ELECTRICAL MEASUREMENTS AND INSTRUMENTATION (Integrated)

Course Code:19EE117

L	T	P	C
2	0	2	3

Prerequisites: Electrical Circuit Analysis, Electronic Devices and Analog Circuits, Digital Electronics, Signals and Systems

Course Outcomes: At the end of the course, the student will be able to

CO 1: Summarize the working principles of various electrical measuring instruments & Instrument Transformers
CO 2: Illustrate the working of different meters for measurement of Power, Power Factor and Energy.
CO 3: Estimate the values of unknown resistance, inductance and capacitance using bridges.
CO 4: Explain the working of different Transducers and Digital Voltmeters.
CO 5: Demonstrate the concepts of Virtual Instrumentation.

UNIT-I 8 Lectures

MEASURING INSTRUMENTS AND INSTRUMENT TRANSFORMERS

Measuring Instruments: PMMC and MI Instruments, Construction, Torque Equation, Range Extension, Effect of temperature, Classification, Errors, Advantages and Disadvantages, Numerical Problems.
Instrument Transformers: Current Transformer and Potential Transformer - construction, theory, phasor diagram, errors and applications.

Learning Outcome: At the end of the unit, the student will be able to

1. Explain the working principle of basic analog instruments / Understand the different errors in a measuring instrument (L2)
2. Apply the concept of Shunt and Series resistances for extension of measuring range of Meters (L3).
3. Illustrate the working of an Instrument Transformer (L2).

UNIT-II 7 Lectures

ANALOG WATTMETERS, POWER FACTOR METERS AND ENERGY METER

Electrodynamometer type wattmeter, power factor meter - Construction, theory, torque equation, Advantages and disadvantages, active and reactive power measurement in single phase, Measurement in three phase.

Analog Energy Meter: Single phase induction type energy meters, construction, theory, Operation, lag adjustments, Max Demand meters/indicators.

Learning Outcome: At the end of the unit, the student will be able to

1. Explain the working principle of a Wattmeter and Power Factor meter (L2)
2. Demonstrate the measurement of Active and Reactive Power in three phase circuits (L2)
3. Describe the working of an Energy meter (L2)

UNIT-III 7 Lectures

DC AND AC BRIDGES

Measurement of resistance - Wheatstone Bridge, Kelvin's Double Bridge, loss of charge method for measurement of high resistance, Measurement of inductance, Capacitance - Maxwell's Bridge,

De-Sauty's Bridge, Anderson Bridge, Schering Bridge, Wien Bridge, Applications and Limitations, Numerical Problems.

Learning Outcome:

1. Classify the bridges and calculate the different unknown resistances (L3).
2. Classify the bridges and calculate the unknown inductance (L3).
3. Calculate the unknown capacitance with bridges (L2).

UNIT-IV 6 Lectures

ELECTRONIC INSTRUMENTS AND TRANSDUCERS

Electronic Instruments: Digital Voltmeters, CRO, measurement of phase and frequency, Lissajous Patterns.

Transducers: Measurement of Temperature, RTD, Thermistors, Thermocouple, LVDT, Strain Gauge, Piezoelectric Transducers, Digital Shaft Encoders, Tachometer, Hall effect sensors.

Learning Outcome:

1. Illustrate the working of a Digital Voltmeter (L2).
2. Analyze the phase and frequency using Lissajous Patterns (L4).
3. Explain the operation of various Transducers and their applications. (L2)

UNIT-V 8 Lectures

INTRODUCTION TO VIRTUAL INSTRUMENTATION

Virtual Instrumentation, Advantages, Architecture of a virtual instrument, data-flow techniques, graphical programming, Virtual Instruments versus Traditional Instruments, Virtual Instruments use in Engineering Applications. Sampling and signal conditioning of analog signals using current/ voltage/ temperature / torque sensors and transducers.

Virtual Instrument, sub virtual instruments, Introduction to data acquisition, Sampling fundamentals, ADC, DAC, Digital I/O, counters and timers, Direct Memory Access.

Learning Outcome:

1. Explain the concepts of Virtual Instrumentation.(L2)
2. Compare between Virtual Instruments and Traditional Instruments.(L5)
3. Outline the concepts of data acquisition. (L2)

TEXT BOOKS:

1. A. K. Sawhney- "*A course in Electrical Measurements Electronic Measurements and Instrumentation*"- Dhanpat Rai and Co., 5th Edition, 2015. (Unit –I to IV).

2. S. Gupta and J. John, *"Virtual Instrumentation using LabVIEW"*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010. (Unit - V)

REFERENCES:

1. W.D. Coopers and Helfrick, "*Modern Electronic instrumentation and Measurements Techniques*", Pearson / Prentice Hall of India P. Ltd.2003
2. G.N.Srinivas and S. Narasimha, "*Electrical and Electronic Measurements and Instrumentation*", B S Publications, 2018.
3. E.W. Golding and F. C. Widdis, "*Electrical Measurements and Measuring Instruments*", 5th Edition, Wheeler Publishers, 2012.
4. Jovitha Jerome, "*Virtual Instrumentation using LABview*" 1st Edition, Prentice Hall of India P. Ltd, 2010.

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LAB

Course Outcomes: At the end of the course, the student will be able to

CO1: Illustrate the working of different meters and bridges.
CO2: Determine the breakdown strength of oil used in transformers and in other high voltage testing kits.
CO3: Calibrate and also calculate the errors of different measuring equipment(s).
CO4: Calculate the active and reactive power of different loads under different loading conditions.
CO5: Calculate the voltage, current and Power using DAC.

LIST OF EXPERIMENTS:

1. Calibration of single phase wattmeter by Phantom loading
2. Calibration of dynamometer type power factor meter.
3. Measurement of parameters of a choke coil using three ammeter and three voltmeter methods.
4. Perform an experiment to find very low resistance, medium resistance and very high resistance using suitable tests.
5. LVDT and capacitance pickup – characteristics and Calibration and assessing the performance with a simulator.
6. Calibration and testing of single phase energy meters.
7. Measurement of Inductance using Anderson Bridge.
8. Measurement of capacitance using Schering Bridge
9. Measurement of Dielectric strength of oil using H.T testing kit.
10. Measurement of 3 phase power under different loading conditions using DAC.

In Addition to the above ten experiments at least any two of the experiments from the following list are required to be conducted

11. Polar curve using Lux meter, Measurement of intensity of illumination of fluorescent lamp.
12. Crompton D.C Potentiometer – Calibration of PMMC ammeter and PMMC Voltmeter.
13. Resistance Strain Gauge-Strain Measurements and Calibration and assessing the measurement with Strain Gauge simulator.
14. Measurement of Voltage and Current using DAC
15. Measurement of temperature coefficients for different conditions using RTD simulator.

TEXT BOOKS:

1. A. K. Sawhney- "*A course in Electrical Measurements Electronic Measurements and Instrumentation*"- Dhanpat Rai and Co., 5th Edition, 2015.
2. S. Gupta and J. John, *"Virtual Instrumentation using LabVIEW"*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.

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1. W.D. Coopers and Helfrick, "*Modern Electronic instrumentation and Measurements Techniques*", Pearson / Prentice Hall of India P. Ltd.2003
2. G.N.Srinivas and S. Narasimha, "*Electrical and Electronic Measurements and Instrumentation*", B S Publications, 2018.
3. E.W. Golding and F. C. Widdis, "*Electrical Measurements and Measuring Instruments*", 5th Edition, Wheeler Publishers, 2012.
4. Jovitha Jerome, "*Virtual Instrumentation using LABview*" 1st Edition, Prentice Hall of India P. Ltd, 2010.