

## **ENGR 3050: Sensors, Measurements and Controls**

This course is required for all Engineering students.

Course Coordinator:

Jianchu (Jason) Yao

Catalog Description:

Fundamental concepts of measurement, transducers, data acquisition, and signal conditioning. Controls systems cover application of mathematical and analytical tools to model, analyze, and design automated feedback control systems for dynamic processes.

Course Structure:

Two 50-minute lectures and one two-hour laboratory session per week (three credits)

Prerequisites:

ENGR 3014 Circuit Analysis

Required Materials:

1. Required: Sensors and Actuators: Control System Instrumentation. Clarence W. de Silva. CRC Press, 2007. ISBN: 1420044834
2. Optional: Modern Control Systems, 10th Edition. Richard C. Dorf and Robert H. Bishop. Prentice Hall, 2005. ISBN 0131457330

Course Learning Outcomes:

Upon completion of this course, students shall be able to:

- Describe fundamental measurement and controls concepts
- Describe categories of transducers needed in industrial processes
- Analyze experiment uncertainty with statistical methods
- Identify possible causes of experimental errors
- Apply engineering tools to measure and analyze industrial processes
- Identify key parameters of instrument system design
- Describe basic signal conditioning techniques
- Apply mathematical models to describe physical systems
- Describe characteristics and performance of feedback control systems
- Analyze and determine stability of linear feedback systems
- Design control systems that meet basic control criteria and specifications
- Document and present control system analyses in a professional manner

Lecture Topics

- Review of circuit analysis
- Transducer categories
- Instrument performance specifications
- Causes of errors and statistical analysis of uncertainty
- Signal conditioning techniques
- Use of differential equations to model dynamic systems
- Transfer functions
- Feedback control system performance
- Feedback control system stability
- Feedback control system sensitivity and robustness

Laboratory/Recitation Topics:

- Operational amplifier circuit
- Design of a thermistor-based thermometer
  - Thermistor characterization
  - Modeling and simulation of a amplification circuit with a Wheatstone bridge

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- Linearization of the amplification circuit
- Integration of the thermistor-based thermometer
- Calibration and test of the thermometer
- Design of a coupled-tank level control system
  - Characterization of level sensors and pump
  - Modeling of the coupled-tank process
  - Design of the closed-loop system to meet performance specifications
  - Design of the controller in a difference equation form
  - Integrate the closed-loop system and evaluate the system performance

### Relevant Program Outcomes:

Graduates of the Engineering Program will demonstrate

- a) Graduates of the Engineering Program will demonstrate an ability to apply knowledge of mathematics, science, and engineering
- b1) Graduates of the Engineering Program will demonstrate an ability to design and conduct experiments
- b2) Graduates of the Engineering Program will demonstrate an ability to analyze and interpret data
- c) Graduates of the Engineering Program will demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- k) Graduates of the Engineering Program will demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

### Professional Component Content:

Math/Science: 0; Engineering: 3 credits; General Education: 0

### Assessment Requirements:

Student Work Samples

- Assignment showing application of mathematics, science, and engineering (Outcome a)
- Assignment showing design and conduct experiments (Outcome b1)
- Assignment showing analysis and interpretation of experimental data (Outcome b2)
- Assignment showing design of a component/system to meet desired needs (Outcome c)
- Assignment showing use of computer programming language (Outcome k)

Student Course Survey

### Last Review:

December 18, 2007 by Jianchu (Jason) Yao