ENG ME 404 Dynamics and Control of Mechanical Systems
2008 – 2009 Catalog Data:

ENG ME 404 Dynamics and Control of Mechanical Systems Prereq: ENG ME 302 or consent of instructor. Modeling of mechanical systems. Introduction to theory of feedback and control. Performance and stability of linear systems. Design of feedback control systems. Practical applications. Includes lab. Cannot be taken for credit in addition to ME 403, ENG BE 402, or ENG EC 402. 4 cr.

Class/Lab Schedule: 4 lecture hours per week, 4 hour labs per semester

Textbook(s) and/or Other Required Material: K. Ogata, Modern Control Engineering, 4th ed., Prentice Hall, 2001

Coordinator: Pierre Dupont, Professor, Mechanical Engineering

Prerequisites by Topic:
1. Ordinary differential equations
2. Dynamics

Goals:
This course is designed to provide the student with the fundamental principles of the control of dynamical systems, with particular emphasis on mechanical systems.

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

i. Become proficient in the modeling of electromechanical systems - The first quarter of this class focuses on the generation and manipulation of mathematical descriptions of coupled electrical and mechanical system components. Linearization and simplification of system dynamics are introduced and students are thoroughly familiarized with Laplace transforms, transfer functions and block diagrams. (A, E, L)
ii. Become proficient in analyzing the performance of electromechanical systems - The concept of evaluating a system based on performance specifications is introduced. Techniques for evaluating time-domain performance in terms of stability, transient response and steady -state error are emphasized. Mastered techniques include root locus diagrams, the Routh-Hurwitz criterion, the Nyquist criterion, Bode plots and the placement of dominant poles. (A, E, L)
iii. Become proficient in the use of control analysis and design software - Use of the software package Matlab and its Control System Toolbox are required on almost all homework assignments. Students first learn each analysis technique by hand. They them learn to use the software to automate these analyses and apply them to systems more complicated than hand analysis would allow. Initial mastery by hand analysis leads to intelligent interpretation of computer output. (K, L)

iv. Become proficient in the design of basic controllers - Students learn design techniques for four basic controllers: PD, PI, phase lead and phase lag. Both time- and frequency -domain techniques are mastered, time permitting. The concept of relative stability is introduced. Students become capable of selecting and designing a controller based on system characteristics and performance specifications. (C, E, L, M, N)

Course Learning Outcomes mapped to Program Outcomes:
(For Program Outcomes, please see attached page or Department Web Site)

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

Topics (time spent in weeks):
1. Introduction to control (0.5)
2. The Laplace Transform and its properties (1)
3. Transfer functions and block diagrams (1)
4. Systems modeling and linearization (1)
5. Transient response of First- and Second-Order systems (1)
6. Basic controllers, stability and steady-state error (1.5)
7. Root-locus analysis and design (2.5)
8. Frequency-domain design (2.5)

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

Status of Continuous Improvement Review of this Course:
Date: April 16, 2009 **Reviewed by:** Structures-Dynamics Committee
Prepared by: Pierre Dupont **Date:** May 21, 2009