INSTRUMENTATION AND MEASUREMENT

ENEE 201

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
The objective of this course is to equip students with essential knowledge in instrumentation and measurement. Students will learn to select and use appropriate instruments for accurate measurements in electrical systems. By course end, they will be skilled in analyzing, troubleshooting, and applying measurement techniques in practical scenarios.

1 Instrumentation Systems (2 hours)

1.1 Functional components of instrumentation system introduction, signal processing, signal transmission, output indication
1.2 Need for electrical, electronics, pneumatic and hydraulic working media systems and conversion devices.
1.3 Analog and digital systems

2 Theory of Measurement (8 hours)

2.1 Static performance parameters (Accuracy, precision, sensitivity, resolution and linearity)
2.2 Dynamic performance parameters (Response time, frequency response and bandwidth)
2.3 Errors in measurement
2.4 Statistical analysis of errors in measurement
2.5 Measurement of voltage and current (Moving coil and moving iron instruments)
2.6 Measurement of low, high and medium resistances
2.7 AC bridge and measurement of inductance and capacitance

3 Transducer (10 hours)

3.1 Introduction and classification of transducer
3.2 Applications of transducer
  3.2.1 Measurement of mechanical variables, displacement, strain, velocity, acceleration and vibration
  3.2.2 Measurement of process variables (Temperature, pressure, level, fluid flow, chemical constituents in gasses or liquids, pH and humidity)

3.2.3 Measurement of biophysical variables blood pressure and myoelectric potentials

4 Electrical Signal Processing and Transmission (6 hours)

4.1 Basic Op-amp characteristics
4.2 Instrumentation amplifier
4.3 Signal amplification, attenuation, integration, differentiation, network isolation and wave shipping
4.4 Effect of noise, analog filtering and digital filtering
4.5 Optical communication, fiber optics and electro-optic conversion device

5 Analog-Digital and Digital-Analog Conversion (6 hours)

5.1 Analog signal and digital signal
5.2 Digital to analog convertors (Weighted resistor type, R-2R ladder type and DAC errors)
5.3 Analog to digital converters (Successive approximation type, ramp type, dual ramp type, flash type and ADC errors)

6 Digital Instrumentation (6 hours)

6.1 Sample data system, sample and hold circuit
6.2 Components of data acquisition system
6.3 Interfacing to the computer

7 Electrical Equipment (7 hours)

7.1 Wattmeter, its types and working principles
7.2 Energy meter, its types and working principles
7.3 Frequency meter, its types and working principles
7.4 Power factor meter
7.5 Instrument transformers

Tutorial (15 hours)

1. Problems involving error calculation.
2. Problems on component calculations for AC and DC bridges.
3. Problems related to various types of transducers.
4. Problems involving operational amplifiers (OP-Amps).
5. Problems related to analog-to-digital (ADC) and digital-to-analog (DAC) converters.

Practical (22.5 hours)

1. Accuracy test in analog meters
2. Operational amplifiers in circuits: Use of Op-amp as summer, inverter, integrator and differentiator

3. Use resistive, inductive and capacitive transducers to measure displacement- Use of strain gauge transducers to measure force
4. Study of various transducers for measurement of Angular displacement, Angular velocity, Pressure and flow- Use optical, Hall of effect and inductive transducer to measure angular displacement: Use tacho-generator to measure angular velocity: Use RTD transducers to measure pressure and flow
5. Digital to analog conversion: Perform static testing of D/A converter
6. Analog to digital conversion- Perform static testing of A/D converter

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	2	4
2	8	10
3	10	14
4	6	8
5	6	8
6	6	8
7	7	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Considine, D.M. (1974). Process instruments and controls handbook. McGraw-Hill.
2. Wolf, S., Smith, R.F.M. (2019). Students reference manual for electronics instrumentation laboratories. Prentice Hall.
3. Doebelin, E.O. (1989). Measurement system, application and design. McGraw-Hill.
4. Sawhney, A.K. (2015). A course in electronic measurement and instrumentation. Dhanpat Rai and Sons.
5. Rangan, C.S., Sharma, G.R., Mani, V.S.V. Instrumentation devices and systems. Tata McGraw-Hill Publishing Company Limited.
6. Gupta, J.B. (2006). A course in electrical & electronics measurement & instrumentation. Kataria & Sons.