Required for Mechanical & Aerospace Engineering

MAE106: Mechanical Systems Laboratory
Winter Quarter 2005

Catalog Data: MAE106 Mechanical Systems Laboratory Units: 4
Experiments in linear systems, including op-amp circuits, vibrations, and control systems. Introduction to digital sampling concepts. Emphasis on demonstrating that mathematical models are useful tools for analysis and design of electro-mechanical systems.
Prerequisites: MAE140 or MAE147; ECE72
Course Overlap: MAE170 provides control theory useful for this course
Cross Listed Course(s): none
Restrictions: none
(Design Units: 2)
Lecture Location: PSCB 120, Tues Thurs 3:30-4:50 Lab Location: EG2102

Textbook: Modern Control Engineering, Fourth Edition, Katsuhiko Ogata, Prentice Hall, 2002

References: Supplemental course notes will be at the Engineering copy center ET203. Course Web Site: http://www.eng.uci.edu/~dreinken/MAE106/mae106home.htm

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Goals: This course covers theory and experiments on motor control systems, electrical filters, amplifiers, structural resonance and vibration. These topics are important for building robots, mechatronic devices, and structures. These systems will be described by linear, ordinary, differential equations. A key goal of the class is to use these equations to predict, understand, and control the behavior of machines.

Prerequisites by Topics: Introduction to Engineering Analysis II (MAE140)
Vibrations (MAE147)
Network Theory and Operational Amplifiers (ECE72)

Lecture Topics:
Week 1 (1/6): No lab scheduled
Lecture 1: Overview, Design Exercise, Review of Circuit Analysis
Reading: Section 3-8
Week 2 (1/11): Lab 1: Laboratory Tools and Motor Control
Lecture 2: Time and Frequency Domains
Lecture 3: First-Order Systems: DC Motors and Electrical Filters
Reading: Chapter 2, Sections 3-1, 3-2, 5-1, 5-2
Week 3 (1/18): Lab 2: Electrical Filters and First-Order Systems
Lecture 4: Lab 1 Quiz; Introduction to Control Theory
Lecture 5: Example of Feedback Control: P-type Velocity Control of a Motor
Reading: Chapter 1, Section 3-3
Week 4 (1/25): Lab 3: Feedback I: P-type Velocity Control of a Motor
Lecture 6: Lab 2 Quiz; Second Order Systems: Time domain
Lecture 7: Second Order systems: Frequency domain
Reading: Sections 5-3, 8-1, 8-2
Week 5 (2/1): Lab 4: Vibration I: Lightly Damped Second Order Systems
Lecture 8: Lab 3 Quiz and Midterm
Lecture 9: PD Motor Control
Reading: Section 5-8
Week 6 (2/8): Lab 5: Feedback II: P and PD Motor Position Control

Lecture 10: Lab 4 Quiz; Systems with Two Modes of Vibration
Lecture 11: Design of a Vibration Isolator
Reading: Class Notes
Week 7 (2/15): Lab 6: Vibration II: System with Two Masses
Lecture 12: Lab 5 Quiz; Advanced Control
Lecture 13: Advanced Control
Reading: Class Notes
Week 8 (2/22): Lab 7: Advanced Control
Lecture 14: Lab 6 Quiz and Design Exam
Lecture 15: Design Exam Review
Week 9 (3/1): No Experiment This Week
Lecture 16: Lab 7 Quiz/ Final Project Discussion
Lecture 17: No Class
Week 10 (3/8): Lecture-free week for working on final projects
Week 11 (3/15): Finals Week – final project contest on day of scheduled final

Computer Usage: For laboratory write-ups and data acquisition.

Laboratory Projects: **Laboratory Location:** Engineering Gateway 2102

Laboratory times:
Section A: Tues 11:00-01:50
Section B: Tues 06:00-08:50P
Section C: Wed 04:00-06:50P
Section D: Thurs 06:00-08:50P
Section E: Friday 10:00-12:50

Laboratory Exercises: Handouts that describe the experiments will be made available on the course web site, along with their solutions. You should work through the lab, referring to the solution. The solution is provided to relieve time pressure and to act as a "consultant" if you get stuck. You can also ask the TA for help if you are confused. Be creative, explore, and have fun in the lab. This is your opportunity to build things that move and see how they work.

Lab Pre-Quizzes: There will be a brief quiz at the beginning of each lab testing whether you have read the experiment handout before coming to laboratory.

Lab Write-Up: Each student will be required to turn in a brief write-up for the lab. The write-up must be typed. You must use a computer graphing program (e.g. Microsoft Exel or Matlab) for all graphs. Zero credit if you don't do this!

Lab Post-Quizzes: There will be a 30-minute quiz in lecture the Tuesday following each laboratory.

Final Project There will be a final project competition involving the design and head-to-head testing of a robotic device. The final project tournament will take place on the day of the scheduled final exam, and will replace the final exam. There will be a write-up due on the day of the final project.

Design Content Description: This course requires solution of design problems related to control and vibration, as well as design and construction of a robotic device for the final project.

Grading Criteria: The grading scale will be:
Lab Pre-Quizzes: 7%
Lab Post-Quizzes: 14%
Lab Write-Ups: 14%
Mid-term exam: 20%
Design exam: 20%
Final project: 25%

Estimated ABET Category Content:

Engineering Science:	2	credits or	50%
Engineering Design:	2	credits or	50%

Prepared by: Prof. David Reinkensmeyer **Date:** 1/6/05