ME450
MODELING OF DYNAMIC SYSTEMS
(Spring 2008)
www.mne.psu.edu/chang/me450

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PREREQUISITES: ME 370, ME 345, CmpSc 201

TEXT: Dynamic Modeling and Control of Engineering Systems, 3rd Ed. by Kulakowski, Gardner and Shearer, Cambridge University Press, 2007.

GRADING:	Homework	35%
	Group Computer Project (2 per group)	15%
	Midterm Exam	25%
	Final Exam	25%

Minimum exam-score requirement:
Either the average in the two exams must be above 50% or must not be 20 points below the class exam-average, or
One of the exam scores must be above 60% or must not be 10 points below the class exam-average, ***and*** *the average in the two exams must be above 45%.*

LEARNING OBJECTIVES:

1. *Use the modeling concepts and techniques presented in class to model various engineering systems*
2. *Solve the model equations analytically and/or using Matlab/Simulink*
3. *Relate the solution of the model equations to the physical response of the system*
4. *Understand the Laplace transform of linear time-invariant (LTI) ordinary differential equations and the concept of transfer functions. Perform frequency-response analyses for LTI systems.*
5. *Understand the concept of feedback control. Perform design/analysis calculations for basic feedback control systems*

Lecture No.	Topic	Reading Material	Suggested Problems
1-2	Introduction, Dynamic systems	Ch. 1	Probl. 1.1-1.3
3-5	Linearization		Probl. 2.8
6-7	Mechanical Systems	Ch. 2	Probl. 2.10
8-9	Input-Output Models	Ch. 3	Example 3.1-3
10-11	State Models	Ch. 3	Probl. 3.3
12	Simulation Block-Diagram Models	6.1-6.3	
13-14	Analytical Solution of Input-Output Models. First Order Models	4.1-4.3	Probl. 4.1a,b
15-18	Second Order Models	4.4	Probl. 4.2, 4.8-4.11
19	Third and Higher Order Models	4.5	Probl. 4.12
20-22	Numerical Solution of State Models	5.1-5.5	Probl. 5.5
Midterm exam		***March 6, 7:00-8:50pm, 026 Hosler***	
23	Computer Simulation Program	Ch. 6	Read Chapter 6 and Appendix 3
24-26	Electrical Systems	7.1-7.4	Probl. 7.5, 7.6
27-28	Hydraulic Systems	9.1-9.3	Probl. 9.1, 9.5
29-31	Mixed Systems	Ch. 10	Probl. 10.4, 10.5
32-34	Transfer Functions	Ch. 11	Probl. 11.6,11.7 Read Appendix 2
35-37	Frequency Response	Ch. 12	Probl. 12.4,12.6
38-41	Control systems	Ch. 14	Probl. 14.2,14.6-7
42-45	System Stability	13.1-13.5	Probl. 14.1,13.4 13.6,13.8
Final exam			

Course Objectives:

1. To model various engineering systems, including mechanical, electrical, thermal and fluid systems and their combinations (mixed systems).
2. To solve the model equations analytically and/or numerically using Matlab/Simulink.
3. To relate the solution of the model equations to the physical response of the system.
4. To acquire basic control concepts with working knowledge on transfer function, frequency response, system stability and steady-state error.
5. To perform basic design/analysis of control systems.

Course Learning Outcomes: After completing this course, students should be able to

1. Recognize energy storing elements in an engineering system and choose appropriate state variables.

2. Develop ordinary differential equations (ODEs) that describe the dynamic behavior of lumped parameter systems including mechanical, fluid, thermal and electrical elements.

3. Analyze nonlinear systems by local linearization around nominal operating points.

4. Draw system block diagrams from the system equations and vice versa: write system equations from block diagrams.

5. Analytically solve linear ODE's for responses to initial conditions and to given excitations such as a step input.

6. Evaluate system performance in terms of “time constant” for first-order linear time-invariant systems (LTIs) and “damping ratio” and “natural frequency” for second-order LTI systems. Understand how to estimate the asymptotes of high-order LTI systems

7. Understand numerical methods of solutions to ODEs. Use Matlab/Simulink to implement various system models.

8. Understand the Laplace transform of linear ODEs and the concept of transfer functions. Perform frequency-response analyses for linear systems.

9. Understand the basic concepts of feedback control. Determine system stability and stability limits for certain classes of feedback systems.

10. Perform design/analysis calculations for basic linear-feedback control systems. Understand the objectives and functions of proportional (P), integral (I), and derivative (D) feedback controls. Design PID feedback controllers for simple linear systems.