CM 3310 / Spring 2010

Instructor: Dr. Tomas Co (ChemSci 202 G, Tel 487-2144, tbco@mtu.edu)
Office Hrs: Mon 11-12, 3-5, Wed 3-5

Course Title: Process Control

Course 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 design and tuning of feedback controllers to improve the operation of chemical processing systems. Laboratory component of the course introduces the basics of data acquisition for the implementation of feedback control of simple systems.

Course Prerequisites: (MA 3520 or MA 3521 or MA 3530 or MA 3560) and PH 2200


Course Outline

I. Continuous Time Dynamics

Learning Objectives: To know how to apply the tools of differential equations for process modeling and analysis of feedback control systems.

Week 1

1. Introduction to process dynamics and control p 1-20
2. Process modelling p. 31-50
3. Solution of Ordinary Differential Equations
   a) Analytical solutions:
      eigenvalues, time constants, damping coefficients

   Week 2

   b) Numerical solutions:
      Euler Method, Runge-Kutta Method
4. Empirical Models
5. Linearization p. 60-66

Week 3
6. PID Control
   a) Concepts (p.156-173)
   b) Analysis

   **Week 4**

   c) Performance  
   d) Tuning Methods p. 198-209

   **Week 5**

Exam 1

II. Laplace Transform Methods

**Learning Objectives:** To learn the techniques of Laplace transforms and how to apply them to component design and analysis of conventional and advanced control configurations.

1. Basics
   a) Definition and elementary transforms p.85-94

   **Week 6**

   b) Method of Partial Fractions

2. Transfer Functions p. 95-119

   **Week 7**

3. Block Diagram Manipulations
4. Stability and Performance

   **Week 8**

5. Routh – Hurwitz Methods p. 173-177

   **Week 9**

Exam 2

6. Other control configurations
   a) IMC p.263-269  
   b) Cascade p.313-323  
   c) Feedforward/Feedback p.324-333

   **Week 10**
III. Frequency Response Methods

**Learning Objectives:** To learn the techniques of frequency response methods for modeling, analysis and design of additional components such as controllers, compensators and filters.

1. Frequency response experiments and data  
   **Week 11**
   p. 216-219

2. Bode and Nyquist Plots  
   a) elementary transfer functions  
   b) transfer functions in series  
   **Week 12**
   p. 219-223  
   p. 223

3. Nyquist stability criterion  
   **Week 13**
   p. 230-231

4. Gain and phase margins  
   **Week 14**
   p.231-232

Exam 3

IV. Advanced Topics (as time permits)

7. Multivariable Control/RGA  
   p.381-408
8. Model Predictive Control/ Dynamic Matrix Control  
   p.487-506

REVIEW

**Week 15**

FINALS
GRADING POLICY

Point Distribution (out of maximum 100 pts)

Projects (3) 25 pts
Laboratory (7) 25 pts
Quizzes (6-8) 10 pts
Exams (3) 30 pts
Finals (1) 10 pts

Letter Grade Equivalence:

100 - 95  A
94.99 - 90  AB
89.99 - 85  B
84.99 - 80  BC
79.99 - 70  C
69.99 - 60  CD
59.99 - 50  D
49.99 - 0  F
Additional Course Policies:

1. Projects need to be done individually and submitted in the form of a brief report.
2. Deadlines on the projects will be enforced strictly. (Each day late means a 10 point deduction.)
3. All projects and exams should be neatly written on one side of an 8-1/2” by 11” paper and stapled together. The name and mailbox number should appear in the upper right corner of the front page. Failure to do so will mean a maximum of 3 pt. deduction.
4. Submit your projects in BOX A (opposite 2nd Floor elevators of the Chem Sci Bldg.)
5. Exams can be taken earlier than the set time for the following reasons: a) time conflicts with other exams or courses, b) time conflicts with approved departmental activities, c) medical appointments, d) family emergencies. To be considered, write a memo at least three days prior to the set date of exam (expect for case d) stating the reason for the request, including supporting attachments. If approved, we will mutually set a time suitable for maximizing the overlap of people taking the early exam. Everyone taking the exam early will be required to sign a form of non-disclosure of exam contents.
6. Taking exams later will be allowed only for those with pre-approved memos or memos with attachments of official documentation, e.g. letter from doctor for medical emergencies.
7. Attendance is required for the laboratory classes. For the lectures, attendance and participation are strongly encouraged.
8. Quizzes will be given on Friday classes. Policy number 6 and 7 also applies to quizzes.

University Policies

Academic regulations and procedures are governed by University policy. Academic dishonesty cases will be handled in accordance the University's policies. See the following for appropriate policies.

Academic Integrity:
http://www.studentaffairs.mtu.edu/dean/judicial/policies/academic_integrity.html

Affirmative Action:
http://www.admin.mtu.edu/aa/

Disability Services:
http://www.admin.mtu.edu/urel/studenthandbook/student_services.html#disability

Equal Opportunity Statement: