MEMS 507 Process Modelling and Control
Spring 2021

Prof Gevelber, Mechanical Engineering

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Office Hours: by appointment. Please take advantage to ask questions, that's what I'm here for. Easy to arrange a zoom meeting.

Course Goal: This course provides an integrated study of physical system dynamics, control concepts, and process design. The goal is to deepen student's physical intuition as well as learning how to determine the appropriate roles for changing the system design and adding closed loop control. Case studies are used to examine the opportunities for developing new process capabilities and products. Examples are drawn from a variety of applications including welding, MEMS, CD manufacturing, thermal processing, film deposition for electronics, optics, energy applications, robotics, biomedical applications and high speed machining.

Requirements and Grading

Homework (20%). Typically due on Wednesday. Solutions will be posted, so late home works will not be accepted [unless medical or other excuse]. **Please bring questions to class on Mondays!** While you can discuss problems and class material with other students, your homework write up should be your own.

Two quizzes (20% each) and take-home at the end of term (35%)

Project (5%)

Project: I'm looking for you to analyze a process you choose from the perspective of the course. (Teams of two are acceptable.) Ideally, it will be a process that can yield a significant competitive advantage if developed and/or improved. However, working on something that you are familiar with is acceptable. I will be glad to discuss options.

Your project should include a description of the processing objectives/performance benchmarks, important process physics/dynamics, control objectives, design options, and possible control strategies. Detailed analysis of the system is not required (i.e. this should be descriptive and not quantitative). **A one paragraph outline of your project is due the 5th session**. You will present your project the last 2 classes of the term. This is a chance to reinforce the relevance of the course to your own work.

You must provide an extended outline, including sources by the 14th class.

Matlab will be used to assist in dynamic simulations, controls analysis, processing, linear algebra, and graphics (it also has other great tools/applications).

Texts:

Introduction to Physical System Dynamics, R. Rosenberg and D. Karnopp, McGraw Hill, 1983. (RK)

Notes from N. Hogan and M. Athans (to be supplied in class).

Control Text: you should have a intro control text such as

Control System Design and Simulation, J. Golten and A. Verwer.

Modern Control Engineering, K. Ogata, Prentice-Hall: The bible, has worked problems.

Feedback Control of Dynamic Systems, G.F. Franklin,
et.al., Addison-Wesley: Nice treatment of mechanical systems
for both classical and some modern approach

Feedback Control Systems, Phillips & Harbor, Prentice Hall.

Automatic Control Systems, B. C. Kuo, Prentice Hall. Verbose, but has it all.

Class	Date	Topic	Notes	Homeworks
1	25-Jan	Intro/Overview		
2	27-Jan	Bond Graph Intro	**HP discuss**	
3	1-Feb	Mech-Elec Syst	**Minds Eye discuss**	
4	3-Feb		**Pilkington Case**	Hmk 1 due
5	8-Feb	Equation Derivation	**Project outline due**	
6	10-Feb			Hmk 2 due
7	16-Feb	Fluid-Thermal syst		
8	17-Feb			Hmk 3 due
9	22-Feb	Applications	Case Study	
10	24-feb			Hmk 4 due
11	1-Mar	Intro Dynamics		
12	3-Mar	**Quiz 1: modeling**		
13	Mar 8	SS to TF	**Ext. Proj Outline**	
14	10-Mar			Hmk 5 due
15	15 Mar	Phys Syst Dynamics		
16	17-Mar			Hmk 6 due
17	22-Mar	Frequency Domain		
18	24-Mar	JHT/accel ex		Hmk 7 due
19	29-Mar	Rel. freq. To time.		Hmk 8 due
	31-Mar			
20	5-Apr	Control Intro		
21	7-Apr	**Quiz 2: dynamics & control**		
22	12-Apr	CL freq anal/design		
23	14-Apr	**Actuator selection**		Hmk 9 due
24	21-Apr		**Take-home out**	
25	26-Apr			Hmk 10&11
26 27	28Apr	**Project Presentations**	**Project Presentations**	
		Finals (5/4-5/8)	**Take-home due 5/5 5pm**	