

203144: Electrical Measurements and Instrumentation

Teaching Scheme
Th : 04 Hrs/ Week
PR : 02 Hrs/ Week

Credits
Th/Tut: 04
PR:01

Examination Scheme [Marks]
In Sem (Online) : 50 Marks
End Sem : 50 Marks
Practical : 50 Marks
Term Work : 25 Marks

Course Objective:

- To provide the knowledge of system of units, classification and essentials of measuring instruments.
- To get the knowledge about the construction & operation of various electrical & non electrical measuring instruments.
- To apply the knowledge to identify the measuring instruments & make use of it for quantifying measurements of electrical parameters.

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

- Understand various characteristics of measuring instruments, their classification and range extension technique.
- Classify resistance, apply measurement techniques for measurement of resistance, inductance.
- Explain construction, working principle and use of dynamometer type wattmeter for measurement of power under balance and unbalance condition.
- Explain Construction, working principle of 1-phase and 3-phase induction, static energy meter and calibration procedures.
- Use of CRO for measurement of various electrical parameters, importance of transducers, their classification, selection criterion and various applications.
- Measurement of various physical parameters using transducers.

Unit 01 :

(9 Hrs)

A. Classification of 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 / digital.

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) (attraction and repulsion), and Permanent Magnet Moving Coil (PMMC), block diagram and operation of digital ammeter & voltmeter.

B. Range Extension: PMMC ammeters and voltmeters using shunts, multipliers. Universal shunt, universal multiplier. Instrument Transformers : Construction, connection of CT & PT in the circuit, advantages of CT / PT over shunt and multipliers for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, burden, ratio and phase angle error.(descriptive treatment only)

Unit 02 :

(8 Hrs)

A. Measurement of Resistance: Measurement of low, medium and high resistance. Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, megger, **loss of charge method**. Earth tester for earth resistance measurement.

B. Measurement of Inductance: Introduction, sources and detectors for A.C. bridge, general equation for bridge at balance. Measurement of inductance: Maxwell's inductance & Maxwell's inductance – Capacitance Bridge, Anderson's bridge.

Unit 03 : (8 Hrs)

Measurement of Power: 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. Power analyzer, Multi meter.

Unit 04 : (7 Hrs)

Measurement of Energy: Construction, working principle, torque equation, errors and adjustments of single phase conventional (induction type) energy meter. Calibration of energy meter. Block diagram and operation of electronic energy meter. Three phase energy meter, TOD meter.

Unit 05 : (8 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 & numerical. Introduction to DSO.
- B. Transducers:** Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers.
- C. Pressure Measurement:** Introduction, classification of pressure as low, medium & high, absolute, gauge, vacuum, static, dynamic & head pressure. High pressure measurement using electric methods, low pressure measurement by McLeod gauge and pirani gauge, capacitive pressure transducer.

Unit 06 : (8 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, application, null voltage, specifications, advantages & disadvantages, effect of frequency on performance.
- C. Strain Gauge:** Introduction, definition of strain, types of strain gauge: Wire strain gauge, foil strain gauge, semiconductor strain gauge etc.; their construction, working, advantages and disadvantages.

Guidelines for Instructor's Manual

- The instructor's manual is to be developed as a hands-on resource and reference.
- The instructor's manual need to include prologue (about University / program / institute / department / foreword / preface etc), University syllabus, conduction & Assessment guidelines, topics under consideration- concept, objectives, outcomes, list of experiments, references etc.
- The feedback seeking sheet for enhancement of instructor's manual may be added as annexure.

Guidelines for Student's Lab Journal

- The laboratory experiments are to be submitted by student in the form of journal.
- Journal consists of prologue, Certificate, table of contents, and write-up of each experiment (Title, Objectives, Outcomes, List of apparatus, Circuit diagram, Theory, Observation Table, Sample Calculation, Result Table, Conclusion / Analysis, exercises - MCQs, assignments, Date of Completion, Assessment grade and assessor's sign with date).

Guidelines for Lab /TW Assessment

- Each experiment will be assigned grade based on parameters with appropriate weightage.
- Suggested parameters include- timely completion, performance, innovation, punctuality and neatness.

Guidelines for Laboratory Conduction

- The instructor is expected to shortlist necessary experiments from the suggested list of experiments. During the practical session the instructor may divide the total students in groups of 4 to 5 students and assign them with different experiments to be performed.
- Proper safety instructions and demonstration of the experiment is to be given before asking the students to perform the experiment. The experiment is carried out by the students under the supervision of the instructor.
- The instructor should take utmost care towards safety of the students, self and other hazards that may be caused by improper operation of the equipment.
- The instructor may also design an experiment which is relevant to the subject and beyond the scope of syllabus.

List of Experiments:

Compulsory Experiments: (06) Six.

1. Demonstration of working parts of various types of meter by opening the instrument & explanation of symbols & notations used on instruments.
2. Extension of instrument range: ammeter, voltmeter, watt meter using CT & PT.
3. Measurement of active & reactive power in three phase circuit using two wattmeter methods (balanced & unbalanced loads).
4. Measurement of active & reactive power in three phase balanced circuit using one wattmeter method with two way switch.
5. Calibration of single phase static energy meter at different power factors.
6. Measurement of voltage, current, time period, frequency & phase angle using CRO.

Any four experiments are to be conducted of following experiments:

1. Measurement of reactive power by one wattmeter with all possible connections of current coil and pressure coil.
2. Measurement of power in three phase, four wire system using three CTs & two wattmeter.
3. Calibration of single phase wattmeter at different power factors.
4. i) Measurement of resistance by ammeter voltmeter method.
ii) Measurement of low resistance using Kelvin's double bridge.
5. Measurement of inductance using Anderson's bridge/ Maxwell's bridge.

6. Displacement measurement by LVDT.
7. Electrical methods for measurement of liquid level.

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

Text Books:

- [T1] A. K. Sawhney, “A Course in Electrical and Electronic Measurements & Instrumentation” Dhanpat Rai & Co.
- [T2] J. B. Gupta, “A Course in Electronics and Electrical Measurements and Instrumentation” S. K. Kataria & Sons,
- [T3] R. K. Jain, “Mechanical and Industrial Measurements” Khanna Publishers.
- [T4] B. C. Nakra & K. K. Chaudhari, “Instrumentation Measurement and Analysis”, Tata McGraw Hill.

Reference Books:

- [R1] E. W. Golding & F. C. Widdies, “Electrical Measurements & Measuring Instruments” Reem Publications.
- [R2] Dr. Rajendra Prasad, Electronic Measurements & Instrumentation, Khanna Publishers
- [R3] Arun K. Ghosh, “Introduction to Measurements and Instrumentation, PHI Publication
- [R4] M. M. S. Anand “Electronics Instruments and Instrumentation Technology” by, PHI Publication.

Unit	Text Books	Reference Books
1	T1,T2,T3,T4	R1,R2,R3,R4
2	T1,T2	R1,R4
3	T1,T2	R1,R2
4	T1,T2	R1,R2
5	T1,T2,T3,T4	R2,R3,R4
6	T1,T2,T3	R2,R3