Course No. and Tiltle: ET 402 Instrumentation

Credit Hours: 3 (2 + 3P)

Course Description: This course, taken by both electronic and mechanical students, introduces the student to the fundamentals of control systems theory and to the principles of signal conditioning and measurement for such systems.

Pre-requisites: ET 190 and senior standing **Required Course**

Textbook: Process Control Instrumentation Technology, 8th edition, by Curtis D. Johnson, Prentice Hall.

Objective: Introduction to the principles of control theory, measuring instrumentation, and signal conditioning

Note: This course relates to ABET program outcomes a, b, c, d, e, f, and g as follows:
(a, b) Theory is explained with mathematical derivations and supported by examples of practical applications.
(c, d) A number of lab experiments require the students to determine component values based on design requirements before running the experiments; they then verify if experimental results are as expected.
(e) All students work in teams in laboratory and projects.
(f) Students have to work on homework, exams, and lab problems.
(g) Students need to write lab reports using proper written language.

COURSE TOPICS:	**Hours:**
1. Introduction to process control: Control principles, the process or plant, measurement, control loop, control element, block diagram.	1
2. Control system response: Steady-state regulation, stability, transient response types.	2
3. Analog and digital processing: Analog and digital data, data conversion, digital control loop.	1
4. Systems of Units: The metric and English systems, basic and derived units, equivalencies and conversion of units.	1
5. Analog signal conditioning: Principles, signal levels, linearization, bridge circuits.	3
6. Operational amplifier circuits, gain, inversion, dc-level shift, differential circuits, instrumentation amplifiers.	3
7. Digital fundamentals, binary numbers, octal and hexadecimal notation, Boolean algebra and theorems.	2
8. Voltage comparators, voltage-level detectors, analog-to-digital and digital-to-analog converters.	3
9. Thermal sensors: Thermal energy, temperature, temperature scales, temperature conversion formulas.	2

10.	Metal resistance versus temperature, linear and quadratic approximations, resistance-temperature detectors, signal conditioning for RTDs, thermistors.	2
11.	Thermocouples: Principle of operation, characteristics, types, millivoltage tables, change of reference, signal conditioning for thermocouples.	3
12.	Mechanical sensors: Displacement and position, level sensors, stress and strain, strain gauges and their signal conditioning.	2
13.	Pressure sensors: Static and dynamic pressure, pressure units, absolute and relative pressure, sensor types.	2
14.	Flow sensors: Flow units, flow types, pipe flow principles, restriction type sensors, flow-pressure relationships.	2
15.	Controller principles: Definitions, control parameters, controller modes.	3
16.	Continuous control: Control modes (proportional, integral, derivative, and composite), error, transient response.	3

Class/Laboratory Schedule

Class meets twice a week for 50 minutes each time. The laboratory session is 2.5 hours once a week.

Laboratory Practice:

Major topics in the course are extensively practiced in laboratory through experiments designed by the instructors. Students are required to write lab reports that include measurements, observations, and answers to questions. Typical electronic instruments in the laboratory include: CADET breadboard, TEKTRONIX digital oscilloscope, TEKTRONIX function generator, FLUKE digital multimeters. Lab session duration: 2.5 hours

List of Lab Experiments:

- Introduction to LabView
- Plotting Static and Dynamic Data with LabView
- A Self-Regulated Control System Simulation
- An Electronic Scale Simulation
- Inverting Voltage Comparator with Hysteresis
- A Simple 4-bit DAC
- Signal Conditioning for Thermocouples
- Simulation of a 2^{nd}-order Differential Equation
- Simulation and Verification of a Proportional Controller

Prepared by: Guillermo Rico Date: 10 December 2010