mutual inductance and coefficient of coupling; Inductance in series and parallel; Hysteresis and Eddy current losses; Energy stored in magnetic fields.	08	15%
2	<b>A. C. Circuits :</b>	20	40%

a)	<b>Single Phase A.C. Circuits:</b> Generation of sinusoidal voltage, Definition of average value, root mean square value, form factor and peak factor; Phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, R-L, R-C and R-L-C circuits; Concepts of Real power, Reactive power, Apparent power and Power factor, Series, Parallel and Series - Parallel circuits; Power in AC circuit, Power factor improvement; Resonance in series and parallel circuits, Q-factor, Bandwidth and Selectivity.	12	25%
b)	<b>Three Phase A.C. Circuits:</b> Necessity and Advantages of three phase systems, Generation of three phase power, Phase sequence, Balanced supply and Balanced load; Relationship between line and phase values of balanced three phase circuit; Power Measurement in balanced three phase circuits.	08	15%
<b>3</b>	<b>Batteries, wiring, illumination &amp; electrical safety:</b>	<b>08</b>	<b>20%</b>
a)	<b>Batteries and Fuel Cell:</b> Introduction of Batteries; The Simple cell, E.M.F and internal resistance of a cell; Primary and Secondary cells, Cell capacity; Types & Specifications of Batteries; Charging & Discharging of Battery; Safe disposal of Batteries; Fuel cell: Principle & Types of fuel cell.	02	05%
b)	<b>Electrical Wiring:</b> Types of wires and cables; Types of Connectors & Switches; System of wiring, domestic and industrial wiring; Simple control circuit in domestic installation.	02	05%
c)	<b>Illumination:</b> Types of lamps, fixtures & reflectors; Illumination schemes for domestic, industrial & commercial premises; Lumen requirements for different categories.	02	05%
d)	<b>Safety &amp; protection:</b> Safety precautions in handling electrical appliances; Electric shock, First aid for electric shock other hazards of electrical laboratories & safety rules; Grounding & Earthing - Importance of grounding and earthing, equipment for grounding, Methods of earthing; Circuit protection devices: Fuses, MCB, ELCB & Relays.	02	05%

#### Reference Books:

1. B.L. Theraja (2012), Electrical Technology, Vol – 1, S. Chand.
2. D.P. Kothari and I.J. Nagrath (2013), Theory and Problems in Basic Electrical Engineering, Prentice Hall, India.
3. John Bird (2012), Electrical Circuit Theory and Technology, Forth edition, Routledge, Taylor and Francis Group.
4. Parker Smith (2003), Problems in Electrical Engineering, CBS Publishers.
5. Surinder P Bali (2013), Electrical Technology, Vol – I, Pearson
6. V. N. Mittal and A. Mittal (2012), Basic Electrical Engineering, Tata McGraw Hill.
7. Vincent Del. Toro (2012), Principles of Electrical Engineering, Prentice Hall, India

8. Surjit Singh, Electrical Estimating & costing, Dhanpat Rai & Co.
9. S.G. Tarnekar, A Textbook of Laboratory Course in Electrical Engineering, S. Chand Publications.
10. S. Rao, Electrical Safety, Fire Safety Engineering, Khanna Publications.
11. David A Bell, Laboratory Manual for Electric Circuits, Prentice- Hall, India.

### **Course Outcome:**

After learning the course the students should be able to:

1. Understand electrical current, potential difference, power and energy, sources of electrical energy, resistance and its behavior with temperature.
2. Use the Ohm's Law and the Kirchhoff's Law and star delta transformation for solving resistive series, parallel and series-parallel circuits.
3. Define Electric field, lines of force, electric field intensity, electric flux, flux density and permittivity. Capacitor, charging and discharging phenomena of capacitors and calculations of capacitance for capacitors connected in series and parallel circuits.
4. Describe the magnetic field, Faradays Laws; Lenz's Law; Fleming's Rules. Flux density, permeability, the Effect of magnetic field on current carrying conductor. Perform calculation of Magnetic circuits. Concept of statically and dynamically induced EMF, self-inductance, mutual inductance and coefficient of coupling.
5. Understand the B-H curve, Hysteresis loop and Eddy current losses. Calculate the Energy stored in magnetic fields.
6. Understand AC Quantities, the mathematical operation on AC waveforms, Draw phasor diagram and waveforms for purely resistive, purely inductive and purely capacitive as well as series and parallel R-L-C circuits and also circuit Resonance and Q-factor and derive resonance frequency for such circuits.
7. Understand Concepts of Real power, Reactive power, apparent power and Power factor and perform calculations of these quantities for series and parallel R-L-C circuits.
8. Describe three phase supply and its advantages. Understand the star and delta connection and their relationships. Draw phasor diagram for balanced and unbalanced three phase circuit. Calculate power and it's measurement by wattmeter.
9. Understand the principle of battery, construction of simple cell. Define the terms internal resistance of a cell, different types of batteries with specifications and its applications. The charging and discharging of the batteries. Fuel cell and their likely future applications.
10. Understand the different types of wires, cables, connectors & switches used for wiring Different types of domestic and industrial wiring.
11. Identify and use of different type of lamps, fixtures & reflectors, Understand the different types of illumination schemes and lumen requirements for different categories.
12. Understand the importance of safety and the precaution to be taken while working with electrical equipments and accessories. Understand the working principle, usage and construction of circuit protection devices such as fuse, MCB, ELCB & Relays.
13. Understand importance of electrical earthing and grounding.

### **List of Experiments:**

1. General introduction to Electrical Engineering Laboratory, experimental set-ups, instruments etc... and to study the standard symbols used for electrical diagram representation.

#### **Based on Module (1)**

2. To observe the effect of temperature on Resistance of metal.

3. Verification of Kirchhoff's Voltage Law and Kirchhoff's Current Law for AC and DC circuits;
4. To study the Capacitors in series and parallel DC circuit.
5. To plot the magnetizing characteristic and study the hysteresis loop for a magnetic material on CRO.

#### **Based on Module (2)**

6. To obtain inductance, power and power factor of the Series R-L circuit with AC supply using Phasor diagram.
7. To obtain capacitance, power and power factor of the Series R-C circuit with AC supply using Phasor diagram.
8. To obtain inductance, capacitance, power and power factor of the Series R-L-C circuit with AC supply using Phasor diagram.
9. Determination of Resonant frequency, Bandwidth and Q factor for RLC network in Series and Parallel resonance.
10. Verification of current and voltage relations in three phase balanced Star and Delta connected loads.
11. Measurement of active and reactive power in balanced 3-phase circuit using two-watt meter method.

#### **Hands on Practice for Electrical Workshop**

#### **Based on Module (3)**

1. Wiring Exercise
  - i) Study of various wiring components i.e. wires, switches, fuses, sockets, plugs lamp holders etc... their uses and ratings.
  - ii) Control of two lamps from two switches (looping in system).
  - iii) Staircase wiring.
  - iv) Study of fluorescent tube circuit, compact fluorescent lamp (CFL) and light emitting diode (LED).
  - v) Study of HID lamps such as mercury-vapour lamp/sodium- vapour lamp circuit.
2. Study of safety precaution while working on electric installations.
3. To study the basic methods of Earthing.

\*PA (M): 10 marks for Active Learning Assignments, 20 marks for other methods of PA

ACTIVE LEARNING ASSIGNMENTS: (i) Preparation of videos for showing real life applications, Preparation of animations for understanding the concepts, Preparation of Pictures with annotations to explain the concepts.

(ii) Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus of Elements of Electrical Engineering is covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be sent to [achievements@gtu.edu.in](mailto:achievements@gtu.edu.in).

\*\* PA (I): 10 marks for a case study of Systems, 10 marks for other methods of PA.

The case study of Systems: The case study should be of a working EE system, which shows the working of the concepts, included in the Syllabus.