Course Title: Measurement and Instrumentation
Course Code: EPEG 317
Credit Hours: 3

Course Description:
Become familiar with the principles, architecture and design of instrumentation systems used for measurement and control.

Course Contents:

Unit 1: Introduction to Process Control
Definition of control systems, History and examples, Concept of feedback and closed loop control, Open-loop versus closed-loop systems, Linear system, Time-invariant system, Process Control principles, Human aided control and Automatic control, Process control block diagram, Analog and digital processing, Supervisory control and direct digital control

Unit 2: Measurement and Error
Measurement, instrument, Functional elements of an instrument, Sensitivity, resolution, threshold, Errors: gross, systematic, random, Precision, Tolerance, significant figures, Statistical analysis: arithmetic mean and median, Deviation from mean, average deviation, standard deviation, Variance, frequency distributions, Probability of error, histogram, probable error, limiting error, relative limiting errors, combination of quantities and limiting errors, Calibration of instruments, Standards: primary, secondary, working, Voltage standards, resistance standards, current standards, Measuring principles using bridges: Wheatstone bridge, Kelvin Bridge, AC bridge Maxwell and Hay bridges, Schering Bridge, Wien bridge

Unit 3: Transducers and Sensors
Transducers and sensors definitions, classifications of transducers, transducer selection factors, resistive transducers, capacitive transducers and inductive transducers, linear variable differential transformer, position and proximity sensors, motion sensors, pressure sensors, level sensors, flow sensors, strain gauges, load cells, resistance temperature detectors, thermistors, thermocouples, thermopiles, piezoelectric transducers, photoconductive cell, photo diode, photovoltaic cell, photo transistors

Unit 4: Introduction to Signal Conditioning
Signal conditioning: linearization techniques, signal conversion, filtering, impedance and power matching; Divider and Bride circuits, Op-amp as inverting amplifier, non-inverting amplifier, summing amplifier, differential amplifier, Op-amp as voltage to current and current to voltage converter, integrator, differentiator, logarithmic amplifier, Design guidelines for signal conditioning

Unit 5: Digital Signal Conditioning Circuits
Principle of interfacing with the analog world; DAC and its performance parameters, Binary weighted DAC, R/2R ladder DAC, Source of Errors in DAC, ADC and its performance parameters, Single ramp type and Dual slope type ADCs, successive approximation type ADC, flash type ADC

Unit 6: Data Acquisition and transfer

Analog and digital data acquisition, sample and hold circuit, noise, interference, grounding and shielding, components of data acquisition systems or boards, data communication standards (RS 232, RS-485, USB, GPIB, Bluetooth, Zigbee etc.) for data acquisition, data logger without and with computer supervisory control

Unit 7: Electrical Measuring Instruments

Essential requirements of an Instruments: deflection system, controlling system and Damping systems, PMMC instruments, Voltmeter types and working principle, Ammeter types and working principle, Ohmmeter types and working principle, Clamp-meter types and working principle, Multi-meter types and working principle, Wattmeter types and working principle, energy meter types and working principle, Time of day meter, power factor meter, frequency meter, Phase meter, Instrument Transformers types and working principle, Megger, tachometer, Displays types for measuring instruments: Cathode Ray Oscilloscope, Liquid Crystal displays, LED display and plasma

Unit 8: Discrete-State Process Control

Definition of discrete-state process control, Characteristics of the system, Relay controllers and ladder diagrams, Programmable Logic Controllers (PLCs), Examples of PLC based industrial control systems and programs, fuzzy logic controller and its application

References:

1. D. Helfric and W. D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, PHI
2. C. Johnson, *Process Control Instrumentation Technology*, 4th Ed, PHI
3. H.S. Kalsi, *Electronic Instrumentation*, Tata McGraw Hill

Evaluation:

In-Semester Evaluation: 50%
End-Semester Evaluation: 50%