

III Year – I SEMESTER

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ELECTRICAL MEASUREMENTS**Preamble:**

This course introduces principle of operation of basic analog and digital measuring instruments for measurement of current, voltage, power, energy etc. Measurement of resistance, inductance and capacitance by using bridge circuits will be discussed in detail. It is expected that student will be thorough with various measuring techniques that are required for an electrical engineer.

Learning Objectives:

- To study the principle of operation and working of different types of instruments. Measurement of voltage and current.
- To study the working principle of operation of different types of instruments for measurement of power and energy.
- To understand the principle of operation and working of dc and ac potentiometers.
- To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.
- To study the principle of operation and working of various types of magnetic measuring instruments.
- To study the applications of CRO for measurement of frequency, phase difference and hysteresis loop using Lissajous patterns.

UNIT-I:**Measuring Instruments**

Classification – Deflecting, control and damping torques – Ammeters and Voltmeters – PMMC, moving iron type, dynamometer and electrostatic instruments – Expression for the deflecting torque and control torque – Errors and compensations– Extension of range using shunts and series resistance – CT and PT: Ratio and phase angle errors – Design considerations.

UNIT –II:**Measurement of Power and Energy**

Single phase and three phase dynamometer wattmeter – LPF and UPF – Expression for deflecting and control torques – Extension of range of wattmeter using instrument transformers – Measurement of active and reactive powers in balanced and unbalanced systems – Type of P.F. Meters – Single phase and three phase dynamometer and moving iron type Single phase induction type energy meter – Driving and braking.

torques – errors and compensations –Testing by phantom loading using R.S.S. meter– Three phase energy meter – Tri vector meter – Maximum demand meters– Electrical resonance type frequency meter and Weston type synchroscope.

UNIT – III:**Potentiometers**

Principle and operation of D.C. Crompton's potentiometer – Standardization – Measurement of unknown resistance – Current – Voltage – AC Potentiometers: polar and coordinate types –Standardization – Applications.

UNIT – IV:**Measurements of Parameters**

Method of measuring low, medium and high resistance – Sensitivity of Wheat stone's bridge – Carey Foster's bridge– Kelvin's double bridge for measuring low resistance– Loss of charge method for measurement of high resistance – Megger– Measurement of earth resistance – Measurement of inductance – Quality Factor – Maxwell's bridge–Hay's bridge – Anderson's bridge–Measurement of capacitance and loss angle – Desautybridge – Schering Bridge–Wagner's earthing device–Wien's bridge.

UNIT – V:**Magnetic Measurements**

Ballistic galvanometer – Equation of motion – Flux meter – Constructional details–Determination of B–H Loop methods of reversals six point method – AC testing – Iron loss of bar samples– Core loss measurements by bridges and potentiometers.

UNIT – VI:**Digital Meters**

Digital Voltmeter–Successive approximation – Measurement of phase difference – Frequency – Hysteresis loop using lissajious patterns in CRO –

Ramp and integrating type–Digital frequency meter–Digital multimeter–Digital Tachometer.

Learning Outcomes:

- Able to choose right type of instrument for measurement of voltage and current for ac and dc.
- Able to choose right type of instrument for measurement of power and energy – able to calibrate energy meter by suitable method
- Able to calibrate ammeter and potentiometer.
- Able to select suitable bridge for measurement of electrical parameters
- Able to use the ballistic galvanometer and flux meter for magnetic measuring instruments
- Able to measure frequency and phase difference between signals using CRO. Able to use digital instruments in electrical measurements.

Text Books:

1. Electrical Measurements and measuring Instruments – by E.W. Golding and F.C.Widdis, fifth Edition, Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques – A.D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.
3. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co. Publications.
2. Electrical Measurements – by Buckingham and Price, Prentice – Hall
3. Electrical Measurements by Forest K. Harris. John Wiley and Sons
4. Electrical Measurements: Fundamentals, Concepts, Applications – by Reissland, M.U, New Age International (P) Limited, Publishers.
5. Electrical and Electronic Measurements –by G.K.Banerjee, PHI Learning Private Ltd., New Delhi–2012.