ESE 441 - Control Systems
Fall Semester 2008
TuTh 11:30 – 1:00
Whitaker Hall 216

Required/Elective Course: Required

Credit: 3 units

2004-2005 Catalog Data: Same as ESE 541.
Introduction to theory and practice of automatic control for both discrete- and continuous-time systems. Representations of the system: transfer function, block diagram, signal flow graph, difference and differential state equation and output equation. Analysis of control system components. Transient and steady-state performance. System analysis: Routh-Hurwitz, root-locus, Nyquist, Bode plots. System design: PID controller, phase-lead, phase-lag, and lead-lag compensators, pole placement via state feedback, observer, stability margins in Nyquist and Bode plots. Emphasis on design principles and their implementation. Design exercises with a CAD (computer-aided design) package for specific engineering problems.

Prerequisite: ESE 351-Signals and Systems, or ME 417-Dynamic Response of Physical Systems

Textbooks: Feedback Systems: An Introduction for Scientists and Engineers, , K.J. Astrom and R. M. Murray, Princeton University Press, NJ, 2008.

Reference: The Student Edition of MATLAB, Version 5 User's Guide, The Matlab Curriculum Series, Prentice Hall, 1997.

Instructor: Christopher I. Byrnes, Edward H. and Florence G. Skinner Professor of Systems Science and Mathematics

Course Objectives: Course is designed to give students in engineering and science the ability to design continuous-time control systems using =feedback and feedforward control.

Prerequisites by topic:
1. Mathematics through differential equations
2. Laplace transforms and linear algebra

Topics Covered:

1. Introduction. Modeling systems. Examples of systems and feedback control. (2 lectures)

2. Dynamic behavior of systems. Ordinary differential equations. Stability. (3 lectures)

3. Linear systems. The matrix exponential. Input/output response. (3 lectures)

4. State feedback. Reachability. Pole-placement and stability by state feedback. State feedback design. (4 lectures)

5. Output feedback. Observability. Observers and state estimation. The separation principle. Output feedback design. (4 lectures)

6. Transfer functions. Laplace transforms. The frequency response. The Bode plot. (3 lectures)

7. Frequency domain analysis. The closed-loop transfer function. The Nyquist plot. Stability margins. Minimum phase systems. Root-locus plots. (4 lectures)

8. Frequency domain design. PID controllers. Lead and lag compensators. Feedforward design. (4 lectures)

Class/Lab Schedule: 2 sessions; 90 minutes per session

Tests: 2 in-class exams, 1 final exam and homeworks.

Computer Usage: Use of MATLAB computer program as a tool in solving design problems (root locus, frequency response, state-space analysis, state-variable feedback, state estimation).

Laboratory: None

Contribution of Course to Meeting the Professional Component:

Math and Basic Sciences:	0 credits or 0%
Humanities and Social Sciences:	0 credits or 0%
Engineering Topics:	3 credits or 100%
Engineering Science:	2 credits or 67%
Engineering Design:	1 credits or 33%

Relationship of Course to Program Outcomes:

(a) Ability to apply math, science, and engineering;
(c) Ability to design a system, component, or process to meet desired needs;
(e) Ability to identify, formulate, and solve engineering problems;
(k) Ability to use techniques, skills, and modern engineering tools in engineering practice;
(l) Preparation for participation in industry, academia, or governmental laboratories.

Prepared By: Christopher I. Byrnes **Prepared On:** 8/26/2008