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
Definitions of terms used in measurement and instrumentation; Measurement, Instrument, Measurand, meter, metrology; Example of process control; Automatic process control; Advantages of electronics in measuring systems; Measurement and process control systems; Analog measuring system model: Temperature control process with analog method; Digital processing systems: Digital supervisory and analog process control systems, Computer based direct digital control

Unit 2: Fundamental and Derived Units in the SI Units
Standards, Accuracy, Precision, Resolution, Sensitivity, Significant figures, Errors, Limiting error; Statistical analysis: average/mean value, Deviation from mean value, Average deviation, Standard deviation, Variance, probability of error, Histogram, Probable error.

Unit 3: Introduction to Electromechanical Indicating Instruments
Operating principle of permanent magnet moving coil (PMMC) galvanometer, Dynamic behavior of PMMC movement, Taut band suspension galvanometer; DC meters: Ammeters, Voltmeter, Ohmmeter, Voltmeter loading effects, Meter protection techniques, Electronic voltmeter

Unit 4: AC Measurement
Sinusoidal signal parameters (average, RMS, peak and peak-to-peak relations); Parameter relations in half-wave rectified sinusoidal signals, Full-wave rectified sinusoidal signals, Triangular wave forms dc signals with sinusoidal waves superimposed, and square waves. Measurement with PMMC movement using single diode and bridge diode rectification; The form factor; Operating principle of AC voltmeter, Peak reading meter, Current transformer, Power meters, Power factor meter, Watt-hour meter, and electrodynamometer; Cathode Ray Oscilloscope– basic principles and applications.

Unit 5: Introduction to Signal Conditioning
Analog signal conditioning: linearization techniques, Signal conversion, Filtering, Impedance and power matching; Operational amplifier in various configurations: Ideal Op-amp analysis, Op-amp specifications, Non-inverting amplifier, inverting amplifier, summing amplifier, differential amplifier, instrumentation amplifier, integrator, differentiator, Logarithmic amplifier, Comparator.

Unit 6: Digital Signal Conditioning Circuits
Interfacing with the analog world (principle); Digital to analog conversion principle and circuits: standard DAC with binary inputs, DAC resolution, Step size, Input weight etc. DAC formulae, DAC with BCD input codes, Bipolar DACs, DAC circuits, Integrated circuit DACs; Analog to digital conversion: Counter type ADC, Successive approximation type ADC, Flash type ADC and design principle, resolution, Reference voltage and formulae, integrated ADC circuits; Sample and hold techniques and circuit principle. Time-multiplexing techniques

Unit 7: Data Acquisition Techniques
Introduction to data acquisition techniques, Data acquisition systems or boards, Data communication standards (RS 232, RS-485, USB, etc.) for data acquisition, Data logger without and with computer supervisory control

Unit 8: Bridges
Measuring principles using bridges: Resistance measurement with Wheatstone bridge, Inductance measurement with Maxwell and Hay bridges, Capacitance measurement with Schering bridge, Bridge unbalanced conditions and their use in measurement, problems in bridges;

Unit 9: Transducers and Sensors
Voltage measurement using potentiometer; Production of constant current sources; Temperature measurement: operating principle of temperature sensors: Metallic sensors (KTY-10)-temperature to resistance, Voltage and current, Semiconductor sensors (thermistor), Thermocouple; Optical sensors: Voltage to light: LED; Light to current or voltage: photo-diode, Photo-transistor; Light to resistance: LDR; Detection of velocity changes using optical sensors; Pressure and torque sensors: strain gauge, Liquid pressure sensors; Position sensors: Potentiometer; LVDT: induction change with position; Capacitance change with position.

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