BBE 4023W / 5023 Process Control and Instrumentation

Fall 2015

COURSE SYLLABUS

Lecture/Disc: 12:50 am - 1:40 pm MW, BioAgEng 106
Labs: 002 - 12:50 – 2:30 pm, F, BioAgEng 105 003 - 12:50 – 2:30 pm, Th, BioAgEng 105
004 – 2:45 – 4:25 pm, F, BioAgEng 105

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Office Hours: 3 – 4 p.m. Monday, 2:30 – 3:30 p.m. Thursday

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Office Hours: 3 – 5 p.m. Wednesday

Grader: K. Coster Email: coste124@umn.edu

Office Hours: Office hours are listed above. We may be available to meet at other times. You are welcome to contact us by phone or email to make an appointment or to stop by to see if we are available to meet. The hour before class or lab is not a good time to meet because we commonly use this time for last minute prep.

Prerequisites: upper div IT or graduate student

Course Description: BBE 4023W, Process Control and Instrumentation, is a required writing intensive course in the BBE undergraduate program. Undergraduate students at the University of Minnesota are required to complete four writing intensive courses in addition to the first-year writing requirement. Writing intensive courses integrate writing into course content, through formal and informal writing assignments, and provide relevant writing instruction. The formal writing assignments are in addition to laboratory reports and other in class writing. At least one formal writing assignment requires you to revise and resubmit written material after receiving instructor feedback. Grades assigned in writing intensive courses are substantially influenced by the quality of your formal written assignments and final report. You are encouraged to use Student Writing Support at the Center for Writing as you complete your writing assignments for BBE 4023W/5023.

Process control or automation is an important engineering skill. For this course we will define a process as a series of actions, changes or functions that bring about an output or product over time that depends on the process inputs and external factors (Spedding, 1988). For process control you need sufficient control over process inputs to produce an output within desired specifications. Examples include water heaters, thermostatically controlled ovens, waste water treatment and cruise control on your car. Industry has infinitely more automatically controlled processes. This course will introduce you to process control terminology, relationships and methods of analysis to assess a process controller's transient response and stability. Some of the processes covered in this class include water heating, liquid level in a tank, flow from tanks, mixing and a bioreactor. The course covers open and closed-loop control including two position (on-off) control, proportional, integral and derivative (PID) control, and feedback, feedforward and cascade control. The course will also provide information on thermostats, timers and actuators including relays, solenoids and solenoid valves. BBE 4023W/5023 will give you a good introduction to become a process control engineer.

Instrumentation can be a course in its own right or a subset of process control. Instrumentation involves sensor selection, signal conditioning, analog to digital conversion, interfacing and calibration. Sensors are commonly used to measure a process output for automatic process control. Sensors are also used by researchers to measure physical changes and conditions. You will learn about sensors and instrumentation precision, accuracy, handling errors and bad data, uncertainty analysis, calibration, time constants, operating ranges and other characteristics to consider when selecting sensors and instrumentation systems.

Course Objectives:

1. Introduce students to instrumentation terminology, specification sheets, instrument performance characteristics, calibration and error analysis.
2. Introduce students to important dynamic mass and energy models of bioproduct and biosystems processes used in manufacturing and processing.
3. Have students simplify dynamic process models for analysis in the S-domain using Laplace Transforms and generate the model transfer functions.
4. Introduce students to open-loop and closed-loop feedback, feedforward and cascade control principles and equipment.
5. Have students classify the basic dynamic behavior of closed-loop process systems based on their time-domain, transfer function, and frequency-domain representations.
6. Have students analyze a feedback control system's stability and performance using analytical techniques and computer software.
7. Introduce students to Proportional-Integral-Derivative (PID) control and its application in bioproducts and biosystems manufacturing and processes.
8. Have students understand practical issues in control engineering and the benefits of control engineering for improving operations, safety, and environmental compliance in process plants.
9. Have students become familiar with various instruments and their use through laboratory excises and demonstrations;
10. Have students become familiar with principles of sensors used to measure mechanical, physical and chemical parameters;
11. Have students become familiar with PC based data acquisition equipment and use;
12. Have students integrate their instrumentation and process control knowledge in a comprehensive written report that proposes an innovative instrumentation and process control system.

This course will help you attain five out of seven of the University of Minnesota Undergraduate Student Learning and Development Outcomes (http://academic.umn.edu/provost/teaching/cesl_loutcomes.html). The outcomes are:

1. Identify, define and solve problems,
2. Locate and critically evaluate information,
3. Master a body of knowledge and mode of inquiry,
4. Communicate effectively, and
5. Acquire skills for effective citizenship and life-long learning.

You will develop your skills through watching narrated PowerPoint videos and completing homework assignments, active learning activities, writing assignments, a presentation, labs and exams.

Flipped Course: This course uses narrated PowerPoint videos that were produced by the instructors for you to watch prior to class meeting times and labs. There are videos for each class meeting and weekly lab and several on writing. You can watch the videos before and/or after class meeting. You are strongly encouraged to watch the videos for the labs prior to the labs so that you can use your time more efficiently.

Course Text – No textbook is required. Students are expected to purchase a course packet from the bookstore.