ELEC3200 System Modeling, Analysis and Control

Course Description

This course introduces basic concepts, tools and techniques for modeling, analysis, and control of dynamical systems. The course starts from the use of differential equations to model continuous time systems. Examples from a variety of Electronic and Computer Engineering disciplines will be given to illustrate the modeling process. Then, basic tools needed for analyzing the behavior of dynamical systems will be presented. Finally, techniques for controlling their behavior will be introduced. Throughout the course, laboratory experiments demonstrating the use of these analysis/design tools will be included. *Exclusion(s):* CENG 4120, MECH 3610 *Prerequisite(s):* (ELEC 2100 OR ELEC 2100H) AND [MATH 2350 OR (MATH 2111 AND MATH 2351)]

List of Topics

Week 1	Introduction/examples/applications; state space models & linearization
Week 2	Laplace transform
Week 3	Transfer functions & dynamic response; transient & steady-state responses; DC gain & final value theorem
Week 4	Simplifying block diagrams, simulation and implementation; MISO/SIMO systems & modeling of closed-loop systems
Week 5	Modeling case studies: ball and beam system, inverted pendulum system; time-domain specification/2nd order systems
Week 6	Dominant poles/zeros, effect of extra poles/zeros, concept of stability & Routh-Hurwitz Criterion; Stability of closed-loop system (skip robust stability)
Week 7	Introduction to PID control and system type; pole placement design
Week 8	Controller design case studies: ball and beam system, inverted pendulum system
Week 9	Steady-state response, system type and internal model principle; undershoot/overshoot
Week 10	Time-domain signals, system norms and their computations; open-loop vs closed-loop control, Bode's sensitivity concepts
Week 11	Introduction to root-locus design method
Week 12	Lead and lag compensation
Week 13	General design guideline and case studies: Ball and Beam systems; Course review

Statement of Objectives/Outcomes:

On successful completion of this course, students will be able to:

CO1 - model simple dynamical systems using differential equations as well as understand the importance of the models in system analysis, synthesis, and simulation.

CO2 - manipulate the models of LTI systems in different forms, such as differential equations, transfer functions, and block diagrams, analytically and by CAD tools (such as MATLAB).

CO3 - understand feedback as a ubiquitous tool to control a system

CO4 - understand the importance of stability in a physical system and understand how to achieve stability using feedback control.

CO5 - complete a real feedback control task from modeling, controller design, simulation, and implementation using CAD tools (such as MATLAB).

CO6 - understand the robustness and performance issues in a control system and the ways to address these issues

Textbook(s):

L. Qiu and K. Zhou, *Introduction to Feedback Control*, Prentice Hall, 2009.

Reference:

K. J. Åström and R. M. Murray, *Feedback System: an introduction for scientists and engineers*, Prentice Hall, 2011

Relationship of Course to Program Outcomes:

Please refer to the Report Section 4.3.2 (iii).

Grading Scheme:

Homework	10%
Lab Reports	15%
Midterm Examination	25%
Final Examination	50%