

3.3 ELECTRICAL MEASUREMENT & INSTRUMENTATION

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RATIONALE

Diploma holders in Electrical Engineering have to work on various jobs in the field as well as in testing laboratories and on control panels, where he performs the duties of installation, operation, maintenance and testing by measuring instruments. Persons working on control panels in power plants, substations and in industries will come across the use of various types of instruments and have to take measurements. Instruments used to read and observe the general electrical quantities like current, voltage, power, energy, frequency, resistance etc and their wave shapes, have been incorporated in this subject.

COURSE OUTCOMES

After undergoing the subject, student will be able to:

- CO1: Comprehend how different types of meters work and their construction.
- CO2: Apply their knowledge to measure electrical quantities using standard analog and digital measuring instruments.
- CO3: Measure different electrical parameters using measuring instruments and interpret the data.
- CO4: Measure frequency, phase with Oscilloscope and DSOs.
- CO5: Describe the working principle, selection criteria and applications of various transducers used in measurement systems.

DETAILED CONTENTS

UNIT I

Measurements of Voltage and Current

- 1.1 Significance of measurement, errors in measurement, types of error, Classification of measuring instruments: indicating, recording and integrating instruments; Essential requirements of an indicating instruments.

- 1.2 Concept of Ammeter, voltmeter, ammeter, construction, working principle, merits, demerits and comparison of moving coil, moving iron meter, rectifier type – Extension of range and calibration of voltmeter and ammeter – Errors and compensation..

UNIT II

Measurement of Power and Electrical Energy

- 2.1 Construction, working principle, merits and demerits of dynamometer wattmeter, Digital wattmeter, Active and reactive power measurement by , two and three wattmeter method. Effect of Power factor on wattmeter reading in two wattmeter method, Maximum Demand indicator.
- 2.2 Construction, working principle, merits and demerits of single-phase and three-phase energy meters (Induction type), Errors and their compensations, Calibration of energy meter using direct loading. Digital energy meter (diagram, construction and application).

UNIT III

Measurement of other Instruments

- 3.1 Construction, working principle and application of Meggar, Earth tester (analog and digital), multi-meter (analog and digital), Frequency meter (dynamometer type), single power factor meter (Electrodynamometer type). Working principle of synchroscope and phase sequence indicator, tong tester (Clamp-on meter), Study of LCR meters and their applications .Construction, working and applications of CT and PT.
- 3.2 Cathode Ray Oscilloscope: Block diagram, working principle of CRO and its various controls. Digital Storage Oscilloscope (DSO).

UNIT IV

Transducer

- 4.1 Introduction, Types of Transducers, Construction and principle of resistive transducer-Potentiometer –variac and strain gauges -No derivation. Only definition and formula for gauge factor, Types of strain gauges like unbonded, bonded and semiconductor. Construction and principle of Inductive transducers-L.V.D.T. and R.V.D.T, their applications.
- 4.2 Construction, principle and applications of transducers – Piezoelectric transducer, photo-conductive cells, photo voltaic cells.

UNIT V

Measurement of Non-Electrical Quantities

- 5.1 Temperature measurement - Construction and Working of RTD, Thermistor and Thermocouple, radiation pyrometer, technical specifications and ranges. Thermal Imager Camera (Concept).
- 5.2 Pressure measurement – Construction and working of bourdon tube, bellow diaphragm strain gauge. Measurement of pH Level.

PRACTICAL EXERCISES

1. Use of analog and digital multimeter for measurement of voltage, current (A.C/D.C) and resistance.
2. To measure the value of earth resistance using earth tester.
3. To measure power, power factor in a single-phase circuit, using wattmeter and power factor meter and to verify results with calculations.
4. Measurement of power and power factor of a three-phase balanced load by two wattmeter method.
5. Measurement of voltage and frequency of a sinusoidal signal using CRO and draw wave shape of signal.
6. Measurement of power in a 3 phase circuit using CT, PT and 3-phase wattmeter.
7. Use of LCR meter for measuring inductance, capacitance and resistance.
8. To record all electrical quantities from the meters installed in the institution premises.
9. To measure Energy at different Loads using Single Phase Digital Energy meter.
10. Calibration of single phase and three-phase energy meter.
11. Measurement of pressure by using LVDT.
12. To measure temperature using a thermo-couple
13. Measurement of temperature by using thermister/Thermal Imager.
14. To measure the strain using electrical strain gauge
15. To measure the pH level using pH meter.

RECOMMENDED BOOKS

1. A.K. Sawhney, "Electric and Electronic Measurement and Instrumentation", Dhanpat Rai and Co. Author, 2014.
2. C.S Rangan, G.R.Sharma. and V.S.V.Mani, "Instrumentation Devices and System", Pen Ram International Publishing India Pvt. Ltd., Fifth Edition.