MEM 355 Performance Enhancement of Dynamic Systems
MEM Department, Drexel University (Spring 2007)

2000 Catalog Data: *Prerequisite MEM 255*. Covers design of automatic control system to achieve stability and desired performance; concepts of controllability, observability, and feedback; system stability analysis; Nyquist stability criterion; system compensation techniques; state-space design of controllers; computer-aided design of feedback controllers and computer simulation. *4-0-4*.

Instructor: **Professor H. G. Kwatny** Office: 151-A Tel: 895-2356 e-mail: hkwatny@coe.drexel.edu URL: http://www.pages.drexel.edu/faculty/hgk22

Textbook & Software: S. Nise, Control Systems Engineering, 4^{th} ed., J. Wiley & Sons, 2004.

The MathWorks, Inc. The Student Edition of MATLAB, Version 5.3, Prentice-Hall,2000.

Topics: Introduction & Review (Laplace Transforms & Transfer Functions (2.1-2.3), State Space (3.1-3.4), State Space ⇔ Transfer Function (3.5-3.6), Time Domain Analysis: modal analysis, poles & zeros (4.1-4.11), stability (6.1-6.5))

Steady-State Errors (7.1-7.7)
The Root Locus Method (8.1-8.10)
Design via Root Locus (9.1-9.5)
Frequency response TF & Bode Plots (10.1-10.2)
Nyquist Theorem (10.3-10.5)
Gain & Phase Margin (10.6, 10.7)
Design via Frequency Domain (11.1, 11.5)
State Space Design: Controllability & Pole Placement (12.1-12.4)
State Space Design: Observability & Observers (12.5-12,6)

Goals: 1. Define the control system design problem and develop a preliminary appreciation of the tradeoffs involved and requirements for robust stability and performance.

2. Develop concepts and tools for ultimate state error analysis.

3. Develop the relationship between time domain and frequency domain performance specifications, e.g, rise time, overshoot, settling time, sensitivity function and bandwidth.

4. Develop frequency domain design methods, including: the root locus method, Nyquist & Bode methods, and stability margins.

5. Provide an introduction to state space design: controllability and obervability, pole placement, design via the separation principle (time permitting).

6. Emphasize computational methods using MATLAB.

Computer Usage: MATLAB

ABET Category: Engineering Science: 25 %
Engineering Design: 75 %

Prepared by: H. G. Kwatny

MEM 355 - Performance Enhancement of Feedback Systems

Table B.3.5 on page 30 of the ME Program Self-study

0 = No content; 1 = Some content; 2 = Significant contents

Criteria a-k	Con-tent	Explanation	Evidence
a. An ability to apply knowledge of mathematics, science and engineering.	**2**	This course requires the students to design control systems that alter system behavior via feedback. They need to work with mathematical abstractions and translate results into the physical world. They use mathematical tools like Nyquist analysis, Bode plots and root locus.	Textbook, Notes (download from website), Homework, Exams, Projects
b. An ability to design and conduct experiments as well as to analyze and interpret data.	**0**	N/A	
c. An ability to design a component or process to meet desired needs.	**2**	Students learn how to formulate performance measures for closed loop processes and to design compensators to meet specified objectives.	Textbook, Notes, Homework, Exams, Projects
d. An ability to function on multidisciplinary teams.	**1**	Students are encouraged to work in small groups on project assignments that involve multidisciplinary skills.	Projects
e. An ability to identify, formulate and solve engineering problems.	**1**	Design projects ask the student formulate and solve engineering problems.	Textbook, Homework, Projects
f. An understanding of professional and ethical responsibility.	**0**	N/A	
g. An ability to communicate effectively.	**1**	Students are assigned projects and need to produce written reports in which they describe their findings.	Project reports.
h. The broad education necessary to understand the impact of engineering solutions in a global/social context.	**0**	Contemporary control problems are discussed and how they arise from public safety or economic considerations.	Class discussion (power point)
i. A recognition of the need for and an ability to engage in lifelong learning.	**1**	The course emphasizes the historical development of the systems and control field, demonstrating the continuing evolution of theory and practice as driven by emerging technologies and societal demands.	Notes, Class discussion (power point)
j. A knowledge of contemporary issues.	**0**	Contemporary issues that involve control systems are discussed, e.g., flight safety, automobile stabilization, nuclear plant safety, power plant emissions, satellite communications.	Class discussion (power point)
k. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.	**2**	Students are required to use MATLAB for solving project assignments. Additional functionality is introduced. Graphical tools are emphasized for interpreting and reporting results.	Homework, projects