Department of Mechanical Engineering
Massachusetts Institute of Technology
2.14 Analysis and Design of Feedback control Systems
Fall 2004
General Information

Instructor:

Prof. David Hardt (hardt@mit.edu) Rm 35-231 x3-2252
Office Hours Monday 2-4 and other times by appointment

Lab TA

Katie Lilienkamp (gonzo@mit.edu) Rm 3-029 x3-2319

Course Secretary

Catherine Nichols (cln@mit.edu) Rm 35-231 x8-5622

Schedule

Lectures	Room 1-273	Monday, Wednesday 11-12:30pm
Labs	Room 1-110	to be arranged
Tutorials	to be arranged	

Quizzes

We will have two quizzes, each covering the material up to the last assignment before the quiz. All will be open book and notes. Questions regarding quizzes (grading, etc.) should be directed to Prof. Hardt.

Design Project

There will be a final project due at the end of the term. It will involve work of groups of 2-3 students and a formal presentation of the results will be required in lieu of a final.

Assignments

We will have about one assignment per week based on the prior weeks readings and lectures Solutions will be available after the assignments are handed in. Assignments will be graded.

Laboratories

There will be 9 Labs (2 hrs each) with times to be arranged. Lab groups of 2-3 people will be organized. Lab reports will be due at the end of each session.

Please note: the Labs are not optional.

Textbook:

Control Systems Engineering 4th Edition, by Norman Nise, ISBN 0-471-44577-0 - Ordered and Available at Quantum Book in Kendall Square

Grading

Quizzes	40%
Assignments	20%
Labs	20%
Final Project	20%

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Design Project

The purpose of the end of term design project is to allow groups of two to explore a problem that interests them, and to complete a complete control system design (on paper) for that problem. This will involve:

- Learning about the problem and formulating a control system design goal
- Creating a model of the system that can be analyzed with linear system methods
- Exploring several alternative designs based on each of the techniques covered in class
- Predicted performance and linear simulation for verification
- Consideration of non-ideal performance, and simulation with this included
- Reduction to a discrete design form for implementation on a digital controller. Analysis of overall engineering considerations such as: hardware selection, power requirements, and safety considerations.

Project Selection

Early in the term the groups should form, and begin looking for problems of interest. We are available to discuss your ideas and help guide you to a feasible problem. All groups must submit a proposal and design plan that must be approved before you begin.

We can suggest problems for you to consider as well. Some examples could include:

- Instrument cooling system
- IC engine combustion control
- Active suspension systems
- Segway scooter controller
- Heavy Equipment motion controller
- Atomic force microscope control
- …
- Auto speed regulator
- CD player tracking controller
- Temperature distribution controller
- Hydraulic robot
- Mag-lev train Suspension System
- Active sway control in buildings

Requirements

- Form groups early in term
- Group writes proposal
- Proposal is reviewed and critiqued for approval by November 17, 2004
- Minimum of one consultation during the final lab periods for each group.
- Groups effort and grade
- Written engineering report with all analyses data, simulations and discussion
- Ten Minute formal presentation to class
- Evaluation of other groups work based on presentation

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DATE		LEC	TOPIC	READING in Nise	ASSIGNMENTS	Assignment Topics	LAB
8-Sep	W	1	INTRODUCTION	Chapter 1	1 Out	1	
13-Sep	M	2	LINEAR SYSTEM REVIEW - SYSTEM MODELING	Chapter 2		2	LAB 1
15-Sep	W	3	LAPLACE TRANSFORM AND TRANSFER FUNCTIONS	Chapter 2	1 Due 2 out	2	Familiarization
20-Sep	M	4	TIME RESPONSE OF TRANSFER FUNCTIONS	Chapter 4		3	LAB 2
22-Sep	W	5	FREQUENCY RESPONSE OF TRANSFER FUNCTIONS	10.1 & 10.2	2 Due 3 out	3	Plant characterization
27-Sep	M	6	CLOSED- LOOP BLOCK DIAGRAMS	5.1 - 5.3		4	LAB 3
29-Sep	W	7	LINEAR STABILITY	6.1-6.4	3 Due 4 out	4	Proportional Velocity
4-Oct	M	8	STEADY STATE ERRORS AND CONTROLLER DESIGN	7.1-7.7		5	No Lab
6-Oct	W	-	QUIZ 1 - THROUGH LECTURE 7			-	
11-Oct	M	-	COLUMBUS DAY - NO CLASS			-	LaB 4
13-Oct	W	9	ROOT LOCUS METHOD	Chapter 8	4 Due 5 out	5	Position Control with Velocity Feedback
18-Oct	M	10	ROOT LOCUS DESIGN	Chapter 9		6	Lab 5
20-Oct	W	11	CASE STUDY IN RL DESIGN		5 Due 6 out	6	Controller Design
25-Oct	M	12	CLOSED-LOOP FREQUENCY RESP0NSE	10.8-10.11		7	LAB 6
27-Oct	W	13	NYQUIST STABILITY & GAIN AND PHASE MARGINS	10.3-10.7	6 Due 7 out	7	Frequency Response Measurement
1-Nov	M	14	DESIGN WITH FREQUENCY RESPONSE	Chapter 11		8	Lab 7
3-Nov	W	15	CASE STUDY IN FREQUENCY RESPONSE DESIGN		7 Due 8 out	8	PI Velocity control
8-Nov	M	16	SAMPLING AND DISCRETE SYSTEMS	Chapter 13		9	Lab 8
10-Nov	W	17	Z-TRANSFORM AND Z-PLANE ROOT LOCUS	Chapter 13	8 Due 9 out	9	PID Position Control
15-Nov	M	-	QUIZ 2 THROUGH LECTURE 16			-	Lab 9
17-Nov	W	18	CASE STUDY IN DIGITAL DESIGN		Friday 19-Nov 9 Due 10 Out	10	System Identification
22-Nov	M	19	STATE SPACE MODELS	Chapter 3		10	No Lab
24-Nov	W	20	STATE SPACE ANALYSIS	Chapter 3	Project Start 10 Due	-	Thanksgiving
29-Nov	M	21	STATE SPACE DESIGN via Pole Placement	Chapter 12		-	LAB 10
1-Dec	W	22	CASE STUDY IN STATE SPACE DESIGN			-	Project Consultations
6-Dec	M	23	DESIGN PROJECT PRESENTATIONS			-	No Lab
8-Dec	W	24	DESIGN PROJECT PRESENTATIONS			-	