MTM G225 & MIM U659 Control and Mechatronics, Spring 2008

Course description

Covers concepts in design and control of electromechanical systems. Topics include review of continuous-time system modeling and dynamic response; principles of feedback, classical control analysis, and design techniques, such as root locus and frequency response; dynamic analysis, design, and control of robots and electromechanical systems; kinematics and dynamics of multiinput, multioutput rigid body systems; inverse kinematics, inverse dynamics, and computed torque control; adaptive and learning control; and introduction to digital implementation of control algorithms.

Instructor information & office hours

Rifat Sipahi, 321 Snell Engineering Center, Phone: 617-373-6011. rifat@coe.neu.edu
Mon 7.40 – 8.15, Wed 4 – 5.30, Fri 4 – 5, or email for quick questions.

Communication

Communication between instructor and students is essential. Students *should* monitor **Blackboard** for all sorts of announcements and periodically check their email accounts *associated* with Blackboard. https://blackboard.neu.edu/

Prerequisites

- Background on undergraduate level 'automatic control' similar to the coverage of MIMU555 is required.
- Strong comprehension of fundamentals of dynamics, vibrations and RLC circuits is required.
- Strong comprehension of MATLAB/Simulink and a symbolic manipulator such as Maple or Mathematica is required.

(Please make sure your COE accounts are functioning properly)

Textbooks

- Chi-Tsong Chen, *Linear System Theory and Design*, Oxford University Press, 1998.
- Vadim I. Utkin, *Sliding Modes in Control and Optimization*, 1992, Springer-Verlag.
- George M. Siouris, *An Engineering Approach to Optimal Control and Estimation Theory*, 1996, John Wiley & Sons.
- Katsuhiko Ogata, *Modern Control Engineering*, 2002, 4th Edition, Prentice Hall.
- Richard C. Dorf, Robert H. Bishop, *Modern Control Systems*, 2000, Prentice Hall.
- Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, *Feedback Control of Dynamics Systems*, 2002, Prentice Hall.
- Wim Michiels, Silviu-Iulian Niculescu, *Stability and Stabilization of Time-Delay Systems*, 2007, SIAM.

Course objectives

1. Comprehension of the fundamentals of feedback control theory (MIM U555) and interpreting the results, obtained via the tools taught, in connection with real life,
2. Characterizing stability / instability, determining stability robustness measure, and synthesizing controllers using root locus.
3. Analysis of frequency response and its utilization for control design including lead/lag compensators.
4. Controller implementation on non-linear dynamics.
5. Understanding optimality measures, application of LQR tools for control synthesis.
6. Understanding consequences of delays to stability, control and robustness. Application of advanced stability assessment techniques on delay differential equations.

Topics to be covered

See page 3 below. Also uploaded in *Blackboard*.

Assessment tools

The students' understanding of the material is assessed through *graded homework*, *non-graded indicator questions (IQ)* and *graded exams*. Students are *responsible* for following the due dates listed on course schedule (see page 3 below).

1. Please return homework (HW) assignments (there are 4) **on time** (will be announced/posted on Blackboard) in the beginning of the class (unless otherwise stated). Late HW submissions are *not allowed*, except when you have an exceptional case.
2. There are 4 exams of **indicator questions** (IQ) as shown on the course schedule (see page 3 below). These exams are closed book and **100% success** is required as a **necessary condition, but not sufficient**, for passing the class. In case a student fails an IQ exam, the instructor will schedule another one with the student. Students may re-take IQ exams (those they failed) **until 6 PM on April 15th, 2008** to secure the success requirement (please schedule with the instructor).

Note that IQ exams are made to establish the minimum level of competency.

3. There are **2 midterm exams** (first one is *closed book* and the second one is *take-home*) and **a final exam** (see course schedule, pg 3 below). Details will be announced at appropriate times. *Check regularly at Blackboard.*

Ethical behavior

1. Students may prefer to discuss with each other when solving homework problems, *however, every student should submit his/her own work.*
2. During exams and IQ exams, no discussion among students is allowed. Students may ask questions to the instructor for clarification purposes.
3. In the process of *assessment tools*, cheating and plagiarism will not be tolerated, and will be handled in accordance with University policies described in the Student Handbook.
4. Particular attention will be paid when evaluating Midterm 2 (take-home).

Special accommodations

If you have specific physical, psychiatric, or learning disabilities that you believe may require accommodations for this course, please meet with me after class to see appropriate adaptations and/or modifications, which might be helpful for you. The Disability Resource Center (DRC), which is located on campus in 20 Dodge Hall (x 2675) can provide you with information and other assistance to help manage any challenges that may affect your performance in your coursework.

Grading policy

1. To pass the course, it is **necessary, but not sufficient,** that 100% success on IQ exams is achieved[1].

2. Distribution of assignments:

4 Homework assignments	15%
Midterm 1	20%
Midterm 2	30%
Final	35%
Total	**100%**

[1] Otherwise, student gets an "incomplete" and needs to convert it to a grade within 1 year period of time.