Course Title: Instrumentation and Control
Course Code: COEG 304
Credit Hours: 3

Course Description:
This course is intended to become familiar with the principles, architecture and design of instrumentation systems used for measurement and control.

Course Contents:

Unit 1: Introduction
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

Unit 2: Mathematical Modeling
Physical balances, Differential equations, Mathematical modeling of mechanical systems and electrical systems, Mathematical modeling of fluid systems

Unit 3: Laplace Transforms
Definitions, Transfer functions, Poles and zeros, Block diagram reduction

Unit 4: Transient and Steady-State-Response Analysis
Standard test signals, transient response of first order systems, second order systems and higher order systems, Concept of dominant poles, Steady state error and type of systems

Unit 5: Stability Analysis
Definitions based on impulse response, Routh-Hurwitz stability criterion.

Unit 6: Introduction to Process Control
Control systems, Process-control block diagram, Control system evaluation, Analog and digital processing, sensor time response, Introduction of PID controllers, Design of P controller

Unit 7: Analog Signal Conditioning
Principles of analog signal conditioning, Passive circuits, Operational amplifiers, OP-amp circuits in instrumentation, Design guidelines

Unit 8: Digital Signal Conditioning
Review of digital fundamentals, AD and DA converters, Data-acquisition systems, Characteristics of digital data

Unit 9: Thermal Sensors
Definition of temperature, Metal resistance versus temperature devices, Thermistors, Thermocouples, other thermal sensors, Design considerations

Unit 10: Mechanical Sensors
Displacement, Location, Position and proximity sensors, Strain sensors, Motion sensors, Pressure sensors, Flow sensors, Optical encoder

Unit 11: Final Control
Final control operation, Signal conversions, Power electronics, Actuators (Pneumatic, Hydraulic and electrical drives), Control elements, Examples of control systems

Unit 12: 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 control systems

References:
1. K. Ogata, *Modern Control Engineering*, 2nd Ed. PHI 1990
2. C. Johnson, *Process Control Instrumentation Technology*, 4th Ed PHI 1995
3. Raymond T. Stefani, *Design of Feedback Control Systems*, 4th Ed. Oxford 2002
4. Krishna Kant, *Computer Based Industrial Control*, 2nd Ed. PHI 1998