# ME 507 Process Modelling and Control
# Spring 2020

**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.

**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, and energy applications, robotics, biomedical applications and high speed machining.

**Requirements and Grading**

Homework (20%) . Due on Thursdays. Solutions will be handed out, so late home works will not be accepted [unless medical or other excuse]. **Please bring questions to class on Tuesdays!** 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 5$^{th}$ 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). DL students will need a ACS account and be able to logon to the campus computers via VPN. On campus student will use Matlab on ACS.

**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 | 22-Jan | Intro/Overview | | |
| 2 | 27-Jan | Bond Graph Intro | **HP discuss** | |
| 3 | 29-Jan | Mech-Elec Syst | **Minds Eye discuss** | Hmk 1 due |
| 4 | 3-Feb | | **Pilkington Case** | |
| 5 | 5-Feb | Equation Derivation | **Project outline due** | Hmk 2 due |
| 6 | 10-Feb | | | |
| 7 | 12-Feb | Fluid-Thermal syst | | Hmk 3 due |
| 8 | 18-Feb | "Mondays class" | | |
| 9 | 19-Feb | Applications | Case Study | Hmk 4 due |
| 10 | 24-Feb | | | |
| 11 | 26-Feb | Intro Dynamics | | Hmk 5 due |
| 12 | 2-Mar | | | |
| 13 | Mar 4 | **Quiz 1: modeling** | | |
| | Mar 9-13 | Spring break | ---------- | ---------- |
| 14 | 16- Mar | SS to TF | **Extended Project Outline Due** | |
| 15 | 18-Mar | Dynamics of Phys Syst | | Hmk 6 due |
| 16 | 23-Mar | | | |
| 17 | 25-Mar | Frequency Domain | | Hmk 7 due |
| 18 | 30-Mar | JHT/accel ex | | |
| 19 | 1-Apr | Rel. freq. To time. | | Hmk 8 due |
| 20 | 6-Apr | Control Intro | | |
| 21 | 8-Apr | **Quiz 2: dynamics & control** | | |
| 22 | 13-Apr | Root Locus | | |
| 23 | 15-Apr | CL freq anal/design | | Hmk 9 due |
| | 20-Apr | No class | | |
| 24 | 22-Apr | **Actuator selection** | | Hmk 10 due |
| 25 | 27-Apr | **Project Presentations** | **Take-home out (due 5/4)** | |
| 26 | 29-Apr | **Wrap-up** | | Hmk 11 due |
| | | Finals (5/5-5/9) | **Take-home due 5/4 4pm** | |