CM3310
Process Control

Curricular Designation: Required

Catalog Description:

Covers methods of analyzing the transient behavior of chemical processing systems. Develops methods of analyzing systems and system components along with the special mathematical techniques needed. These concepts are then applied to illustrate mathematical modeling of large-scale chemical processing systems.

Credits: 3.0, Lec-Rec-Lab: (2-0-2), Semesters Offered: Spring

Prerequisites:

(MA 3520 - Elementary Differential Equations
or MA 3521 - Elementary Differential Equations
or MA 3530 - Introduction to Differential Equations or
or MA 3560 - Mathematical Modeling with Differential Equations
and PH 2200 - University Physics II-Electricity and Magnetism
and CM 2110 - Fundamentals of Chemical Engineering 1
and CM 2120 - Fundamentals of Chemical Engineering 2

Textbooks(s) and/or Other Required Materials:

Lecture Notes for CM3310 (available online)

(Not required but recommended references:)
B. Wayne Bequette, Process Control, Modeling, Design and Simulation,
Prentice Hall, 2003
Course Objectives
1. Master the modeling and analysis of dynamic processes
2. Master the basic principles of feedback control
3. Master the mathematical methods used for process modeling and control
4. Master PID feedback control design and tuning
5. Master the techniques for stability and performance analysis of controlled processes
6. Master the principles and analysis of block diagrams
7. Familiarity with basic concepts of industrial automation of batch processes
8. Familiarity with computer tools for control design and analysis
9. Familiarity with real-world implementation of sensors and control
10. Familiarity with data acquisition and empirical modeling
11. Familiarity with frequency domain techniques for analysis and robust design
12. Familiarity with advanced control configuration and methods

Topics Covered:
1. Basics of Process Control
   - Introduction to Process Control and Automation
   - Elements of Feedback Control
   - On-off and PID Control
   - Introduction to Process Modeling
   - Review of ODEs
   - Stability and Performance Analysis: Open loop
   - Stability and Performance Analysis: Closed loop
   - PID Tuning
2. Introduction to Transfer Functions
   - Application of TFs to Basic Feedback Control Analysis and Design
   - Application of TFs to Other Control Configuration
3. Some Process Control Application to Chemical Engineering Unit Operations
   - Distillation Control
   - Blending Control
   - Reactor Control
   - Other processes
4. Basics of Industrial Automation
   - Introduction to automation
   - Discrete (Sequence) Event Control
   - Programming via Sequential Flow Diagrams
   - Basics of Programmable Logic Controllers (PLC)
   - Introduction to ISA 88 for Batch Process Control
   - Simulation using STATEFLOW
5. Supplementary Topics (as time allows)
   - Frequency Domain Analysis
   - Nyquist and Bode Plots
• Robust Design via Stability Margins
• Model Predictive Control
• Neural Network Control

Class/Laboratory Schedule: Class: 3 hours/week for 12 weeks  Lab: 2 hours/week for 4 weeks

Contribution of Course to Curriculum: Engineering and Science
### Relationship of Course to Program Outcomes:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Contribution</th>
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<tbody>
<tr>
<td>a) An ability to apply knowledge of mathematics, basic science and engineering science</td>
<td>Substantial</td>
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<td>b) An ability to design and conduct experiments as well as to analyze and interpret data</td>
<td>Substantial</td>
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<td>c) An ability to design a system, component or process to meet needs within realistic constraints</td>
<td>Substantial</td>
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<td>d) An ability to function on multidisciplinary teams</td>
<td>Minimal</td>
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<td>e) An ability to identify, formulate, and solve engineering problems</td>
<td>Substantial</td>
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<td>f) An understanding of professional and ethical responsibility</td>
<td>Minimal</td>
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<td>g) An ability to communicate effectively</td>
<td>Moderate</td>
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<td>h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context.</td>
<td>Moderate</td>
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<td>i) A recognition of the need for, and the ability to engage in lifelong learning</td>
<td>Moderate</td>
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<td>j) A knowledge of contemporary issues</td>
<td>Minimal</td>
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<td>k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
<td>Substantial</td>
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### Prepared by:

Assoc. Prof. Tomas Co

February 8, 2017