ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

IV Semester: EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AEE008	**Core**	**3**	**2**	**-**	**4**	**30**	**70**	**100**
Contact Classes: 45	**Tutorial Classes: 15**	**Practical Classes: Nil**				**Total Classes: 60**		

OBJECTIVES:

The course should enable the students to:

I Demonstrate the construction, working and characteristics of electrical measurement instruments.

II Illustrate the principles of energy measurement in electrical loads.

III Outline the use of cathode ray oscilloscope.

IV Evaluate various transducers for electrical measurement

CLOURSE LEARNING OUTCOMES (CLOs):

At the end of the course, the student will have the ability to:

1. Identify various effects on measuring instruments used to measure electrical quantity.
2. Compare PMMC and MI instruments in view of construction, extension range and various errors.
3. Explain the instruments works on electrostatic effect principle.
4. Construct the potentiometer to measure the small voltages and discuss the importance of standardization in instruments.
5. Use Potentiometer applications in measurement of voltage, current, resistance and power.
6. Distinguish between current transformer and potential transformer.
7. Analysis of ratio error and phase angle error in instrument transformers.
8. Demonstrate the construction and operation of single phase wattmeter and three phase wattmeter.
9. Identify the best method for the measurement of active and reactive powers in balanced, unbalanced system.
10. Generalize the importance of induction effect in the working of energy meter and also describe the energy meter calibration.
11. Compute the unknown resistance using various DC bridges.
12. Predict the unknown inductance and its quality factor using different types of AC bridges.
13. Estimate the capacitance between two conducting surfaces using various AC bridges.
14. Define the transducers and classify the transducers based on measurement of electrical quantities.

15.	Design a suitable transducer for the measurement of displacement, pressure, resistances, capacitance, speed and position.
16.	Summarize the features, application and various working models of cathode ray oscilloscope.
17.	Explain the measurement of phase angle and frequency of various electrical quantities.
18.	Apply the concept of electromagnetic and electrostatic fields to solve real time world applications.
19.	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations.

Unit-I	**INTRODUCTION TO MEASURING INSTRUMENTS**
Introduction: Classification of measuring instruments, deflecting, damping and control torques, types of errors, ammeter and voltmeter: PMMC, MI instruments, expression for deflection and control torque, errors and compensation, extension of range using shunts and series resistances; Electro static voltmeter, electro dynamic type, attracted type, disc type, extension of range of ES voltmeters..	
Unit-II	**POTENTIOMETERS AND INSTRUMENT TRANSFORMERS**
DC Potentiometers: Principle and operation of Crompton potentiometer, standardization, measurement of unknown resistance, current, voltage; AC potentiometers: polar and coordinate type, standardization, applications; Instrument transformers: CT and PT, ratio and phase angle error.	
Unit-III	**MEASUREMENT OF POWER AND ENERGY**
Measurement of Power: Single phase dynamometer type wattmeter, LPF and UPF, double elements and three elements dynamometer wattmeter; Expression for deflection and control torque, extension of range of wattmeter by using instrument transformers, measurement of active and reactive power for balanced and unbalanced Systems. Measurement of Energy: Single phase induction type energy meter, driving and braking torques, errors and compensations, testing by phantom loading using RSS meter, three phase energy meter, introduction to net energy metering , maximum demand meters.	
Unit-IV	**DC AND AC BRIDGES**
Measurement of Resistance: Methods of measuring low, medium, high resistance, Wheatstone bridge, carry foster, Kelvin's double bridge, loss of charge method; Measurement of Inductance: Maxwell's bridge, hay's bridge , Anderson's bridge, Owen's bridge; Measurement of Capacitance: Desauty's bridge, Wein's bridge, Schering bridge.	
Unit-V	**TRANSDUCERS AND OSCILLOSCOPES**
Transducers: Definition of transducers, classification of transducers, advantages of electrical transducers, characteristics and choice of transducers, principle of operation of LVDT and capacitor transducers, LVDT applications, strain gauge and its principle of operation, gauge factor, thermistors, thermocouples, synchros, piezo-electric transducers, photovoltaic, photo conductive cells, photo diodes; Cathode ray oscilloscope: cathode ray tube, time base generator, horizontal and vertical amplifiers, CRO probes, applications of CRO, measurement of phase and frequency, Lissajous patterns, sampling oscilloscope, analog oscilloscope, tubeless	

Text Books:

1. A K Sawhney, "Electrical and Electronic measurement and instruments", Dhanpat Rai and Sons Publications, 2002.
2. E W Golding and F C Widdis, "Electrical measurements and measuring instruments", Wheeler publishing, 5th Edition, 2006.

Reference Books:

1. Buckingham and Price, "Electrical measurements", Prentice Hall, 1nd Edition, 2000.
2. D V S Murthy, "Transducers and Instrumentation", Prentice Hall of India, 2nd Edition, 2009.
3. A S Morris, "Principles of measurement of instrumentation", Pearson/Prentice Hall of India, 2nd Edition, 1994.
4. H S Kalsi, "Electronic Instrumentation", Tata McGraw-Hill Publications, 1st Edition 1995.