

## EE-3002 ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

### COURSE OBJECTIVE

The primary objective of the course is to introduce operation principles of instruments, terminology related to measurements and to have an adequate knowledge in measurement techniques for voltage, current, power and energy.

### COURSE CONTENT

Introduction, History and overview of measurement system, Fundamentals of Measurement system, Static and Dynamic Characteristics of measurement systems: Systematic Characteristics, Generalized model, Transfer function, Techniques for dynamic compensation, Accuracy of measurement systems in steady state: Measurement error, Error probability function, Error reduction techniques, Reliability, Choice and Economics of measurement systems. Loading effects due to shunt connected and series connected instruments, calibration curve, Testing & calibration of instruments.

**Galvanometers** – Theory, principle of operation and construction of ballistic galvanometer, D'Arsonval galvanometer, Definition of analog & digital instruments, Classification of analog instruments, their operating principle, Operating force, Types of supports, Damping, Controlling.

**Different types of Ammeter & Voltmeter** – PMMC, MI, Electrodynamometer, Induction, Expression for control & deflection torque, their advantages, disadvantages & error, Extension of range of instruments using shunt & multiplier.

Digital Voltmeter, Ammeter, Multimeter and Wattmeter.

**Instrument transformers:** Potential and current transformers, ratio and phase angle errors, testing of instrument transformers, Difference between CT and PT, errors and reduction of errors.

**Measurement of power:** Power in AC and DC Circuit, Electrodynamometer type of wattmeter, Construction, theory, operation & error, Low power factor & UPF wattmeter, Double element and three element dynamometer wattmeter, Measurement of power in three phase circuit, one, two & three wattmeter method, Measurement of reactive power by single wattmeter, Measurement of power using CTs & PTs.

**Measurement of Energy:** Single phase and three phase digital / Electronic energy meter – construction & operation – Energy flow and power calculations, errors – Testing by phantom loading, Tri-vector meter, Maximum demand meter, Ampere hour meter.

**Power factor meter**– Single phase and three phase Electro-dynamometer type & moving iron type. **Frequency meter** – Vibrating reed, Resonance type & Weston type, Synchronoscope,

**Ohmmeter** –series & stunt type, Megger & Ratio meter.

**Resistance Measurement** – Classification of low, medium & high resistance – Voltmeter-Ammeter method, Wheatstone Bridge, Kelvin's double bridge & loss of charge methods for resistance measurement, Earth resistance measurement.

**Magnetic Measurement** – B-H Curve, Hysteresis Loop determination, Power loss in sheet metal – Lloyd Fischer square for measurement of power loss.

### Text book:-

1. A.K. Sawhney; 'A course in Electrical & Electronic Measurements & Instrumentation'; Dhanpat Rai & co(p) Ltd ,New Delhi

### Reference books:-

1. G. K. Banerjee, 'Electrical and Electronic Measurements'. PHI Learning Pvt.Ltd.
2. R. B. Northrop, 'Introduction to Instrumentation and Measurement'; CRC press Taylor & Francis
3. Vijay Singh; 'Fundamentals of Electrical & Electronic Measurements', New Age International Publishers.

## **COURSE OUTCOME:**

1. After successful completion of course, Students are expected to possess an in-depth understanding and Knowledge of the concepts and principles of measurement of electrical and non electrical viz. physical quantities and instruments.

## **EVALUATION**

Evaluation will be continuous an integral part of the class as well through external assessment. Laboratory assessment will be based on external assessment, assignments, presentations, and interview of each candidate.

## **Topics for the laboratory (Expandable):**

1. Measurement of low resistance using Kelvin's Double bridge
2. Measurement of medium resistance using Wheatstone's bridge
3. Measurement of high resistance by loss of charge method
4. Measurement of Insulation resistance using Megger
5. Measurement of earth resistance by fall of potential method and verification by using earth tester
6. Measurement of power in a single phase ac circuit by 3 voltmeter/ 3 Ammeter method
7. Calibration of a dynamometer type of wattmeter with respect to a standard/Sub Standard wattmeter
8. Calibration of single phase digital/ Electronic type energy meter.
9. Calibration of a dynamometer type of wattmeter by Phantom Loading method.
10. Measurements using Instrument Transformers.
11. Study of various types of Indicating Instruments.
12. Measurement of Power in three phase circuit by one, two & three wattmeters.