

Course Name: Measurement and Instrumentation
Course Number: EE - 313
Credits: 2-1-0-3
Prerequisites: IC 160: Basic Electrical Engineering and IC 161 Basic Electronics Engineering
Intended for: UG
Distribution: Elective
Semester: 5th and 7th semester

Course Outline:

This course aims to provide a basic understanding of sensors and instrumentation, and their use within measurement systems in an integrated and coherent manner. The course is best suited for electrical and mechanical engineering students, which expose them to the *generalist* view of measurement and thus made aware of the devices and analytical methods. The topics cover will include all of the elements in a typical measurement system, starting with the capture of a measurement signal by a sensor and then proceeding through the stages of signal processing, sensor output transducing, signal transmission and signal display or recording. Ancillary issues, such as calibration and measurements system reliability, will also be covered.

Modules:

1. Fundamentals of measuring instruments [10 lectures]
Terminology, Units and standards, functional elements of an instrument, input-output configuration, static characteristics and static calibration - least squares calibration curves - static sensitivity - linearity, dynamic characteristics - dynamic response analysis - operational and sinusoidal transfer function - zero-, first-, and second-order instruments, Errors and handling of errors in measurement.
2. Motion and dimensional measurement [12 lectures]
Relative displacement and velocity: translational and rotational - resistive potentiometers - resistance strain gauge - differential transformers - eddy current noncontacting transducers - ultrasonic transducers - mechanical flyball angular velocity sensor - mechanical revolution counters and timers, relative acceleration, accelerometers - deflection type - null balance type, gyroscopic angular-displacement and velocity sensors, laser rangefinders, ultrasonic rangefinders, radars for automobiles.
3. Force, torque, and shaft power measurement [3 lectures]
Elastic force transducers - bonded-strain-gauge transducers - differential-transformer transducers - piezoelectric transducers - variable-reluctance, torque measurement on rotating shafts, dynamometers, vibrating-wire force transducers.
4. Sound and Vibration measurement [3 lectures]
Deadweight gauges and manometers, elastic transducers, vibrating cylinder transducers, high-pressure measurement, low pressure measurement - diaphragm gauges - McLeod gauge - Knudsen gauge - momentum transfer gauges - thermal conductivity gauges - ionisation

- gauges - dual gauge technique, sound measurement - microphones - pressure response - acoustic intensity - acoustic emission.
5. Temperature and heat-flux measurement [5 lectures]
Thermal expansion methods - bimetallic thermometers - liquid-in-glass thermometers - pressure thermometers, thermoelectric sensors, electrical resistance sensors - conductive - bulk semiconductor, junction semiconductor sensors, digital thermometers, radiation methods - detectors - automatic null balance - optical - two color - fluoroptic - infrared imaging.
 6. Manipulation, transmission and recording of data [4 lectures]
Bridge circuits, amplifiers, filters, integration and differentiation, cable transmission, fiber-optic data, radio telemetry, Pneumatic transmission, instrument connectivity, potentiometers, digital voltmeters and mutimeters, electromechanical servotype XT and XY recorders, data acquisition systems.
 7. Electrical and Electronic Measurements [6 lectures]
Signal generation, Principle of LCR meter, Probe compensation, Spectrum analysis, Instrument Transformers, Measurement of Power and Wattmeters, Measurement of Energy and Industrial Metering, Digital Storage Oscilloscope, Issues of sampling, memory, ADC speed.

Textbooks:

1. E. O. Doebelin, D. N. Manik, Measurement systems Application and Design, McGraw Hill Book Company, Fifth Edition, 2007.
2. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Ltd., New Delhi, Third Edition, 2010.

References:

1. A.K. Sawhney, A course in electrical and electronic measurements and instrumentation, Dhanpat Rai Publications, 19th Edition, 2011.
2. A. S. Morris, Measurement and Instrumentation Principles, Butterworth-Heinemann, Third Edition, 2001.
3. P. Holman, Experimental Methods for Engineers International Student Edition, McGraw Hill Book Company, 1971.
4. W. C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGraw-Hill, 2005.