ENG ME 507/MS 507 Process Modeling and Control

2008-2009 Catalog Data:
ENG ME 507/MS 507 Process Modeling and Control Prereq: ENG EK 307 and CAS MA 226 or equivalent coursework and permission of the instructor; senior or graduate standing in engineering. An introduction to modeling and control as applied to industrial unit processes providing the basis for process development and improvement. Major themes include an integrated treatment of modeling multidomain physical systems (electrical, mechanical, fluid, thermal), application of classical control techniques, and system design. Topics include modeling techniques, analysis of linear dynamics, control fundamentals in the time and frequency domain, and actuator selection and control structure design. Examples drawn from a variety of manufacturing processes and case studies. 4 cr.

Class/Lab Schedule: 4 lecture hours per week

Status in the Curriculum: Elective; Systems Elective in Manufacturing Program

Textbook(s) and/or Other Required Material: "Introduction to Physical System Dynamics", R. Rosenberg and D. Karnopp, McGraw Hill, 1983.
"Control System Design and Simulation", J. Golten and A. Verwer. 1991 McGraw Hill
Notes from N. Hogan and M. Athans, Case studies and additional readings
Recommended References: Feedback Control of Dynamic Systems, G.F. Franklin, et.al., Addison-Wesley:

Coordinator: Michael Gevelber, Associate Professor, Mechanical Engineering

Prerequisites by topic:
1. Senior or graduate standing in Engineering;
2. Circuits
3. Differential equations

Goals:
This course develops the knowledge base needed to improve and develop unique manufacturing capabilities as well as for new products. The course provides and integrated study of physical system dynamics, control concepts, and process design. The goal is to deepen students' physical intuition as well as learning how to determine the appropriate roles for changing the system design and adding closed loop control. Examples are drawn from a variety of applications including welding, MEMS, disk drives, CD manufacturing, thermal processing, film deposition for electronics and energy applications, robotics, biomedical applications and high speed machining.
Case studies are used to examine the opportunities for developing new process capabilities and products in a manufacturing enterprise.

Course Learning Outcomes:
As an outcome of completing this course, students will:

i. Develop an ability to model multi-domain physical systems for both product and process
ii. Develop an understanding of the fundamental dynamics of physical systems and relate to physical aspects of the system design, including coupling.
iii. Develop an understanding of how control can be used to improve performance both for product and process, meeting performance objectives and reduce variation.
iv. Develop an understanding of the performance trade-offs and opportunities for improvement through integrating system and control design.
v. Develop an ability to design both control system and system to meet performance objective.
vi. Develop an understanding of business issues related to both product and process development, conduct and present a case study of major course framework.

Course Learning Outcomes mapped to Program Outcomes:

Program:	**A**	**B**	C	D	E	F	G	H	I	J	K	L	M	N
Course:	i, iv	i, ii	v, vi, iii	vi	iii,v vi	vi	vi	vi		vi	i,ii,iii, iv, vi	i, ii, iii	i,ii,iii, iv,v	i,ii,iii ,iv,v
Emphasis:	5	3	3	2	4	2	3	2	1	3	4	4	5	5

Topics (time spent in weeks):
1. Modelling of physical systems: generalizable power basis for multi domain systems and equation derivation. (5)
2. Analysis of linear system dynamics, relation of dynamic characteristics to physical system characteristics. (4)
3. Control analysis and design: root locus, closed loop frequency analysis and design, actuator selection, relation of time and frequency domains. (4)
4. Manufacturing issues: case studies (rapid thermal wafer processing, design of ion etcher, Czochralski crystal growth, plasma spray), relation to SPC/Taguchi/closed loop control. (1)

Course Requirements:
1. Homework: weekly assignment that covers both example problems of the related course material, as well as more open ended design/analysis problems representative of real process problems.
2. Project: Students analyze a process from the perspective of the course that includes a description of the processing objectives/performance benchmarks, important process physics/dynamics, control objectives, design options, and possible control strategies.

Contribution of Course to Meeting the Professional Component:
Engineering topics: 100%

Status of Continuous Improvement Review of this Course:
Prepared by: Professor Michael Gevelber **Date:** 5/2/09