Electrical Engineering 402: Control Systems Theory

Course Description: 3 Cr. U/G Basic Control System Analysis with the use of time and frequency domain methods. Prereq: Jr St; ElecEng 234(P).

Textbook: Feedback Control of Dynamic Systems 3rd Ed., G. Franklin, J.D. Power and A Emani-Naeini, Prentice Hall.

Prerequisites by Topics:

- Concepts and analysis methods of the dynamics of simple mechanical systems
- Concepts and analysis methods of the dynamics of electrical circuits
- Analysis methods of first- and second-order differential equations
- Concepts and analysis methods of the Laplace transform
- Concepts and methods of linear algebra
- Concepts and methods of complex arithmetic
- Basic computer skills

Course Learning Outcomes:

- Students will be able to identify the inputs, outputs and major components of control systems.
- Students will be able to develop the governing differential equation and transfer function of 1st – 4th order electrical, mechanical, and electro-mechanical systems.
- Students will be able to determine the static and dynamic response of a system.
- Students will be able to apply the root locus method to design feedback control to achieve dynamic and static performance goals.
- Students will be able to use Matlab to analyze linear control systems.
- Students will be able to experimentally identify the dynamics of an electro-mechanical system.
- Students will be able to experimentally determine the performance of an electro-mechanical servo.
- Students will be able to design and experimentally implement a controller for an electro-mechanical servo.

Topics Covered:

- Laplace transform
- Control system description and block diagrams
- Dynamics of typical controlled systems
- Development and simplification of transfer functions
- Analytic tools for predicting system response and performance
- Root locus design techniques

Written Communications

- Laboratory reports. The format of the laboratory reports is quite open; the Style Guide provides that reports should be written as if by a consultant or subcontractor on a project, reporting to the prime contractor. Concise yet complete is the objective.

Laboratory

- Open-Loop and Closed-Loop Control

- Controller Performance versus Loop Gain
- A Dynamic Model and PI Control
- Frequency Domain Identification and PD and PID Error Responses
- Target Tracking

The laboratory is a major strength of the course. The use of system identification and introduction of controller design from the very first project are innovations to controls teaching (see attached article).

Class/Laboratory Schedule: 28 lectures, 8 discussion sections, 6 laboratory sections.

Contribution of Course to Meeting the Professional Component:

This course contributes to the engineering topics component of the curriculum, primarily in engineering science and design. Students learn fundamental engineering science concepts related to dynamics, Laplace transforms and systems theory, as well as specific engineering science concepts related to control systems analysis and design.

Relationship to Program Objectives:

Program Outcome	Explanation
i.	Students model dynamic systems and work with differential equations.
iii,iv.	Students analyze and design control systems, both on paper and on hardware.
v.	Students gain laboratory experience in system identification and controller design.
vi,vii.	Students use Matlab to analyze dynamic systems and design control.

Prepared by: Brian Armstrong, October 11, 2001.

Methods of Assessment:

- Prerequisite exam
- Graded homework
- Graded Laboratory Reports
- Graded examinations
- Course evaluation by students

Resources Commonly Available:

- Instructor
- Teaching assistant (discussion and laboratory sections)
- Matlab software
- Laboratory facilities in room Physics B47.

Desirable Student Competencies:

Required background provided by prerequisite course and by freshman and sophomore physics, and by CE 201 and CE 202 statics and dynamics courses.